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WEED INFESTATION OF WINTER WHEAT IN ECOLOGICAL AND CONVENTIONAL FARMING SYSTEMS

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Summary

The aim of this work was to investigate the influence of ecological and conventional farming system on weed seedbank in soil and actual weed infestation on winter wheat at selected agricultural farms in Sebechleby, Plavé Vozokany and Dačov Lom. At the co-operative Sebechleby were determined significant differences between higher weed seedbank in ecological (22 800 weed seeds per m^2) than in conventional system (6 600 weed seeds per m^2). Higher number of determined weed species was detected in weed seedstock in ecological system at Plavé Vozokany and Sebechleby. Dominant weed species in ecological system at all farms was *Chenopodium album L.*, with the share of 45,6 % (Sebechleby), 44,8 % (Dačov Lom) and 38,5 % (Plavé Vozokany). Before the harvest of winter7 wheat, the degree of weed infestation was almost equal in ecological system at all co-operative farms. Characteristics of ecological systems was occurrence of perennial species *Cirsium arvense*. In accordance with our expectation, higher degree of weed infestation was determined in ecological system.

Key words: ecological farming system, conventional farming system, weed seedbank, actual weed infestation

Introduction

Agricultural farmers, without differences are they ecological or conventional growers say that weed management is one of the biggest challenges they face.
Surface and subsurface weed seedbank in soil is a suitable indicator of weed flora in deferent farming and cultivation systems. Knowledge about weed seedbank gives us an evidence about crop cultivation in the past and at the same time it helps to set prognosis for the future.

Material and methods

The objectives of this study were to investigate the influence of farming system (ecological and conventional) on weed seedbank and actual weed infestation of winter wheat. Experiment were realised at agricultural farms in Sebechleby, Plavé Vozokany and Dačov Lom.

Table 1 Characteristics of regions

Agricultural farms	*Sebechleby*	*Plavé Vozokany*	*Dačov Lom*
altitude (m)	300	200	590
average temperature (˚C)	7,5	9,5	8,5
annual precipitation (mm)	674	534	713

Weed seedbank was determined in 1998 in the depth of 0,0-0,15 m according to the methodology of Hron and Kohout (1974), from monitoring places of the field plot in seven replicates. Actual weed infestation was determined in 1998 and 1999, two times during vegetative period (spring and summer aspect), in five replicates (1x1 m) which represented all parts of the field (middle, margins). Weed coverage was determinate by estimation method, species composition and number of weeds per m^2 by counting.

Results and discussion

The whole seedstock in the depth of 0,0-0,15 m of soil reached the highest rate 38 900 and 35 300 weed seeds per m^2 at the co-operative farm of Plavé Vozokany in both farming system (tab. 2). There were no significant differences between the systems at the farms of Plavé Vozokany and Dačov Lom. Significant differences were determined at the co-operative Sebechleby, with higher weed seedbank in ecological (22 800 weed seeds per m^2) than in conventional system (6 600 weed seeds per m^2). In our previous work, there were no significant differences between the system when using conventional soil cultivation. Minimum cultivation significantly rose up the weed seedstock in the soil (L.- Bartošová et al. 2000). Higher number of determined weed species in weed seedstock was detected in ecological system at Plavé Vozokany and Sebechleby, whereas at co-operative Dačov Lom the broader spectrum of weed species was detected in conventional system. Number of detected weed species in ecological system was equal at all cooperative farms and represented eight weed species. In conventional system number of weed species varied from six to ten. Dominant weed species in ecological system at all farms was *Chenopodium album L.*, with the share of 45,6 % (Sebechleby), 44,8 % (Dačov Lom) and 38,5 % (Plavé Vozokany). Second most important weed species were *Rumex crispus L.* and *Amarathus retroflexus L*. In conventional system dominant weed species at co-operative farm Sebechleby was also *Chenopodium album L.*, whereas this weed was the second most important at Plavé Vozokany and Dačov Lom. Here dominant weed species was *Amaranthus retroflexus L.* with the share of 53,5 % at Plavé Vozokany farm and 44,8 % at Dačov Lom. Similar soil cultivation in both farming systems at all agricultural farms caused no significant differences between vertical layout of seeds. Only at co-operative Sebechleby in conventional farming system where found differences i.e. highest number of seeds in the depth of 0,0-0,05 m.

Actual weed infestation and number of weeds per m^2 was the highest in the spring at co-operative farm Dačov Lom. At agricultural co-operative Sebechleby, only rare degree of weed infestation was determined in both system (table 3). Before the harvest of winter wheat, the degree of weed infestation was almost equal in ecological systems at all co-operative farms. A common characteristics of ecological systems was occurrence of perennial species *Cirsium arvense* and *Convolvulus arvensis L*. *Cirsium arvense* was the most dangerous weed species, with higher propagation before harvest of winter wheat than during the spring. In the summer aspect of observation the share of *Cirsium arvense* was 38,5 % at Sebechleby, 31,8 % at Plavé Vozokany and at Dačov Lom the share of both perennial weed species represented 38,4 %. In accordance with our expectation, higher degree of weed infestation was determined in ecological system. Only at co-operative farm Plavé Vozokany, higher degree of weed infestation was found out in conventional than ecological system in spring (before chemical or mechanical treatments), where dominant weed species where *Viola arvensis, Stellaria media, Lamium purpureum L., Anthemis arvensis L.*, all winter weed species with high competitive ability in winter cereals at the initial growth stages. Comparing two terms of observation, ecological farming system had better influence on competitive ability of wheat stand at co-operative Plavé Vozokany and Dačov Lom. Before harvest, at the co-operative Sebechleby was significantly higher level of weed infestation because of lower crop-weed competition in the spring.

Table 2 Number of weed seeds per m^2 in 1998 at co-operative farms

Weed species	***SEBECHLEBY***		***PLAVÉ VOZOKANY***		*Dačov Lom*	
	Eco. system(1)	*Con. system(2)*	*Eco. system*	*Con. system*	*Eco. system*	*Con. system*
AMARE	2300	1000	8100	20800	2300	10800
ATRPA	300	900	1200	1700	600	1400
CAPBP	-	-	200	-	-	100
CIRAR	-	-	500	-	600	-
CONAR	-	-	-	100	-	-
GALAP	-	-	-	-	-	100
CHEAL	10400	4100	13600	13200	9500	8600
PERMA	200	-	-	-	-	-
PLALA	600	400	-	-	600	100
RUMCR	100	100	6900	2600	4800	2000
SETPU	8800	-	-	-	-	-
STEME	-	-	4600	300	2400	400
TAROF	-	-	-	-	-	300
THLAR	100	100	200	200	400	300
Total	22800	6600	35300	38900	21200	24100

(1) ecological farming system, (2) conventional farming system

Table 3 Average number of weeds per m^2 in winter wheat in 1998 and 1999

Weed species	***Spring aspect***						***Summer aspect***					
	SEBECHLEBY		***PLAVÉ VOZOKANY***		***Dačov Lom***		***SEBECHLEBY***		***PLAVÉ VOZOKANY***		***Dačov Lom***	
	Eco.(1)	*Con.(2)*	*Eco.*	*Con.*	*Eco.*	*Con.*	*Eco.*	*Con.*	*Eco.*	*Con.*	*Eco.*	*Con.*
AMARE	-	-	-	-	-	0,5	-	-	-	-	-	-
ANTAR	-	-	2,0	3,7	18,2	4,9	13,1	-	-	1,4	4,3	2,2
APESV	-	-	-	-	-	-	1,4	-	-	-	2,2	0,8
ATRPA	-	-	-	-	1,2	-	-	-	-	-	0,3	-
AVEFA	-	-	-	-	2,1	0,6	-	-	-	-	-	-
BRAOL	-	1,6	-	-	-	-	-	-	-	-	-	-
CAPBP	-	-	0,3	0,7	0,3	0,1	-	-	-	-	0,6	0,2
CARDR	-	-	-	1,4	0,6	1,6	-	-	-	-	-	-
CICHI	-	-	-	-	0,1	0,2	-	-	-	-	-	-
CIRAR	4,7	-	3,0	3,4	0,1	0,2	11,2	0,2	4,2	3,4	4,9	1,5
CONAR	-	-	-	-	14,0	1,4	3,3	0,1	-	-	2,6	0,3
EROCI	-	-	-	-	0,2	-	-	-	-	-	-	-
EQUAR	-	-	-	-	-	-	-	-	-	-	0,1	0,4
FALCO	-	-	-	-	0,7	0,3	-	-	3,1	-	1,7	0,1
GAETE	-	-	-	-	-	0,1	-	-	-	-	-	-
GALAP	0,1	-	0,2	-	0,3	2,0	-	-	-	-	0,4	0,2
CHEAL	-	-	0,5	-	19,7	5,9	-	-	-	-	-	-
LAMPU	-	-	-	4,1	-	-	-	-	-	-	-	-
PAPRH	-	-	0,2	0,1	-	-	-	-	-	-	-	-
PERMA	-	-	-	-	13,6	0,6	-	-	-	-	-	-
POLAV	-	-	3,0	-	2,8	1,1	0,1	0,6	5,4	-	1,9	1,4
RAPRA	-	-	-	-	0,4	-	-	-	-	-	-	-
RUMCR	-	-	-	-	0,1	-	-	-	-	-	-	-
STEME	-	-	-	8,6	-	0,1	-	-	0,1	2,9	0,1	0,5
TAROF	0,1	-	-	0,2	-	-	-	-	-	-	-	-
VERAR	0,2	-	3,3	0,4	3,4	7,7	-	0,5	-	0,8	-	1,4
VIOAR	-	-	-	11,3	0,3	0,4	-	0,3	0,4	4,4	0,4	1,6
Total	5,1	1,6	12,5	33,9	78,1	27,7	29,1	1,7	13,2	12,9	19,5	10,6

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SUSTAINABLE CEREAL PRODUCTION IN HUNGARY

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Strongly simplifying we could distingues two agricultural models nowadays: conventional and alternative (sustainable). In the alternative agriculture we could reach the sustainability (from ecological, agronomical and economical aspects) by taking greater roles and advantages of the biological interactions and natural cycles that are already at work or available to work on the farm. Beacuse of the differences of ecological and economical circumstances there is no intrinsically correct way to proceed, so alternative (sustainable) agriculture requires different practices, methods, cropping systems etc.

The different agricultural models could be adequate individually from different aspects (agronomical, environmental, economical, social etc aspects). Although many production systems may pass the rigors of environmental protection, economic security and social acceptibility individually, few are satisfying all the facets necessary for a successful agriculture. Sustainable agriculture could be such an agricultural system.

In sustainable crop production it is very important to know precisely the agroecological conditions of crop management. Within that we have to study the climatic, soil, geographical conditions, we have to adapt the crop management to the agroecological conditions (site-specific models), and we want to avoid the environmental pollution in different agroecosystems. In the field of biological-genetic factors we have to improve the biodiversity, to breed new genotypes and we have to integrate the biological and agrotechnical elements (variety-specific technologies).

In sustainable agriculture we have to increasingly rely on the interactions among the different agrotechnical elements. The fertilization plays a central role in the agrotechnical elements of sustainable agriculture (direct and indirect effect of fertilization). Reducing external, industrial inputs is also an important issue.

In the sustainable agricultural system we have to improve the usage of interactions among agroecological, biological ang agrotechnical factors.

The crop quality and its improvement has also a central role in this system.

We have to keep in our mind that every production system should be economically viable which need some governemental and other market helps and preferences.

It is also very important that the society should accept the programme and methods of sustainable agriculture. It means not only an increasing and special demand of good quality and healthy food, but a special thinking of the majority of society concerning the farming practice (energy-saving, low-input methods etc.) and concerning the environmental protection (to avoid, not ameliorate the pollutions in the agroecosystems).

We are sure that we have to change our thinking about the principles of crop production (for example in wheat management). In the past we wanted to carry out, to make the optimum values of different agrotechnical factors, because our main aim was to obtain the maximum yield. The quality of crops had less importance. At present and in the future we want to carry out the necessary minimum values of many agrotechnical elements and to make optimum values of some critical factors (like fertilization etc.) to obtain optimum yield with good quality of crop products.

Theoretically in the sustainable crop management different technologies could be (extensive, low-input, mid-tech, intensive) but in our (Hungarian) conditions we can use widly two technologies: low input and mid-tech.

In our polifactorial research project we study the different crop management models in wheat production. The table 1. shows good results with the using of appropriate technological elements (in the cases of LISA and mid-tech [b] we got the same yields [7 t/ha] as in the case of intensive model). The economical efficiency and environmental pollution are strongly higher in intensive model, than in mid-tech or LISA models.

Table 1 Different crop management models in winter wheat production

Crop model	Forecrop	Genotype	Planting mode	Plant production	N-fert. (kg/ha)	Yield (kg/ha)	Yield difference	
							(kg/ha)	%
Extensive	w.wheat	Mv 15	normal	conventional	0+0	4217	0	100,0
LISA	peas	Fatima 2	new	env.friendly	30+0	6958	2741	165,0
Mid-tech(a)	w.wheat	Fatima 2	new	conventional	30+30	4912	695	116,5
Mid-tech(b)	peas	Mv 15	normal	env.friendly	30+30	6895	2678	163,5
Intensive(a)	w.wheat	Mv 15	normal	conventional	60+30	5470	1253	129,7
Intensive(b)	peas	Mv 15	normal	conventional	30+30	7017	2800	166,4

Among the production elements fertilization has central and integrated role on the increasement of agronomic and economic efficiency and on the environmental hazards and protection in wheat production. Our long-term experimental results pointed out that the average-yield without fertilization (control) was 4439 kg/ha and we obtained fairly good yield surplus (2162 kg/ha in average) with the application of optimum doses of NPK fertilizers (average yield was 6601 kg/ha). This good extra-yield was obtained on chernozem soil characterised by excellent natural physical, chemical and nutrient-supply characteristics.

In extreme (like continental) climatic conditions it is very important to reduce, to minimise the harmful climatic effects on crop (wheat) production. With the appropriate fertilization and the precise application of other agrotechnical elements we could reduce the unfavourable effects of ecological factors. Our scientific results pointed out that the optimum fertilization could increase the yield stability. In control treatment the fluctuation interval of yield was much higher (71 %) than in the optimum fertilizer application (48 %). The apprepriate fertilization could increase the water-utilisation of crops (wheat). In optimum fertilization the yield-surpluses per one unit precipitation in different periods of vegetation time were much higher comparing with control coefficients (in control 8-20 kg mm^{-1} rainfall, in optimum NPK doses 15-28 kg mm^{-1} rainfall).

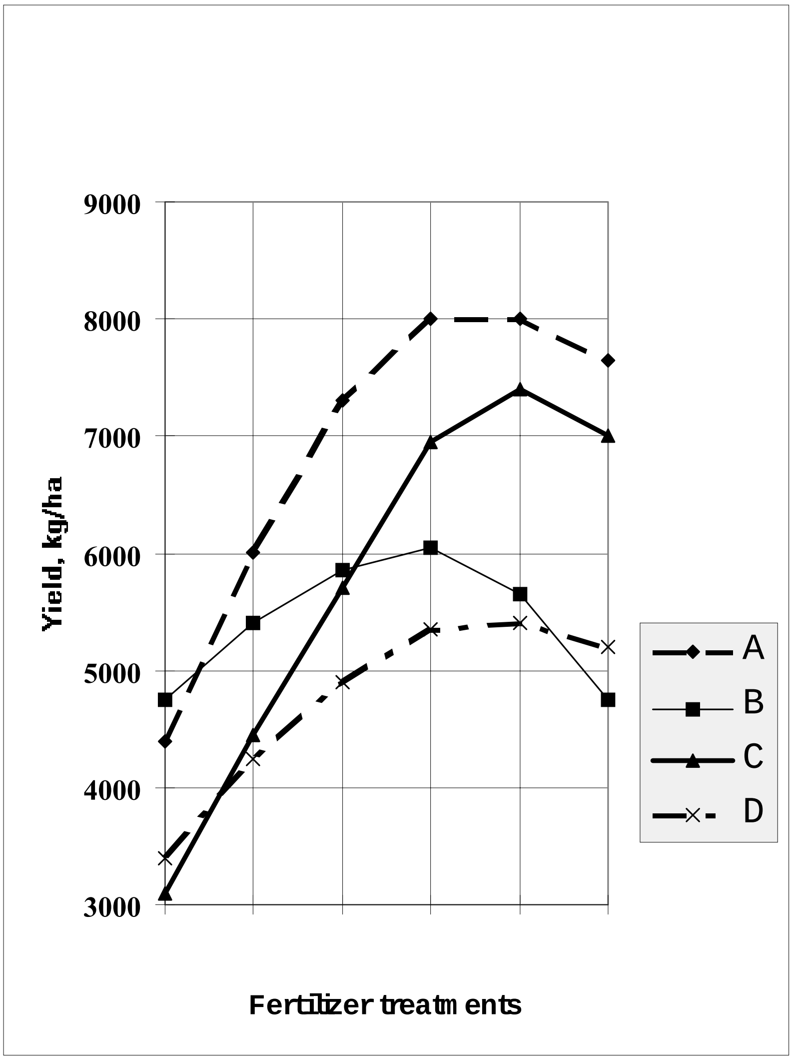
Our long-term experiments proved that the optimum doses of NPK fertilizers (mainly N) and the efficiency of fertilization were affected by not only ecological factors (cropyear, soil) but were strongly modified by agrotechnical elements.

In harmonised fertilization (NPK and others) the most important element is nitrogen because of its very active role in the physiological processes in plants and its special mineralizations in soils. Our long-term experimental results proved that the optimum N-doses varied from 60 kg/ha to 120 kg/ha on chernozem soil depending on cropyears, agrotechnical elements and genotypes. For the determination of fertilizer responses of different wheat genotypes we used the following parameters:

- natural nutrient utilisation (yields in control treatment)
- specific fertilizer utilisation (yield-increasement per unit NPK)
- maximum yield in optimum fertilizer treatment
- optimum fertilizer dose (N+PK)
- fertilizer response curves

Our long-term experimental data proved that on the basis of the nutrient-utilisation, -demand and fertilizer response of different winter wheat varieties the varieties can be divided into 4 types (figure 1.).
Type A is a modern genotype regarding fertilizer response (it combines extensive and intensive nutrient-utilisation traits), type B is an extensive genotype (it has strong very good utilisation of natural nutrient resources), type C is a traditionally intensive genotype (which means that this type needs bigger fertilizer doses) and type D is an out-of-date genotype (it could be characterised by weak natural nutrient utilisation and weak fertilizer response).
With the application of variety-specific fertilization we could increase not only the yield and agronomic efficiency of wheat production but we could manifest the quality-potential of genotypes.

Figure 1. Types of fertilizer response in winter wheat varieties (Peter Pepó, 1989, chernozem soil)



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BRADYRHYZOBIUM JAPONICUM STRAINS ACTIVITY UNDER DIFFERENT NH^{+}_{4} AND NO_3^- LEVEL IN NUTRITION MEDIUM

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Summary

The nodulating soybean isolines are capable obtain partial or complete N-fertiliser requirements through fixation of the atmospheric nitrogen. The symbiotic assimilation is strongly inhibited by high concentration N- compounds in soil and nodules are either absent or they are inactive. The plants were planted in greenhouse on 1/2, 1 fold and 3 fold N doses in Reid-York´s and Knop´s nutrient solution. The small plants were inoculation by 7 *B.japonicum* strains. 3 fold level of N in both forms (NH^{-}_{4} and NO_3^-) affected inhibition of nodulation. The tested strains reacted differently in nitrogenase activity, uptake amount of N, rate of growth and respiration rate in relation to level and form of N ions in solution.

***Key words*: soybean; *Bradyrhizobium* strains activity; NH^{-}_{4} and NO_3- level in nutrition medium, N_2 symbiotic fixation.

Introduction

Bradyrhizobium japonicum as a specific microsymbiont to soybean initially absent in Slovak soils, but usually survives well after introduction. Our recent results (Kubová et al., 1999), also Obaton (1996) show good survive and next high activity of B. japonicum in a field even 6 years after recent soybean planted.

The form of nutrition that plants prefer depends on environmental conditions and on the age of plants. Energy expenses to NH^{+}_{4} assimilation are lower than for other nitrogen forms, and represents more favourable source of nitrogen. However, it was found out that only nitrogenase activity has direct positive effect on the content soluble proteins and grain yield.

Nitrate reductase (NR, E.C.: 1.6.6.4) and nitrogenase (NG, E.C.: 1.18.2.1) co-exist in legume root nodules. Their activity decreases under conditions of high NH^{+}_{4} and NO^{-}_{3} concentration in nutrient medium (Caba et all. 1994).

B. japonicum strains differ in many parameters- compatibility to soybean cultivars, nodulation, symbiosis efficiency, sensitivity, or resistance to environmental factors.

The goal of this research was to find out the nodulation and metabolic activity of 6 *Bradyrhizobium japonicum* strains and their mix - Rizobin, their relationship to physiological processes of soybean plants under different level of N- nutrition and its form, to find out strains sensitivity and resistant to high level of N-nutrition.

Material and methods

Bradyrhizobium japonicum strains multiplied on peat substrate were obtained from collection of RIPP Praha - Ruzyně. Next strains were applied:D 216, D 536, D 538, D 574, D 575, D 597 and Rizobin.

The soybean seeds cv. *Maple Arrow* after disinfection by concentrated H_2O_2 were put on specific germinator. Small plants were transferred to plastic pockets with shutter that enabled to fix plant shoots. Before putting the plants into pockets their root system was dipped into responsible rhizobial preparation.

The plants were planted in greenhouse on half, I fold and 3 fold N doses in Reid-York´s (NH^{+}_{4} - ions) and Knop´s nutrient solution (NO^{-}_{3} - ions), plus control with distilled water. Nutrient solution and water were added according to the need of plants. The measurement of physiological and metabolic processes was done in V 3 stage according Fehr and Cavins scal.

The activity of nitrogenase (NG) was determined by the acetylene reduction assay on gas chromatograph Chrom . The growth characteristic of plants as a length of shoot and root, number of leaves, dry weight, protein content is result of interactive work of all factors and symbiosis efficiency. The respiration rates of leaves and roots were estimated by Warburg´s manometric method and calculated in $mm^3\ O_2.g^{-1}$ of dry matter.min^{-1}.

Results

The first nodules on root system appeared 35 days after inoculation. Amount of N taken up by plant during experiment is following: 15.6 mg N in the 1/2 level of NH_4^+ ; 15.1mg N in the 1/2 level of NO_3^- ; 30.0 mg N in the 1x level of NH_4^+ ; 21.8 mg N in the 1x level of NO_3^- ;61.06mg N in the 3x level of NH_4^+ ; 70.7 mg N in the 3x level of NO_3^-.

The differences are caused by need and ability of plants to uptake, transport and utilise N supplied in nutrient solution. High level of NH_4^+ caused consuming away of shoots. Influence of 3x level of NO_3^- was not as much drastic. We should assume that soybean is better adapted to higher level of NO_3^- in environment.

Nodulation is strongly influenced by N concentration in nutrition medium. 3 fold level of N in both forms ($NH_4^+$and NO_3^-) affected absolutely inhibition of nodulation (Fig.1). Half level of N in cation form stimulated nodulation. Very significantly reacts to it *B. japonicum* strains D_{216}, D_{597} and Rizobin. Even at anion N form were bacteria of Rizobin very virulent up to 1 x level of N. NO_3^- form in higher concentration is well accepted by D_{538} strain. Generally should be stated that for good nodulation and nitrogenase activity is more suitable 1/2 level of N in cation form (Fig 2). The tested strains reacted differently. At NH_4^+ form was the highest nitrogenase activity with strain D_{574} and Rizobin and in NO_3^- form was high activity even at 1 x level with strains D_{538}, D_{216} and Rizobin.

The respiration rate is not in realation to high activity of nitrogenase, growth and nodulation (Fig. 3, 4). The respiration rate was increased for roots and leaves at high N concentration. (3x level N H_4^+). It refer to metabolism disorders and destruction of organism structures.

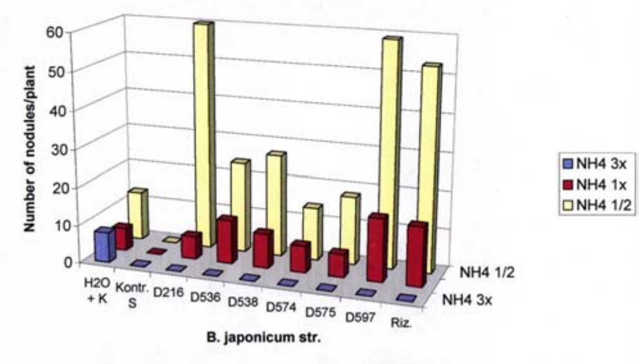

Figure 1: Number of nodules – ½, 1, 3x dose NH4+

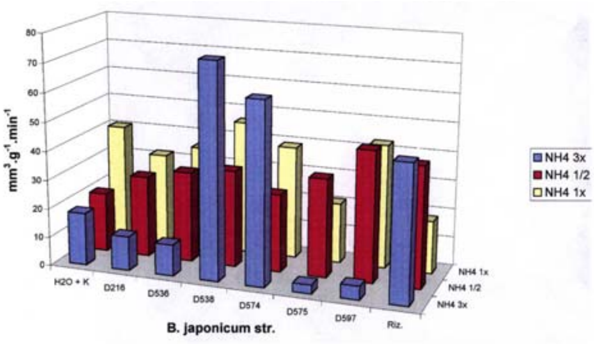

Figure 2: Nitrogenase activity – ½, 1, 3x doses NH4+

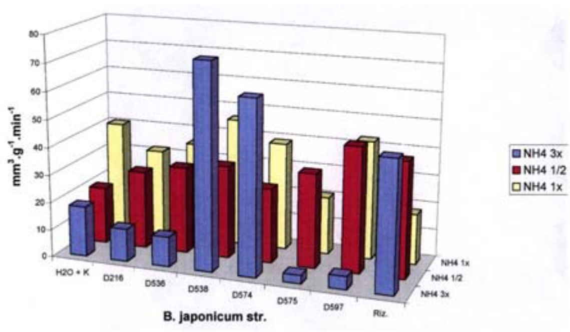

Figure 3:Respiration rate of shoots – ½, 1, 3x doses NH4+

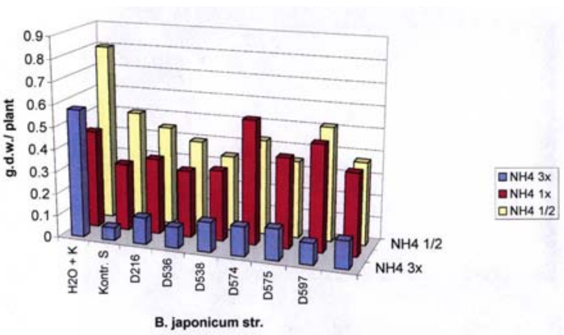

Figure 4: Dry weight of root – ½, 1, 3x NH4+

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SOIL MICROBIAL ACTIVITY UNDER DIFFERENT MANAGEMENT

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Summary

The effects of integrated (IS) and ecological (ES) management of soil on the biomass of microorganisms (C_{mic}) and dehydrogenase activity (DHA) were investigated in the period 1999-2000. The soils used were collected from a stationary experiment established in 1990 on gley brown soil at the Experimental Station of the Slovak Agricultural University, Nitra. For each field with a different structure of crops two fertilization treatments were used : (a) no fertilization and (b) use of manure for silage maize and, within IS, also mineral fertilizers for balancing. A higher amount of microbial biomass (C_{mic}) in terms of absolute values was noted for ES but without statistical significance. Cultivated crops and the timing of soil sampling were found to have the greatest effect on the parameters observed in individual experimental years and within the two systems of soil management.

Key words: soil microbial biomass, enzymatic activity of soil, dehydrogenase, integrated management of soil, ecological management of soil

Introduction

In the recent years many works have been published in which alternative and conventional systems are compared and evaluated from different aspects (Beyer et al., 1993; Kandeler et al., 1999). The most often used parameters which are used to assess the soil biological activity is an amount of microbial biomass (Šatrůčková, 1993), which is usually supplemented with determination of the enzyme activity (Šíša, 1993; Beyer et al., 1993). A choice of sensitive indicators of the soil quality reflecting the effects of soil management should also help those who cultivate soil and take an active part in sustainability of agro-ecosystems.

Material and methods

Within the stationary experiment established on gley brown soil, the effects of two systems of soil management, namely the integrated system (IS) and the ecological system (ES), on soil biological activity were observed in the above mentioned type of soil during the growing period of 1999 - 2000. The fields chosen from the experiment to study soil biological activity are given in Table 1. For each of these fields two treatments of fertilizing were used: (a) no fertlization and (b) organic fertilization using manure for silage maize and within IS, it was also supplemented with mineral fertilizers for the purposes of balancing. Soil samples were collected 5 - 6 times in a depth of 0 - 0.2 m during the vegetation period. After being passed through a 2 mm sieve, they were analysed for:

- basic soil characteristics: oxidizable organic carbon (C_{ox}), total nitrogen (N_t), pH active and exchangeable;
- biomass carbon of soil microorganisms (C_{mic}) (Vance et al., 1987);
- dehydrogenase activity (DHA) (Casida et al., 1964);

For the statistical evaluation of results, the χ^2 test of good conformity was used, then analysis of variance was used for comparing means of the basic set and Scheffe test for testing the differences in means (Stehlíková, work being at the printers).

Table 1 Crop rotation in chosen fields of integrated and ecological systems

Year	Integrated system			Ecological system		
	Field I	Field V	Field VII	Field II	Field V	Field VII
1999	bean + alfalfa	spring barley	winter wheat	bean + alfalfa	pea	winter wheat
2000	Alfalfa	winter wheat	silage maize	Alfalfa	silage maize	pea

Results and discusssion

One of the parameters which is most often studied for the purposes of evaluating the biological status of soil is an amount of microbial biomass

Table 2 Basic soil characteristics within the integrated and ecological system soil management (average values)

Soil Management	Year	C_{ox} [%]	N_t [%]	$pH_{(H2O)}$	$pH_{(KCl)}$	C_{mic}	DHA
IS+ fert.a	1999	1.21	0.138	6.62	5.32	168.17	5.00
	2000	1.20	0.163	6.98	5.19	169.67	5.53
IS+fert.b	1999	1.31	0.144	6.66	5.40	172.59	5.04
	2000	1.36	0.170	6.46	5.37	157.30	6.19
ES+fert.a	1999	1.25	0.146	6.58	5.30	164.41	5.42
	2000	1.27	0.167	6.40	5.43	213.37	6.13
ES+fert.b	1999	1.29	0.151	6.62	5.39	167.61	5.70
	2000	1.28	0.166	6.47	5.41	184.56	5.59

C_{mic} in mg per kg dry soil
DHA in μg TPF per g dry soil per hour
IS = integrated system of soil management
ES = ecological system of soil management
fert. = fertilization

(Šantrůčková, 1993). According to our results, the differences in an amount of biomass between IS and ES only occured in the second experimental year (Table 2). The absolute values within ES were 35.48 mg C.kg $^{-1}$ higher on average, but without statistical significance, in the fields where alfalfa, silage maize and pea (*Pisum sativum*) were grown. An influence of the quality and amount of plant residues ploughed in soil has been confirmed for both of the systems (Table 3). Within IS, the crops with statistical significance affected the quantity of biomass in either of the experimental years, the greatest values being determined for the soil under alfalfa in the year 2000 (199.28 mg C.kg $^{-1}$ dry soil) and under bean with undersown alfalfa in 1999 (187.3 mg C.kg $^{-1}$ dry soil). As far as ES is concerned, the significant effect of crops was observed in 1999, with the highest value for the soil under wheat 184.38 mg C.kg^{-1} dry soil). The dynamics of biomass within individual experimental years as well the systems of soil management was affected by the time factor, i.e. the timing of soil sampling. There was no statistical significance of differences between fertilization treatments (a, b).
Many authors consider the determination of soil microbial biomass together with enzyme activities to be a sensitive and suitable indicator of changes in the influence of anthropogenic interventions. However, the views on suitability of the use of individual parameters are different.
Based on our measurements, in spite of non-significant differences between the two systems of soil management for 2 years of observations (Table 3), we can indicate that DHA is a good indicator of general physiological processes of soil microflora. It sensitively reacts to changes in a supply of organic substances to soil in the form of after-harvest residues and root secretions. Also, changes in an amount of DHA by soil microflora have supported this fact. Within ES, the effect of crop was highly significant in both of the experimental years, with the highest values for the soil under wheat in 1999 (9.84 μg TPF per g dry soil per hour) and under alfalfa in 2000 (12.09 μg TPF per g dry soil per hour). As to IS, the significance was only confirmed in the year 2000 when higher values were determined for the soil under alfalfa and wheat in comparison with maize. The biological soil activity expressed by DHA was affected by the time factor (statistically significant at α = 0.01) in both years and within both the systems of soil management, the highest values being observed for the soil samples taken in September.

Table 3 Analysis of variance according to ANOVA for soil microbial biomass and soil dehydrogenase activity

Source of variability	Count	F	Test statistic	Significant level
Year 1999				
Soil microbial biomass				
Fertilization IS	18	1	0.31	0.59
Fertilization ES	18	1	0.21	0.66
Sampling IS	6	5	4.96	0.00++
Sampling ES	6	5	2.39	0.07
Crop IS	12	2	4.56	0.02+
Crop ES	12	2	9.85	0.00++
Soil dehydrogenase activity				
Fertilization IS	18	1	0.03	0.88
Fertilization ES	18	1	1.64	0.21
Sampling IS	6	5	42.04	0.00++
Sampling ES	6	5	29.78	0.00++
Crop IS	12	2	1.68	0.21
Crop ES	12	2	16.95	0.00++
Year 2000				
Soil microbial biomass				
Fertilization IS	15	1	1.01	0.33
Fertilization ES	15	1	3.24	0.09
Sampling IS	6	4	3.37	0.03+
Sampling ES	6	4	3.31	0.03+
Crop IS	10	2	11.10	0.00++
Crop ES	10	2	3.23	0.06
Soil dehydrogenase activity				
Fertilization IS	15	1	4.88	0.04+
Fertilization ES	15	1	5.83	0.03+
Sampling IS	6	4	37.15	0.00++
Sampling ES	6	4	116.02	0.00++
Crop IS	10	2	20.24	0.00++
Crop ES	10	2	45.92	0.00++

f-degree of freedom

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WEED INFESTATION OF WINTER RAPE IN SLOVAK REPUBLIC

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Summary

In 1998-2000 years weed infestation of winter rape in Slovak Republic is presented. The most important weed species in winter rape in three growing regions are listed.

Key words: winter rape, weed infestation, weediness, weeds, crops as weeds

Introduction

Winter rape (*Brassica napus* ssp. *napus*) is the most important oil-bearing plant in the Slovak Republic at present time. Growing areas were increased from 32 000 ha (in 1999) to 115 300 ha (in 2000). The enlargement of growing areas is caused by relative good yield stability and its good financial implementation. Growing areas of oil-bearing plants (rape, sunflower) are higher than 12% of arable land in some agrobusinesses. This concentration means many risks – e. g. pests and diseases occurrence, but especially weeds.

Material and methods

In 1998-2000 years weed infestation of winter rape in growing regions in 45 different agroecological sites of the Slovak Republic was researched. Weed infestation was evaluated first time in autumn in a growth stage 4-5 leafs after application of preemergent herbicides. The second evaluation was realised in spring, before aplication of postemergent herbicides. The effectiveness of herbicides was assessed 3-4 weeks after its application. Weediness was evaluated by prediction-amount method.

Results

Weed infestation results of winter rape in Slovak republic are showed in table 1 and figures 1, 2. Results are introduced in 4th degree of weediness (strong weediness, more than 25 % density . m^{-2}); *Triticum aestivum* shedding in 3rd degree of weediness (middle weediness, 6 – 25% density . m^{-2}). Selected intervals of weediness are 5% (with exception 20 – 30%).
The results shows high degree of weediness with *Anthemis arvensis, Matricaria chamomilla* and *Triticum aestivum* in sugar beet growing region in 1998, respectively 2000 (> 30%). In potato growing region with altitude higher than 450m above sea level were established larger spectrum of weeds with high harmfullness (+++), especially *Galium aparine, Elytrigia repens (= Agropyron repens), Tithymalus helioscopia (= Euphorbia helioscopia)* and others. High occurrence of *Triticum aestivum* in all groving regions of Slovak Republic in 1998 and 1999 is a proof of low quality of overcrop harvest and it caused problems with crops as weeds in winter rape.
The dominant weed species in 1998 in maize growing region were: *Tripleurospermum perforatum (= Matricaria inodora)* – 23%, *Capsella bursa pastoris* – 21%, *Triticum aestivum* shedding – 18% and *Anthemis* spp. – 7%. In sugar beet growing region was any weed species in 4th degree of weediness listed. But winter wheat shedding was ascertained in 100% growing areas of winter rape, it mean 16 400 ha. The most frequent weed species in 4th degree of weediness in potato growing region was *Capsella bursa-pastoris* - 11%. Occurrence of another weed species in 4th degree of weediness was not found.
In 1999 in maize growing region we ascertained 14,2% winter wheat shedding, which is connected with problems at harvest . *Tripleurospermum perforatum (=Matricaria inodora)* was widespread in 4,5% growing areas and *Stellaria media* in 1,3%. In sugar beet growing region was very varied weed flora composition. The most important weed was winter barley shedding – 19,3%, *Anthemis arvensis* – 12,7%, *Galium aparine* – 6,9%, *Elytrigia repens(=Agropyron repens)* – 4,2%, *Apera spica-venti* – 3,8% and so one. Similar weed spectrum was found in potato growing region, too. Winter wheat shedding reached 7,4% of growing areas of winter rape, *Capsella bursa-pastoris* – 6,8%, *Thlaspi arvense* – 6,8%, *Elytrigia repens (= Agropyron repens)* – 2,3%, *Anthemis arvensis* – 1,4%, *Galium aparine* – 0,2%, *Tithymalus helioscopia (= Euphorbia helioscopia)* – 0,2%.
High occurrence of *Tripleurospermum perforatum (=Matricaria inodora)* – 30% and *Anthemis arvensis* – 30% was listed in maize growing region in the year 2000. *Cirsium arvense* was founded at 4% growing areas. Similar situation in weediness was in sugar beet growing region. Significantly decreasing of weediness was observed in potato growing region. *Apera spica-venti* was founded at 4% and *Elytrigia repens(= Agropyron repens)* at 2% growing areas.

Table 1 Weed infestation of winter rape in Slovak republic in 1998-2000 years (in % - BAYER - CODE)

Years	1998			1999			2000		
Growing region (g. r.)	maize g. r.	sugar beet g. r.	potato g. r.	maize g. r.	sugar beet g. r.	potato g. r.	maize g. r.	sugar beet g. r.	potato g. r.
< 5%				STEME MATIN	APESV AGRRE	GALAP EPHHE AGRRE ANTAR	CIRAR		APESV AGRRE
5 – 10%	ANTAR				GALAP	CAPBP THLAR TRIAE		GALAP	
10 – 15%			CAPBP	TRIAE	ANTAR				
15 – 20%	TRIAE				HORVU				
20 – 30%	CAPBP MATIN						MATIN ANTAR		
> 30%		TRIAE (3)						ANTAR MATCH	

Notes: ANTAR – *Anthemis arvensis*, (O); TRIAE(3) – *Triticum aestivum*, (winter wheat - K); CAPBP – *Capsella bursa-pastoris*, (O); MATIN – *Matricaria inodorum*, (O); STEME – *Stellaria media*, (O); APESV – *apera spica-venti*, (O); AGRRE – *Agropyron repens*, (TPK); GALAP – *Galium aparine*, (O); HORVU – *Hordeum vulgare*, (winter barley - K); EPHHE – *Euphorbia helioscopia*, (THK); THLAR – *Thlaspi arvense*, (O); CIRAR – *Cirsium arvense*, (TPK); MATCH – *Matricaria chamomilla,* (O)

O – winter weed species; TPK – shallow root perennial weed species; THK – deep root perennial weed species; K – crops as weeds; TRIAE (3) – 3rd degree (EWRS) – middle weed infestation

Discussion

Winter rape has a special position in regulation of weed occurence. It takes place after winter cereals in crop rotations in majority cases (winter barley, winter wheat). It is giving possibility for higher composition of winter one year weed species, e. g. *Tripleurospermum inodorum* (= *Matricaria inodora*), *Galium aparine, Apera spica-venti, Thlaspi arvense, Capsella bursa-pastoris* and so one. Ontogenesis of this weeds is aproximated to ontogenesis of winter rape (Aldrich – Kremer 1997).
Winter rape has good competition ability to weeds, which are no tolerant to stand shadowing in vegetation period. Intensive pre-sowing soil treatment damages root systems compactness of weeds with vegetative propagation, e. g. *Elytrigia repens (= Agropyron repens), Cirsium arvense* and so one (Černuško et al. 2000).
The basis of mechanical regulation of weed infestation is early and quality made stubble ploughing. Stubble ploughing is very suitable for regulation of forecroop shedding, usually cereal shedding. After forecrop harvest is very short time to sowing winter rape (14-21 days). Stubble ploughing is possible to make in good rainfall conditions only, which are suitable for germination and emergence of cereal shedding. In rainfall deficit conditions (which are so often in Slovakia, as in 2000 year), it is more effective shedding placement into the soil, e. g. by shallov tillage (Pikula et al. 1999, Líška et al. 1995).

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WEED INFESTATION OF WINTER WHEAT IN INTEGRATED AND ECOLOGICAL ARABLE FARMING SYSTEM

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Summary

Ecological and integrated arable farming systems were established on brown clay-loamy soil in the south Slovakia in 1990. The influence of these systems on weed infestation in winter wheat was investigated in 1998-2000. The development of winter wheat and weed infestation were influenced mainly by weather conditions and cultivation measures within the farming systems. Higher weed infestation expressed by number of weeds per m^2, number of weed species, but also dry matter weight of weeds before the harvest of winter wheat, was in ecological system. Weed infestation in spring, in the stage of the end of tillering of winter wheat, was very high with the following dominant weed species in integrated system: Tripeurospermum perforatum, Medicago sativa, Cirsium arvense, Cardaria draba. In ecological system the dominant weed species were: Medicago sativa, Cirsium arvense, Tripeurospermum perforatum, Cardaria draba. During vegetation period, the degree of weed infestation was changed in both systems. In integrated system, applied herbicides lowered the weed occurrence from 43.2 to 2.6 weeds per m^2. In ecological system, non-chemical measures and concurrence ability of winter wheat lower the number of weeds from 64.9 pieces per m^2 in spring to 14.4 pieces per m^2 before harvest. But the dry matter weight of weeds was in ecological system 5.9 times higher than in integrated.

Key words: integrated system, ecological system, actual weed infestation, winter wheat

Introduction

Weeds, as a very important harmful factor, occur every year in the fields in various species composition and amount. High degree of weed infestation can cause significant lowering of quantity and quality of production. A well balanced system of weed regulation within sustainable crop production system can eliminate the use of herbicides on ecologically acceptable level. Owing to chemical selection there is an evident increase of weed species with genetically based tolerance against herbicides (Kohout, 1993; in. Týr, 2000). Present weed infestation of cereals is mainly caused by species like: *Apera spica-venti, Avena fatua Cirsium arvense, Sonchus spp., Cardaria draba, Convolvulus arvensis* (Schroeder et al., 1993; Týr - Pospišil, 1999). Our previous results showed that the most important problem in ecological system are perennial weed species (Lacko-Bartošová et al., 2000).

Materials and Methods

Long term field experiments of integrated and ecological arable farming systems were established in the autumn of 1990 at the Slovak Agricultural University Research Station near Nitra on brown clayloamy soil. In both systems natural regulation processes are supported by crop rotations with intercrops, integrated crop nutrition, integrated and non-chemical crop protection. In both systems conventional soil cultivation is used. Crop rotations are shown in Table 1.

Table 1: Crop rotations of integrated and ecological systems.

No.	*Integrated system*	***Ecological system***
1.	winter wheat / intercrop	field bean + alfalfa
2.	common pea	alfalfa
3.	winter wheat / intercrop	winter wheat / intercrop
4.	maize for silage	common pea / intercrop
5.	spring barley	maize for silage
6.	alfalfa	spring barley / intercrop

Weed infestation of winter wheat stand was determined in the spring (before chemical and mechanical treatment) in four replicates from the area of 1 m^2 by counting method and before harvest of winter wheat by counting and weighting methods.

Results and discussion

On the basis of statistical evaluation, in our experiments was determined high influence of farming system on actual weed infestation during vegetative period of winter wheat. Weed infestation is the most important factor of successfulness of ecological production. In the stand of winter wheat, in comparison with the other crops in crop rotation, is the influence of weed infestation and the damages caused by weeds lower, because of relatively soon development of stand in the spring.

Actual weed infestation in the spring during the years of observation was very high and varied from 25.5 to 78.8 weeds per m^2 and was from 1.1 to 2.5 times higher in ecological than in integrated system. In integrated system the herbicides Granstar 75 WG and Agritox 50 SL was used, with good to excellent efficacy on weed flora. Number of weeds and their weight before the harvest of winter wheat were in integrated system lower by 4.2 – 22.6 times in comparison with ecological system. The dominant weed species in ecological system were perennials: *Medicago sativa, Cirsium arvense, Cardaria draba* and annual weed species: *Tripleurospermum perforatum*. Concurrence ability of winter wheat stand and applied mechanical measures lower the number of weeds at later stages of winter wheat development and growth.

Table 2: Actual weed infestation of winter wheat stand (average for 1998 – 2000)

Year	Farming systems	No. of weeds in spring		Most frequent weeds in spring	No. of weeds before harvest per m^2	%	Dry matter weight of weeds $g.m^{-2}$	%	Most frequent weeds in summer
		No.m^{-2}	%						
1998	A	25.23	100.0	TRIPE, CARDR, CAPBP, CIRAR	0.25	100.0	0.29	100.0	CONAR, LATTU, - , -
	B	63.23	250.6	TRIPE, CARDR, CAPBP, CIRAR	1.91	764.0	6.54	2255.2	CIRAR, TRIPE, STEME, -
	XAB	44.39	-	TRIPE, CARDR, CAPBP, CIRAR	1.08	-	3.42	-	CIRAR, TRIPE, CONAR, LATTU
1999	A	71.12	100.0	CIRAR, TRIPE, MEDSA, CHEAL	1.75	100.0	8.49	100.0	CONAR, CIRAR, - , -
	B	78.80	110.8	CIRAR, TRIPE, MEDSA, CHEAL	12.8	731.4	84.30	992.9	CONAR, CIRAR, TRIPE, -
	XAB	74.96	-	CIRAR, TRIPE, MEDSA, CHEAL	7.26	-	46.40	-	CONAR, CIRAR, TRIPE, -
2000	A	33.19	100.0	MEDSA, TRIPE, CIRAR, CAPBP	5.75	100.0	20.40	100.0	CONAR, CIRAR, MEDSA, TRIPE
	B	46.75	140.9	MEDSA, CIRAR, TRIPE, STEME	28.50	495.7	81.63	400.2	CIRAR, MEDSA, TRIPE, SONAR
	XAB	39.97	-	MEDSA, CIRAR, TRIPE, STEME	17.13	-	51.02	-	CIRAR, CONAR, MEDSA, TRIPE
98-00	XA	43.18	100.0	TRIPE, MEDSA, CIRAR, CARDR	2.58	100.0	9.73	100.0	CONAR, CIRAR LATTU, MEDSA
	XB	62.93	145.7	MEDSA, CIRAR, TRIPE, CARDR	14.40	558.1	57.49	590.9	CIRAR, CONAR, MEDSA, TRIPE
	xAB	53.06	-	MEDSA, TRIPE, CIRAR, CARDR	8.49	-	33.61	-	CIRAR, CONAR, MEDSA, TRIPE

Legend: A – integrated system, B – ecological system, xAB – average AB, TRIPE - *Tripleurospermum perforatum*, CARDR – *Cardaria draba*, CAPBP – *Capsella bursa-pastoris*, CIRAR – *Cirsium arvense*, CONAR – *Convolvulus arvensis*, LATTU – *Lathyrus tuberosus*, STEME – *Stellaria media*, CHEAL – *Chenopodium album*, MEDSA – *Medicago sativa*.

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THE INFLUENCE OF DIFFERENT SOIL CULTIVATION INTENSITY ON SOIL HUMIDITY DYNAMICS IN MAIZE STAND

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Summary

The soil humidity by different cropping systems and different soil cultivation have been evaluated at the Experimental Base Dolná Malanta near Nitra on brown clay – loamy soil during 1995-1997. The influence of cultivation – mouldboard ploughing plus surface cultivation of ploughed field (B1) and combined cultivator only (B3) on soil humidity dynamics has been ascertained. The maize was growing at four course crop rotation after winter wheat as a pre-crop plant. Samples were taken five times during vegetation period to the depth of 0.6 m with six levels at 0.1 m range. No significant differences between two soil cultivation in any depth level have been noted.

Key words: soil humidity, soil cultivation, minimisation, maize.

Introduction

Soil cultivation is one of the basic points in crops cultivation. Actual soil humidity is changing quite quickly in shallow layer of soil by soil cultivation. Water in the soil has many very important functions, mainly for soil fertility, because soil water with nutrients together are one of the main conditions for cultivating crops. Therefore adjustment of water regime is one of most important aims of soil cultivation. Favourable content of water in the soil has positive impact for soil cultivation (quality of cultivation, lower energy consumption etc.). Mechanical effect of soil cultivation regulates the thermodynamic conditions in arable layer of soil and permeability of the soil for water. This depend of granularity, structure of mineral soil composition and sorption complex, as well. Soil permeability is significantly increased by soil fauna, vertical crevices in the dry heavy soil, etc. Mechanical loosen of the soil increases soil permeability at all. Soaking of water to the soil is decreased by soil compaction and consolidation.

Materials and methods

Experiments were established on Research Station of Slovak Agricultural University in Nitra, Dolná Malanta, on clay-loamy brown soil, which are created on loess parent rock. Research Station is situated in warm climate region, 173 m above sea level, with average annual air's temperature 9.6°C, average annual precipitation 580 mm. Content of humus in arable layer (0.0-0.35 m) is 2.33 %. Rate of humid acid to fulvid acid is 1.31; exchange acidity (in KCl) is 5.49; volume weight reduced is 1.32 g.cm^{-3}; porosity 49 %, maximal capillary water's capacity 34 %; minimal air's capacity 15 % and cationic sorption capacity is 165.4 mmol chemical equivalent for 1 kg of soil (Hanes et al., 1991).
The soil humidity was observed in different farming systems and different basic soil cultivation in maize stand during 1995, 1996 and 1997. Winter wheat was a pre-crop for maize, spring barley and common pea were cultivated after maize. Variations of soil cultivation were: ploughing to the depth of 0.3 m with following of surface arrangement of ploughed field (B1) and loosening of soil with combinatory (B3). Whole block was fertilising by balance method for average yield's level of 8 t.ha^{-1}.
Soil humidity was determined five-times during vegetative period of maize to the depth of 0.60 m at six layers, regularly with 0.1 m intervals of depth in three replications. Dates of sampling was determined by the most important of agrotechnical operations and growing stages of crop, as well. Evaluation of founded data were done by analysis of variance with helping of appropriate tables.

Results and discussion

During three observed years, the weather conditions was very different, mainly in the viewpoint of precipitation and its distribution. In spite of it, the dynamics of soil humidity reached very equable course. Results explicitly confirmed, that between two determined soil cultivation variances (1. ploughing to the depth of 0.3 m with following of surface arrangement of ploughed field, 2. loosening of soil with combinatory) were not significant differences of water content in the soil. High significant differences of water content in the soil during the years were influenced by different sampling of the soil samples. Significant influence of determined soil cultivation to the changes of soil humidity was not founded. Similarly Blevins et al. (1971) and Talafantová (1978) reported, that the content of water in non-cultivation soil is not significantly different with comparison of arable land.
Significant differences in content of soil water were determined within years, only. The soil humidity was increased with the soil depth. In 1996, we founded almost equal soil humidity in soil layers. Gnatenko (1992), Vereteľnikov et al. (1992) founded higher content of soil water until to depth of 1.0-1.5 m, almost in dry conditions in favour of loosening against ploughing.

Table 1: Soil humidity in maize stand (cultivated after winter wheat) during 1995-1997 in depth of the soil 0.0-0.6 m

Cultivation	Date					*Average*
1995	3. 4.	10. 5.	21. 6.	13. 7.	22. 8.	-
B1	21.86	19.69	21.73	13.95	8.38	17.12
B3	22.12	20.71	22.11	11.67	8.04	16.93
1996	25. 3.	29. 4.	3. 6.	11. 7.	26. 8.	-
B1	22.42	17.10	23.97	17.57	13.94	19.00
B3	22.20	16.80	22.73	19.70	14.55	19.20
1997	11. 4.	7. 5.	2. 6.	16. 7.	20. 8.	-
B1	19.67	18.74	16.88	20.56	15.12	18.19
B3	19.42	18.77	16.69	19.45	14.80	17.83

Legend: B1: ploughing to the depth 0.3 m with following surface arrangement of ploughed field; B3: loosening of soil with combinatory.

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WINTER BARLEY GRAIN PRODUCTION IN DEPENDENCE ON SOME SAVING GROWING TECHNOLOGIES DURING TWO CLIMATIC DIFFERENT YEARS

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Summary

We have examined the influence of different soil cultivation ways, varieties and year on the grain yield amount of winter barley in field polyfactor experiments in 1998/1999 and 1999/2000. There were four varieties (Luxor – multi-rowed, Babylone, Hanna, Tiffany – two-rowed variety) and three different tillage types (A-ploughing + post-harvest remainders, B-ploughing without remainders, C-discs without remainders). Results shown that there had been a statistically manifested difference between the crop of two and multi-row barley in favour of Luxor variety (0,48 to 1,02 $t.ha^{-1}$). The years crop influence has also been statistically manifested by the difference from 0,44 $t.ha^{-1}$ (Luxor) to 1,14 $t.ha^{-1}$ (Babylone). Results have shown that there had been a different reaction of varieties to tillage. Luxor, Hanna and Tiffany variety had reacted to the shallow soil

cultivating (C, discs) by crop increase from 0,26 to 0,97 t.ha^{-1}. Babylone variety had reached more yield crop by conventional tillage (0,28-0,42 t.ha^{-1}) in both years.

Key words: winter barley, fertilization, soil cultivation, variety, ploughing, shallow, years, crop

Introduction

The main purport of soil cultivation is to create suitable conditions for quick seed germination, regular plant growing and development, and to secure stability of the yield in climatically unfavourable years.

Continued improving of technical means according with the effort to produce more rationally by similar or higher yield amounts lead to several minimisation ways and systems in the soil cultivation. Research results from several cereal soil cultivation systems can be applied to a conception of so-called rational soil cultivation system representing such a system when only appropriate, i.e. reasonable soil cultivation measures are realised.
Problems on the soil protection in cereals are dealt by several authors (Kováč, Marko 1997, Procházková, Dovrtěl, Suškevič 1997, Molnárová, Žembery 1997 and others).
Objective of our paper is to evaluate the influence of some saving measures during the soil cultivation in dependency of the year climatic conditions on the grain yield amount in two and multi-rowed winter barley.

Material and methods

We have examined the influence of different soil cultivation ways, varieties and year on the grain yield amount of two and multi-rowed winter barley in conditions of warm corn production area with an year total precipitation amount of 561 mm and an average year temperature of 9,7 °C (according to 30-year average) on clay brown soil with medium phosphorus, ample potassium and the humus content of 2.7 %.
Examined varieties: year 1998/1999 multi-rowed winter barley - Luxor
two-rowed barley - Babylone a Hanna
year 1999/2000 multi-row winter barley - Luxor
two-rowed barley - Babylone a Tiffany
3 soil cultivation methods:
A – ploughing up to 0.20 m + post-harvest remainders
B – ploughing up to 0.20 m, without remainders
C – shallow soil cultivation without remainders (disc harrow)
Forecrop was rape. Number of treatments - 4.
The influence of examined production technology elements and year on the yield amount was evaluated by the analysis of variance by means of the Statgraphics software. The climatic characteristics course of regarded years are shown in figure 1-4.

Figure 1

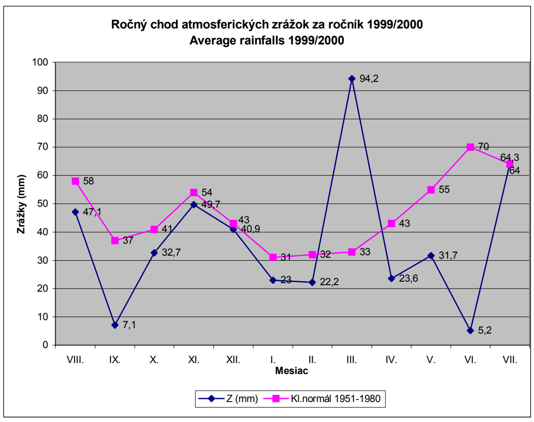


Figure 2

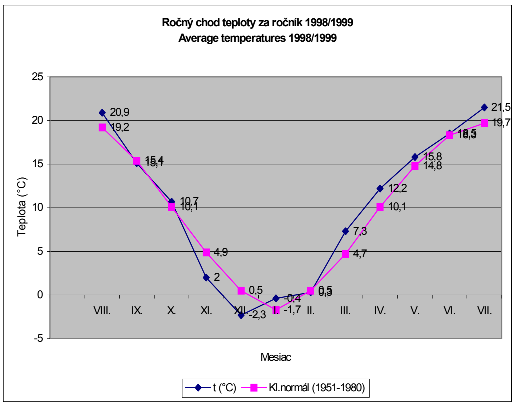


Figure 3

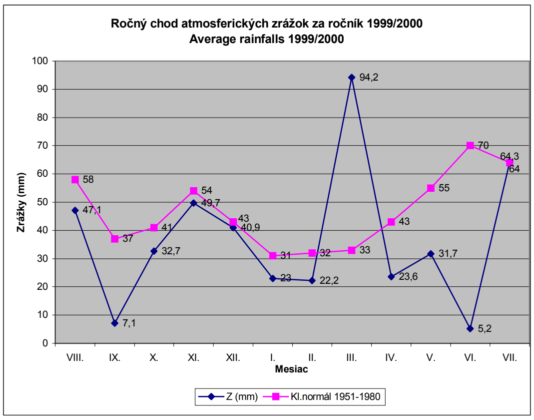
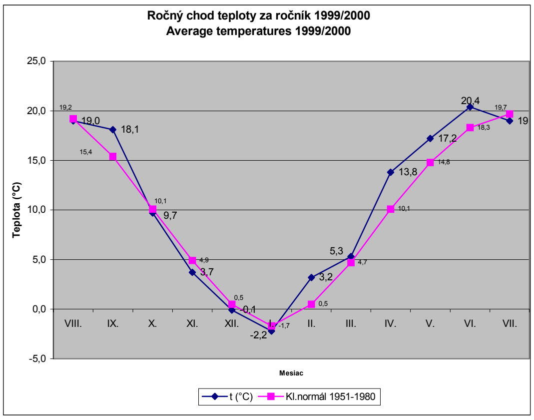


Figure 4



Results and discussion

Results have shown possibility of a partial elimination of injurious climatic influence on the yield formation by soil cultivation ways. In the season 1998/1999 with extremely rainy autumn – September 404.3%, October 190% (Figure 1,2), barley sowing delayed till the 30th October. The stand rose only for 55-60% till winter. That is why the formation of the basic yield-formation element – number of plants - was influenced negatively. Extremely wet autumn was relieved by dry winter and spring period, which influenced negatively the shoot formation and the total number of spikes (this was 426 to 440 pcs per m^2 in multi-rowed variety Luxor, 486 to 628 pcs per m^2 in two-rowed variety Hanna and 457 to 548 pcs per m^2 in Babylone). Petr, Pflug, Šnejdar (1985) consider as the optimal one 400 – 600 spikes per square meter, Molnárová (1990) more than 500 spikes. In two-rowed varieties figure Kufelj (1999) as optimal one 734 – 747 spikes per square meter. There was observed an different reaction to single soil cultivation ways by examined varieties.
Average grain yield in season 1998/1999 ranged from 6,65 t.ha^{-1} (Babylone) to 7,74 t.ha^{-1} (Luxor). Luxor and Hanna varieties reached the highest yield amount by shallow soil cultivation method (C), Babylone by ploughing up to 0.20 m + post-harvest remainders (A) (Table 1).
The yield difference between the multi-rowed variety Luxor and two-rowed varieties was statistically highly significant.
In season 1999/2000 was the total amount of precipitation for 232,7 mm lower compare to previous year and it reached only 78.7% (Figure 3,4). Contrary to previous year was September extremely dry, with total precipitations of 7.1 mm (19.2%). This dry period delayed till the third decade of October, with total precipitations of 6,8 mm. The stand came up completely only in the case of shallow tillage (C). Incoming favourable precipitation during the shoot growing phase ensured good shooting and that is why also by lower plant number in A,B treatments was a good stand cover contributing to the yield. Grain yield comparing to the previous year amount was statistically highly significant higher for 0.44 to 1.14 tons per hectare. Similar as in the previous year, in average for the whole experiment, the highest yield was in the multi-row variety Luxor (8.18 t.ha^{-1}). Positive reaction to the shallow soil cultivation was noticed by Luxor (8.61 t.ha^{-1}) and Tiffany (7.75 t.ha^{-1}). Babylone react more positively on conventional tillage (A, B) (Table 2). These results partially confirm the opinion of Procházková, Dovrtěl and Suškevič (1997), according to them it is important to adapt the soil cultivation system in the corn production area to moisture conditions and to apply the shallow tillage especially during dry years.

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Tab 1. Influence of the cultivation way on the grain yield in winter barley in year 1998/99

Variety	Way of cultivation	Yield $t.ha^{-1}$	Difference caused by the way of cultivation		
			$t.ha^{-1}$	%	*Sk*
LUXOR	A	7,61	-	100,00	-
	B	7,74	0,13	101,71	390
	C	7,87	0,26	103,42	780
HANNA	A	6,67	-	100,00	-
	B	6,52	-0,15	97,75	-450
	C	6,98	0,31	104,65	930
BABYLONE	A	6,76	-	100.00	-
	B	6,33	-0,43	93,64	-1290
	C	6,58	-0,18	97,34	-540

$Hd_{0,05}$: 0,20089 $Hd_{0,01}$: 0,25147

Tab.2: Influence of the cultivation way on the grain yield in winter barley in year 1999/2000

Variety	Way of cultivation	Yield $t.ha^{-1}$	Difference caused by the way of cultivation		
			$t.ha^{-1}$	%	Sk
LUXOR	A	7,64	-	100	
	B	8,30	0,66	108,6	2112
	C	8,61	0,97	112,7	3104
TIFFANY	A	7,64	-	100	
	B	7,51	-0,13	98,3	-416
	C	7,75	0,11	101,4	352
BABYLONE	A	7,71	-	100	
	B	7,91	0,20	102,6	640
	C	7,49	-0,22	97,1	-704

$Hd_{0,05}$ cultivation:0,67223, $Hd_{0,01}$ cultivation:1,13411

DEVELOPMENT OF MELLIFEROUS PLANT MIXTURES WITH LONG LASTING FLOWERING PERIOD

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Summary

In this project we would like to develop mixtures of melliferous plant species with long lasting flowering period to offer bee pasture for the honey bees and wild bees and for the protection and reconstruction of the original association of the eroded uncultivated lands. The reasons for the research are the foreseeable increasing amount of the fallow, the presently decreasing natural bee forage lands, and the increasing territories of the eroded uncultivated lands. The experiment was set in the two places. There have been 6 melliferous plant mixtures examined: 3 annual and 3 perennial, in four repetition.
The purpose of the examinations were to detect the flowering stages and fenological aspects of the species in the mixture, the soil covering and the weed suppression effect of the mixtures. We have examined the appropriate time of sowing of the mixtures and the optimal percentage of the components in the mixture.
Our examinations so far have resulted that our plant mixtures have been flowering continuously from the end of May ensuring good bee forage for the wild bees living on the territories and for the visiting honey bees as well. From the annual mixtures mustard and buchweat, from the perennials saintfoin, melilot and coronilla proved good weed suppressive effect and long flowering period.

Key words: Melliferous flora, fallow, plant mixture, beepasture, honey bees, wild bees

Introduction

In the course of our accession to the European Community nearly 200 000 ha arable land should be drawn out of cultivation. On the low productivity flat or mountain territories the moving can help in recreating the original association, the fertilisers and the oversowing sustain the degraded situation. On the uncultivated lands the invasion of the dangerous weed species can be prevented by the increasing the succession and with sowing seeds of the original association. (Fekete at al. 1997)
In this project we would like to develop mixtures of melliferous plant species with long lasting flowering period for the protection and reconstruction of the original association of the eroded uncultivated lands and to offer bee pasture for the honey bees and wild bees.
The reasons for the research are the foreseeable increasing amount of the fallow, the presently decreasing natural bee forage lands (Cserényi 1997), and the increasing territories of the eroded uncultivated lands.
The purpose of the examinations were to detect the flowering stages and fenological aspects of the species in the mixture, the soil covering and the weed suppression effect of the mixtures. We have examined the appropriate time of sowing of the mixtures and the optimal percentage of the components in the mixture.

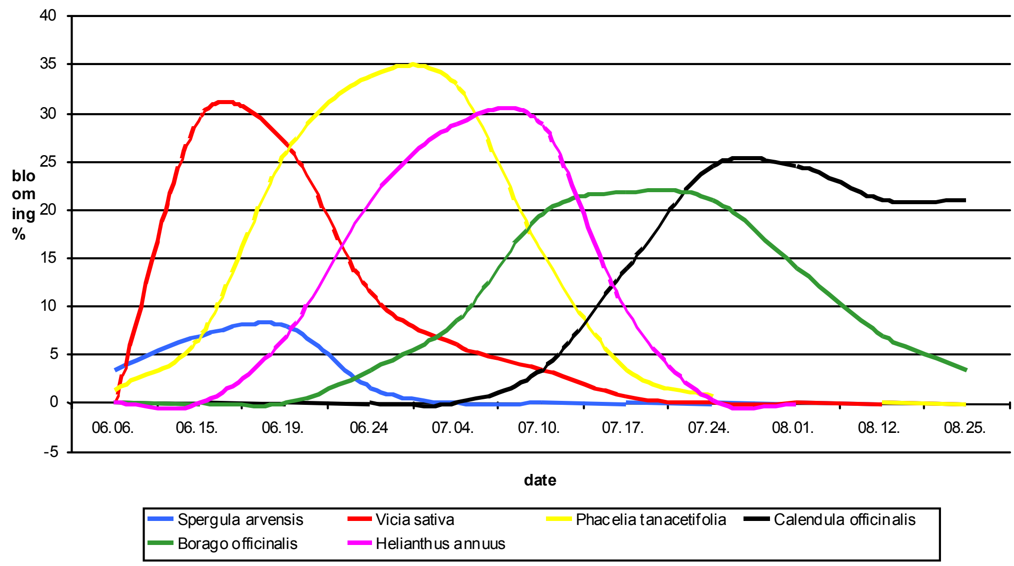
Material and methods

Places of the experiment: Place1. Experiment field of the Szent István University, Department of Ecological and Sustainable Production Systems, Soroksár Experiment Station , The soil was a light sandy soil, with low humus content (0,6-1%), and pH 7-8.
2. Putnok, Fleishmann Rudolf Experiment Station of Szent István University, Gödöllő. The soil was a heavy clay soil, with low pH 5-6 and low humus content.
Sowing method was by hand, on the surface. The seed of the species in the mixtures was mixed and sowed together in the same time on the surface. The soil preparation was similar as we sow grass. Date of sowing was: 29. April. The plots were $10m^2$ at Soroksár and $25m^2$ at Putnok in four repetition. The origin of the seed was from the Agrobotanical Institute, Tápioszele, OMMI, and Research Institute of Herbal plants.
After the mixtures were started to grow there were regular phenological examinations specially the flowering periods of the species, when the number of flowers and the blooming stage were detected. The occurence of the weeds and their soil covering percentage were also detected tree times a year according to Ujvárosi - Braun-Blanquet method.

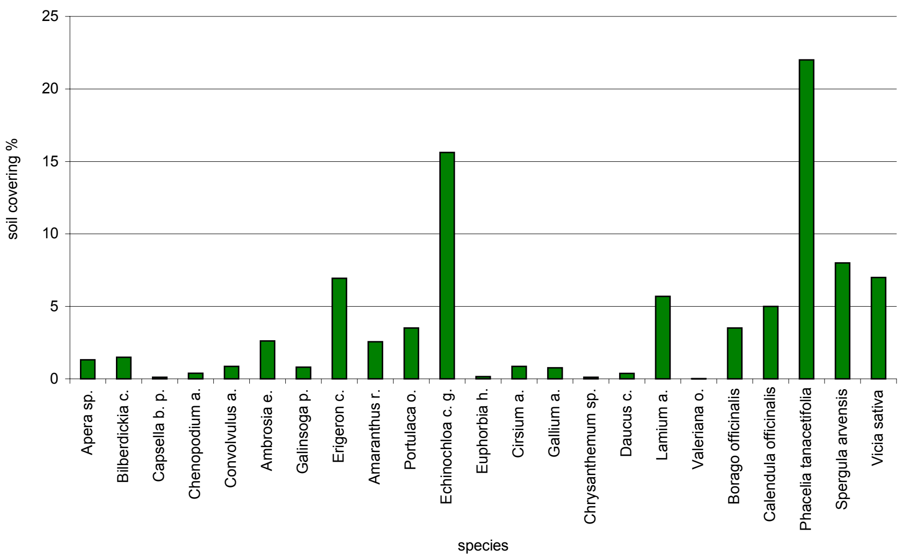
Results

Evaluation of Mixture 1.
Components in Mixture 1.: Sinapis alba, Fagopiron esculentum, Melilotus albus/Coronilla varia, Ocimium basilicum, Aster dumosus,/Callistephus, Carum carvi, Helianthus annuus
The main components of the spring aspect were buckwheat and mustard, gave an even continuous association on plots. Although the appearance of the turnip flea beetle damaged the mustard.
Because of the sowing happened in April the flowering period of the two species were almost in the same period. They gave good bee pasture after the black locust. The herbal plants could not detected in measurable level they were suppressed by filed species. Sunflower and Melilot was flowering in the middle and late summer. When melilot is in the first year it flowers at the end of the summer only, in the second year we can have two flowering time because of cutting.
Evaluation of mixture 2.
Components in M.2. Spergula arvensis, Vicia sativa, Phacelia tanacetifolia, Calendula officinalis, Borago officinalis Helianthus annuus, (Lupinus albus).
The first component in the early spring aspect is Spergula arvensis, corn spurrey. This small weakly structured plant is quite tolerant to the shortage of water so gave good soil covering and flowering in June. Facelia was main component for early summer covering the plot nicely and gave a very good intensive flowering period for the bees. Vicia sativa, common vetch could complete the flowering of facelia almost 80%. Borago officinalis, borage bring flowers according to the seed quantity in the mixture, was attractive for the bees. Calendula officinalis gave a continuous flowering from July but the bee-visitation was naturally less than on Facelia flowers. Sunflower was in low seed proportion in this mixture, and the performance was relevant to it.

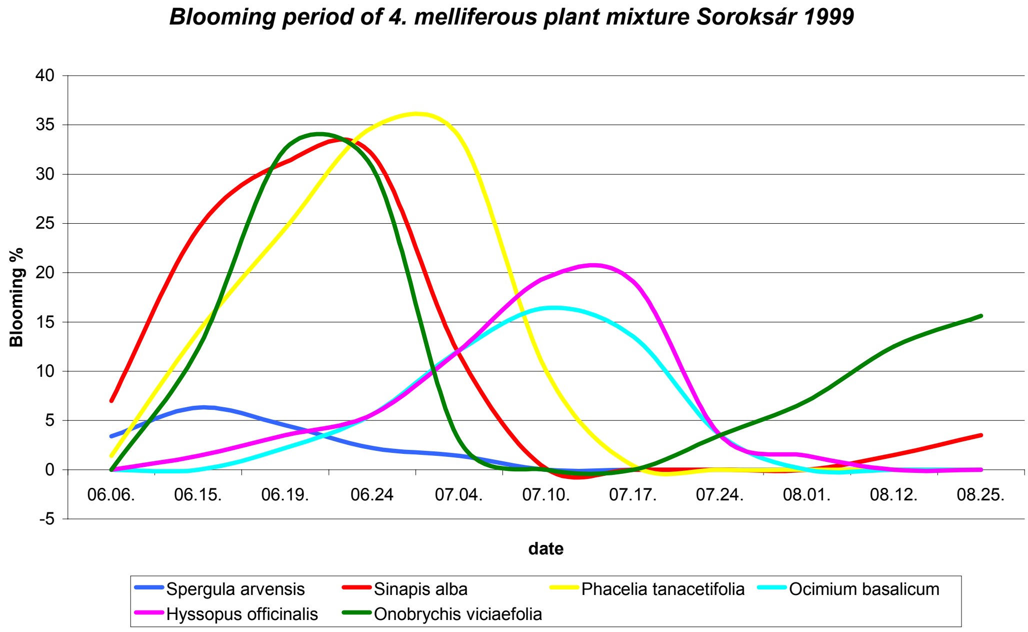
Blooming period of 2. melliferous plant mixture Soroksár 1999



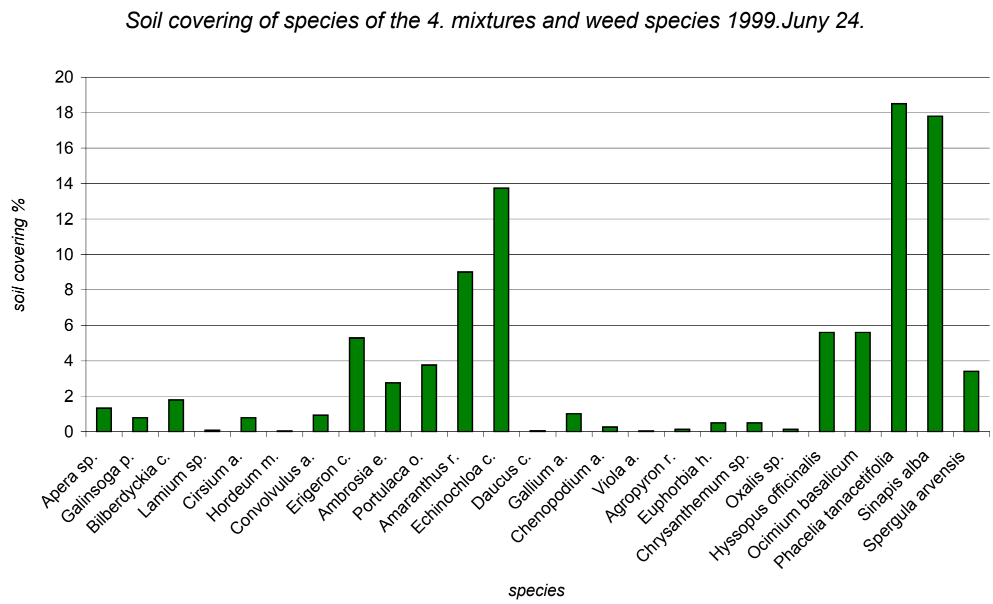
Soil covering of species of the 2. mixtures and weed species 1999.Juny 24.



Evaluation of the 3. mixture
Components in M.3.: Sinapis alba, Lathirus sativus, Melilotus albus/Coronilla varia, Majoranna officinalis, Calendula officinalis
The main components of the spring aspect was Sinapis alba, mustard, gave an even but not continuous association with Lathyrus sativus on plots. The appearance of the turnip flea beetle damaged the mustard it had influenced the performance of flowering.
The sowing time was in April that resulted the flowering period of the two species were almost in the same period. They gave good bee pasture after the black locust for the honey bees and for the wild bees. From the species in this mixture Calendula, Melilot, and Malva sylvestris ensured reasonable bee pasture in July and August.
Evaluation of 4. Mixture
Components in M.4.: Spergula arvensis, Sinapis alba, Phacelia tanacetifolia, Ocimum basalicum, Hyssopus officinalis, Salvia officinalis , Onobrichis viciaefolia/Lupinus albus, Grass I. : Festuca rubra, Poa pratensis, Lolium perenne.



The main components of the 4. mixture were Spergula arvensis, corn spurrey and mustard in the early spring aspect. They gave an even continuous association with the dominance of the mustard. Later Facelia covered the plot and gave very good abundance of flowers. Unfortunately the herbal species did not performed well, because the habitat of field plants. Onobrychis viciefolia, saintfoin give a nice flower amount at the end of summer in august in the first year. In the second year it flowered twice because of cutting : in June and from the mid of July-August. It gave a good, frequently visited bee pasture and suppressed the weeds. Grasses helped the soil covering of the mixture to suppress the weeds.



Evaluation of the 5. mixture

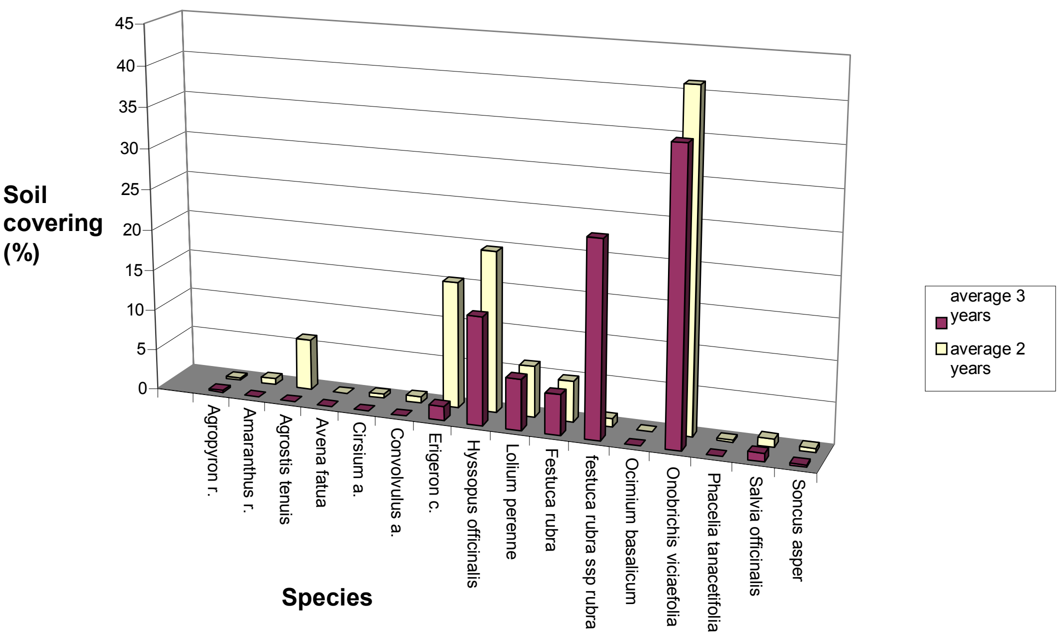
Components in M. 5. Sinapis alba, Melilotus albus/Coronilla varia, Fagopyron esculentum, Oreganum vulgare, Nepeta pannonica, Thymus vulgaris, Drakocephalum moldavica, Grass II.:Festuca rubra ssp Rubra, Festuca rubra ssp Commutata, Festuca rubra ssp Trichophylla

The main components of the spring aspect were buckwheat and mustard, gave an even continuous association on plots. Because of the sowing happened in April the flowering period of the two species were almost in the same period. They gave medium-good bee pasture after the black locust. Unfortunately turnip flea beetle damaged the mustard, this is why it was not attractive enough.

The herbal and ornamental plants could not detected in measurable level they were suppressed by filed species. Melilot was flowering in the middle and late summer. When melilot is in the first year it flowers at the end of the summer only, in the second year we can have two flowering time because of cutting, so it could elongate the flowering period of the mixture. Dracocephalum moldavicum a herbal plant in this mixture flowered in July and in August with moderate intensity because of seed quantity.

Evaluation of mixture 6.
Components in M6.: Sinapis alba, Fagopyron esculentum, Coronilla varia, Helianthus annuus, Calendula officinalis, Aster sp.
The main components of the spring aspect were buckwheat and mustard again, gave an even continuous association on plots. Because of the sowing happened in April the flowering period of the two species were almost in the same period. They gave medium-good bee pasture after the black locust. Turnip flea beetle also damaged the mustard here, this is why it was not attractive enough.
Coronilla varia flowered with low intensity in July and August in the first year, but in the second year it flowered in June, and in August too and gave nice abundance of flowers. It covered the soil very well and suppressed the weeds too.
The occurrence of wild bees: The most frequent wild bees and flies on the plots were: Erisyphus balteamus, Syrphus ribesii, Eristalix tenax, Andrena ovatula, Megachile argentea, Megachile rotundata, Bombus terrestris, Bombus agrorum
Figure 5.

Soil covering values of weed and cultivated plant species in mixture 5. (1999-2000.)



Discussion

From this two years experiment we could determine some those field, herbal and ornamental species that can tolerate growing in a mixture.
From the examined annual species we could suggest Spergula arvensis as early spring and Fagopiron esculentum, Sinapis alba for late spring. The most attractive species was facelia.
The perennial species gave better performance in the second year, but Onobrichis viciefolia, saintfoin was nicely flowering in the first year too.
From the herbal species Hyssopus officinalis could cope with the field species specially under dry conditions. We have to mention Borage, and Salvia although they were less intensive. According to our results so far we may plan annual and perennial mixture too. The most economic solution seems to be when the annual components gradually go into a perennial association like in mixture 4.,5.,6.
The quantity of the seeds of species in the mixtures is still under examination, because the percent of the herbal plants were lifted and the ratio of some perennials (like melilot) were decreased. This resulted better performance for the herbal species also they does not really competitive with filed species.

When these mixtures entered into the second year only those have given proper performance which contain perennial species : Onobrichys viciefolia on sandy soil, with 7-7,5pH, and Melilotus albus, or Coronilla varia for clay soil with low pH. For the third year grass species have gain territory Festuca rubra and subspecies, which are also components of the perennial mixtures. The evaluation of the third and second year old mixtures are shown on Figure 5.
This experiment is planned for longer period, because weather soil, seed quality has influenced our results, and prevented us to do all the planned examinations related to nectar and pollen productivity of the species in mixture.
Different ecological circumstances of areas need different kind and composition of mixtures we composed 6 mixtures suitable for sandy soil and the composition was modified for heavy clay soil with low pH.

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DYNAMICS OF UPTAKE AND ACCUMULATION OF NITROGEN BY WINTER WHEAT VEGETATION

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Summary

An influence of differentiated nitrogen doses on the dynamics of uptake and accumulation of nitrogen by the winter wheat vegetation was observed during the period of 1987-1989. The results were obtained from field experiments established at two experimental stations of UKSUP (Central Control and Examination Agricultural Institute) in Veľké Ripňany (172 m above sea) and in Báhoň (159 m above the sea). It was found out that at high grain yields in Veľké Ripňany the differences in the positions of the uptake line are not as significant as in the case of Báhoň locality. It is a result of a high level of mobile available nitrogen in soil, accumulated by lucerne which eliminates the effect of the applied nitrogen doses. Grain yield in Báhoň corresponds with the uptake lines of nitrogen. Significant statistical differences have been detected in each year from the period of shooting (r_{1987} =0.73^{++}, r_{1988} = 0.82^{++}, r_{1989} = 0.76^{++}) up to the full maturity (r_{1987} = 0.97^{++}, r_{1988} = 0.98^{++} , r_{1989} = 0.98^{++}) . Compared to the non-fertilized control, the vegetation which was nitrogen fertilized took up at the end of tillering more nitrogen by 4.2 - 13.4 kg N.ha^{-1}, at the beginning of shooting by 21.3 -35.7 kg.ha^{-1}, at the end of shooting by 13.5 - 74.8 kg.ha^{-1} and in milk maturity by 22.8 - 105.4 kg N.ha^{-1}.

***Key words**: nitrogen, winter wheat, uptake, biomass, yield*

Nitrogen holds an unreplaceable position in the plant nutrition, compared to other nutrients it has the greatest influence on the quantity and quality of the yield. The higher are the requirements on the yield, biomass production, the more nutrients are transported from the soil and these need to be replaced by fertilization. Targeting influence on the production process course, and simultaneously meeting environmental protection requirements, can be carried out only via scientifically proven plant nutrition in a complex of other environmental determinants (*Bízik 1989; Ložek 1998; Jolankai and Ragasits 1995*).
The article deals with processed results of a study on the influence of differentiated fertilization on the nitrogen uptake and accumulation dynamics in the Viginta variety of winter wheat vegetation at regular sampling of soil and plant in three growing periods of year 1987, 1988 and 1989.

Material and methods

The results were obtained from field experiments established at two experimental stations of UKSUP (Central Control and Examination Agricultural Institute) in Veľké Ripňany and Báhoň where gradually increasing nitrogen doses and five authors methodologies for evaluation of nitrogen nutrition status for wheat fertilization needs were tested. In Veľké Ripňany the experiment was set up on brown soil, foreplant was lucerne, in Báhoň it was set up on black soil, foreplat was winter wheat. An overview of nitrogen fertilization treatments, nitrogen doses and attained grain yields of winter wheat are presented in table 1. Phosphorus and potassium fertilization was in all treatments applied in the same doses determined by the fertilization plan, except for treatment 8 and 9, where based on the plant analysis fertilization by foliar application of Fostim was carried out.

Table 1 Influence of differentiated conditions of N nutrition on the yield and natural grain production (3 years average)

Treatment	Veľké Ripňany			Báhoň		
	N dose	Yield	Nat. prod.	N dose	Yield	Nat. prod.
	$kg.ha^{-1}$	$t.ha^{-1}$	$kg.kg^{-1}$ N	$kg.ha^{-1}$	$t.ha^{-1}$	$kg.kg^{-1}$ N
1	0	9.06	-	0	5.61	-
2	80	9.20	115	80	7.24	91
3	120	8.99	75	120	7.30	61
4	160	9.18	57	160	7.53	47
5	200	9.08	45	200	7.51	38
6 – Baier method	122	9.29	76	164	7.43	45
7 – Michalík & Ložek (N) method	55	9.20	167	83	7.15	86
8 – Michalík & Ložek (N+P) method	62 +13 P	8.90	144	58 + 17 P	6.84	118
9 – Bízik method	118 +3 P	9.15	78	134 + 3 P	7.37	55
10 – Lopatník method	157	9.17	58	177	7.39	42

Results and discussion

The uptake of nitrogen by winter wheat vegetation is significantly modelled by fertilization. Different uptake conditions, and therefore fytomass production conditions, can be generally presented via uptake lines. Therefore, differentiated nitrogen nutrition has been shown by a different courses of the uptake lines. Uptake lines for nitrogen, if wheat was not nitrogen fertilized, (treatment 1) are the lowest ones and with the increasing nitrogen dose rises its uptake and the tangent of the S lines linear part. More characteristic course of these relationships was detected at the base in Báhoň (figure 3).
It is also being confirmed that higher nitrogen uptake is tightly connected to the grain yield (higher nitrogen uptake, higher yield and vice versa), especially if there are greater position differences between the uptake lines. In case of Báhoň the line position was the lowest under the lowest yield (6,48 $t.ha^{-1}$) in treatment 8 (figure 4). At high grain yields reached in experiments in Veľké Ripňany, no such high differences in the uptake lines courses have been detected (figure 1 and 2). It is a result of a high level of mobile source of available nitrogen in soil, that suppresses the effect of applied nitrogen doses in a fertilizer. A close relationship between the soil nitrogen sources, its uptake, utilisation and yield production is being proven. This can be used for yield prognosis during the growing period and for corrections of the nutrition status of the vegetation (*Bízik 1989*).

Figure 1 Uptake of N by wheat during growing period in $kg.ha^{-1}$ (average for period 1987-1989, Veľké Ripňany)

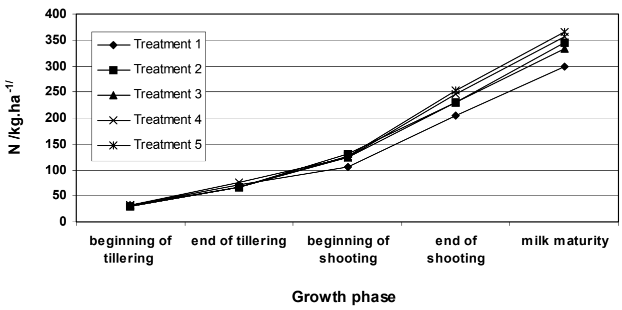


Figure 2 Uptake of N by wheat during growing period in kg.ha^{-1} (average for period 1987-1989, Veľké Ripňany)

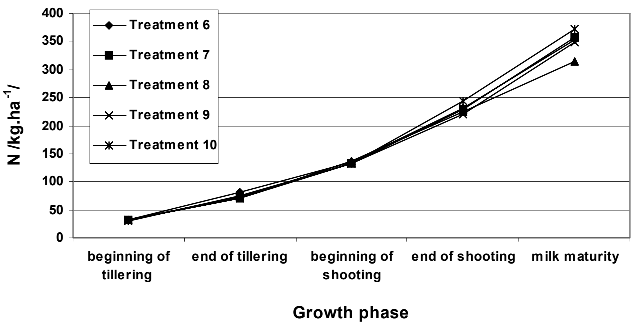
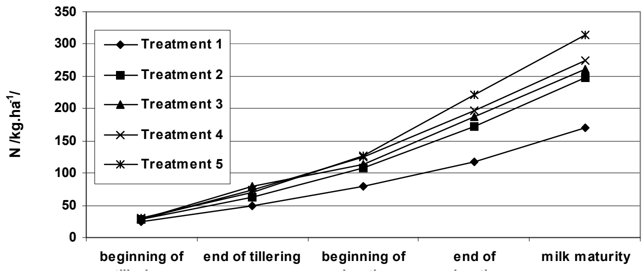


Figure 3 Uptake of N by wheat during growing period in kg.ha^{-1} (average for period 1987-1989, Báhoň)



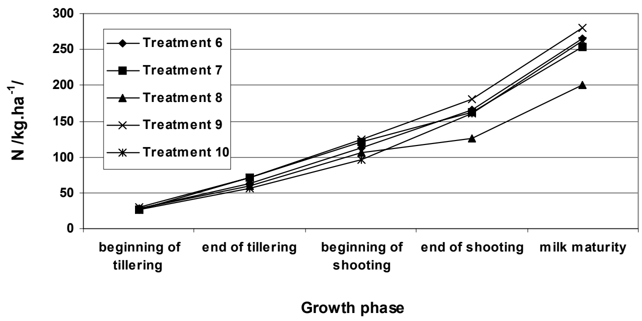


Figure 4 Uptake of N by wheat during growing period in kg.ha^{-1} (average for period 1987-1989, Báhoň)

Uptake of nitrogen in relation to the grain yield is statistically significant at a lower supply of soil nitrogen sources. Statistically significant differences in experiments in Báhoň were detected from the beginnig of shooting to the full maturity. The results are in line with findings of *Smetánková (1985); Halás (1993) and Cerling (1987)* who found out that shooting phase is the most important for the grain production. The findings are logical, since nitrogen from fertilizers is effective with a certain delay from their application.

No statistical relationship between the nitrogen uptake and grain yield in any of the growth phases has been confirmed in Veľké Ripňany.

If the nitrogen uptake by winter wheat is evaluated quantitatively per individual growth phases, we can state that a vegetation fertilized by nitrogen took up more nitrogen at the end of tillering by 4.2 - 13.4 kg N.ha^{-1}, at the beginning of shooting by 21.3 - 35.7 N kg.ha^{-1}, at the end of shooting by 13.5 - 74.8 N kg.ha^{-1} and in milk maturity by 22.8 N kg.ha^{-1} compared to the non-fertilized vegetation (treatment 1).

Response of the winter wheat vegetation to the nitrogen fertilization was shown in a different manner in respect of both locations and years. In 1987 there was determined a significant or highly significant relationship between the nitrogen doses and nitrogen uptake in the shooting phase ($r = 0.80^{++}$, or $r = 0.78^{++}$), in milk maturity ($r = 0.75^{+}$) and in full maturity ($r = 0.84^{++}$)

in Veľké Ripňany. In year 1988 on the same stand there was the significant value determined at the end of shooting (r = 0.74^{+}), in year 1989 at the end of tillering (r = 0.63^{+}). In Báhoň this relationship was statistically significant in all year under review, from the beginning of shooting to full maturity.

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SOIL STRUCTURE AND FOOD WHEAT QUALITY

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Summary

In this contribution, changes in the quality of food wheat grown since 1994 in the tetraculture (barley - pea - wheat - corn) are shown in connection to the soil structure evolution. Significant positive changes emerged in the soil structural state and the food wheat quality, seven years from the start of the research (2000). The percentage of the water-resistant structural aggregates increased, whereas, in the same time the abundance of the microaggregates decreased. The gluten content, SDS-value, and valorigraphic value increased in both - grain and flour. The wheat quality improvement, compared to the initial state, was observed in the very same variants showing positive tendencies for the soil water-resistant structural aggregates as well.

***Keywords*: ** food wheat, quality, soil structure, water-resistant soil aggregates

Introduction

The soil structure integrates all the basic physical characteristics of the soil system (Mamedov 1974, Jambor 1992, Morgan 1996, Mucha et al 2000). The agronomical importance of the soil structure, water-resistant in particular, manifestates itself in the creation of more aerated topsoil with favorable conditions in respect to the spring-up, further growth and evolution of cultivated crops. Compared to the soil far from the optimal structural state (high abundance of microaggregates), it (the soil in the good structural state) releases the water and nutrients reserves more economically.
Thus, we were interested, how the changes in the abundance of the water-resistant aggregates would exhibit themselves in the quality of food wheat.

Material and methods

The research was carried out during 1994 – 2000 via a stationary field trial in the experimental base of the SPU in Dolná Malanta. The soil in the locality of interest is Orthic Luvisol created from the preluvial sediments. The detailed description can be found in Hanes et al (1997).
The investigated variants included the one without fertilization (O), the tillage of all after-harvest-remnants (straw and root rests) under soil combined with NPK industrial fertilizers (PZ), and the tillage of stubble and root rests under soil + NPK (PH). The NPK-doses were determined by a balance method for the planed wheat yield of 6 t ha^{-1}. The C:N ratio in the straw was adjusted (0,5 kg N in 100 kg of straw). A conventional tillage to depth of 0,2 m (B1) and a treatment without soil turning (B2) were applied.
Observed parameters and methods covered: water-resistant structural aggregates and microaggregates (Dolgov 1958), flour yield, gluten content (STN 461011 part 9 1993), gluten quality after Berliner in modification of Horel, Hýža, and Prugar (Prugar et al 1959), ability of flour to sediment characterized by seditest (Axford et al 1979, STN 461021 1993), αamylases activity by falling number (STN/ISO 3039 1993), and rheologic properties of dough by valorigraphic value.

Results and Discussion

The content of the most valuable category of water-resistant structural aggregates (0,5–3 mm) was in the year 1994 unsatisfactory – only 16%. After seven years (2000), the measured amounts (~ 30%) signal more favorable situation. The increase was affected more by the fertilization and the time interval (all time-dependent effects) than by the soil treatment (statistically insignificant).

Year		1994					2000				
Parameter		I&II	G	SDS	FN	VV	I&II	G	SDS	FN	VV
Variant		[%]	[%]	[ml]	[s]	[points]	[%]	[%]	[ml]	[s]	[points]
B1	O	67,00	20,50	30,30	319,00	56,40	38,50	28,77	66,33	361,00	62,80
	PZ	70,00	26,20	37,20	365,00	65,90	42,00	27,70	61,00	358,00	63,50
	PH	68,00	26,20	34,20	387,00	61,30	41,50	29,77	63,33	374,33	67,60
Average for B1		68,33	24,30	33,90	357,00	61,20	40,67	28,75	63,55	364,44	64,63
B2	O	67,00	20,50	32,30	342,00	57,90	44,50	23,10	54,67	363,67	61,40
	PZ	67,00	23,90	37,20	369,00	63,30	45,00	24,93	56,67	356,33	62,70
	PH	67,00	22,80	34,20	387,00	56,20	42,00	26,17	58,00	381,67	60,80
Average for B2		67,00	22,40	34,57	366,00	59,13	43,83	24,73	56,45	367,22	61,63
Year Average		67,67	23,35	34,23	361,50	60,17	42,25	26,74	60,00	365,83	63,13

Tab. 1: Food wheat quality (I&II – flour yield, G – gluten content, SDS – SDS-test value, FN – falling number, VV – valorigraphic value).

In the initial year of the experiment (Tab. 1), the wheat quality can be characterized as average: flour yield was less than 68%, SDS-test below 35 ml, wet gluten content under 25% but with very good bulking (in excess of 16 ml). Seven years later (Tab. 1), all of the quality parameters improved significantly in grain and obtained flour as well. Solely the flour yield was lower – this can be connected to the low grain yield (7-years minimum) in this abnormally dry year 2000.
The wheat quality improvement, compared to the initial state, was observed in the very same variants showing positive tendencies for the soil water-resistant structural aggregates as well.

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INFLUENCE OF ANTHROPOGENIC FACTORS ON THE PRODUCTION MILK POTENTIAL OF GRASS STANDS

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Summary

The production and quality of dry matter of hay (association *Lolio-Cynosuretum typicum*) were observed in 1992-1996. The observation was carried out on the seminatural grass stand and on the grass stand with additional sowing of grass and clover enriched by artificial fertilizer. The capacity of dry matter consumption of milk cows was used for evaluation of quality of production milk potential. The production milk potential of feeding ration was calculated on the basis of energy and nitrogenous substances.Higher values of production milk potential PDI on the perennial grass stands (figure1) with the maximum 21.27 l.head.day^{-1} resulted from the comparison of observed grass stands. The evaluated index of the renewed grass stands was lower than the values obtained on the perennial grass stands (in the first usage by 1.40 l, in the second one by 1.94 l and in the third one by 1.16 l.head.day^{-1}).When evaluating the production milk potential NEL (figure 1), we found out that the perennial grass stands produced 11.64-12.28 l of milk per head/ day and the renewed grass stands produced 10.82-13.87 l of milk per head.day^{-1}. The production milk potential was limited by energy value of dry matter of hay. If we want to change the surplus of nitrogenous substances in a feeding ration into the real production of milk, we have to subsidize a daily feeding ration of milk cows using the suitable amount of energy.

Key words: natural grassland, floristic composition, production milk potential

Introduction

Coarse fodder from grass stands is the main source of nutrition of milk cows in marginal areas of Slovakia. The suitable production of dry matter is also required together with dry matter's high quality (Holúbek 2000).

The notion of quality is represented by a number of characteristics which influence the ability of fodder plants to satisfy specific requirements of animals and determine the suitability of fodder plants for feeding .The quality plays an important role in determination of production milk potential of grass stands measured in units of animal production (milk, meat and wool). The wide range of interactions between grass stands and animals has a great influence on quality. The quality of forage crop and fodder plant should be observed together (Míka 1992).

Material and methods

The experimental observation was carried out on the seminatural grass stands of the agricultural enterprise Nitrianske Pravno (Strážovské vrchy, geographical unit Malá Magura- Chvojnica locality) in the years 1992-1996.

Our experiment was based on the block method (two blocks were used in the experiment). The first block consisted of the original perennial grass stand which was identified, on the basis of its botanical structure, as the association *Lolio-Cynosuretum cristati* R.Tx. 1937.The second block comprised of the renewed grass stand which was radically renewed by ploughing in autumn 1991. In spring 1992, the ploughing was followed by the sowing of clover – grass mixture : *Lolium multiflorum* hybrid „Felina" 12 kg.ha^{-1}, *Lolium perenne* variety „Metropol" 8 kg.ha^{-1}, *Dactylis glomerata* variety „Nela" 4 kg.ha^{-1}, *Trifolium pratense* variety „Sigord" 3 kg.ha^{-1}, *Trifolium repens* variety „Huia" 2 kg.ha^{-1}.The same variants of mineral nutrition and methods of nitrogen division of individual cuttings were used for both blocks. At the same time, the identical forms of artificial fertilizer were also used .

The grass stands were used in their late pasture ripeness. The yield of the grass stand of individual parcels (1.2x10 m) was determined at harvest. The sample with its weight 0.5kg was used to determine the dry matter. Then the calculation of dry matter production in t.ha^{-1} followed.

The Research Institute of Agriculture in Nyon participated in determination of agronomical value of dry matter of hay.

The capacity of dry matter consumption of milk cows was calculated to help us evaluate the quality of grass stands (Petrikovič 1994) Then the production milk potential was calculated on the basis of energy and nitrogenous substances (Sommer et al. 1994). The milk cow with the live weight of 600 kg and with the milk production of 10kg FCM milk per head/day was used for the calculation of dry matter consumption from the grass stand.

The production milk potential of the grass stand on the basis of NEL and PDI was calculated according to the following relationship:

$$PMP_{NEL} = \frac{\text{MJ NEL on milk production}}{\text{MJ NEL on 1 kg FCM}} \quad (\text{kg.head.day}^{-1})$$

$$PMP_{PDI} = \frac{\text{PDI on milk production}}{\text{PDI on l kg FCM}} \text{(kg.head.day}^{-1}\text{)}$$

Results and discusion

The evaluation of production milk potential calculated from the energy value of fodder plants

The concentration of energy (energy content in a unit of dry matter of fodder plant) is the most important feature of quality of fodder plant and it is also closely linked with the consumption of fodder plants by animals as well as with the fodder plant's production effect. The average values indicate that the values of production milk potential NEL on the perennial grass stand were very similar in the first utilization, in the second one and also in the third one . The values of the renewed grass stand rose from the first utilization (10.82 l.head.day^{-1}) to the third utilization (13.87 l.head.day^{-1}). It is interesting that the highest value of production milk potential NEL (perennial grass stand 12.39 l.head.day^{-1}; renewed grass stand 12.49 l.head.day^{-1})was determined on the non-fertilized areas of both grass stands in the period of five years. According to the above mentioned facts, we were able to determine the following results : the non-fertilized grass stands accumulated more energy and the production milk potential NEL of non-fertilized areas was higher than the production milk potential NEL of fertilized grass stands.
The application of nitrogenous fertilizer did not influence the values of production milk potential NEL substantially. We were able to observe the opposite tendency represented by higher values of production milk potential NEL on non-fertilized grass stands. The nitrogenous fertilization lowered the content of netto energy in dry matter.

Table 1 The production milk potential of daily feeding ration consisting of grass stand and calculating on the basis of production milk potential PDI and NEL (l of milk .head.day^{-1})

Years 1992-1996	Variants	Perennial grass stand				Renewed grass stand			
		Utilization				Utilization			
		I.	II.	III.	x	I.	II.	III.	X
production milk potential NEL	1	12.42	12.29	12.46	12.39	11.70	11.86	13.93	12.49
	2	12.11	11.29	11.64	11.68	11.00	11.32	13.76	12.03
	3	12.13	11.07	12.07	11.76	11.27	12.09	13.89	12.42
	4	11.80	11.93	12.97	12.23	9.32	11.60	13.91	11.61
	x	12.12	11.64	12.28	12.02	10.82	11.72	13.87	12.14
production milk potential PDI	1	20.16	18.18	21.30	19.88	20.18	16.85	20.79	19.27
	2	20.20	16.99	21.96	19.72	20.04	16.89	21.43	19.45
	3	20.20	18.51	20.74	19.82	18.70	15.89	19.28	17.96
	4	23.25	22.75	21.08	22.36	19.32	19.03	18.94	19.10
	x	20.96	19.11	21.27	20.44	19.56	17.17	20.11	18.95

variant 1 – non-fertilized locality; variant 2 – 30 P + 60 kg K.ha^{-1}; variant 3 – PK + 90 N.ha^{-1}; variant 4 – PK + 180 N kg.ha^{-1}

The evaluation of the production milk potential calculated on the basis of real digestion of nitrogenous substances (the production milk potential PDI)
According to Ščehovič (1994), nitrogenous substances belong to a group of main qualitative features of fodder plants from grass stands. In the new systems of evaluation of nitrogenous substances, the digestion and metabolism of nitrogen can be interpreted together with the identification and quantification of losses of nitrogen which are caused by the inappropriate consumption of nitrogen (Sommer, Čerešňáková 1995). We used the acquired knowledge for calculation of production milk potential PDI. It can be derived from figure 1 that the perennial grass stands in average values had higher values of production milk potential PDI (20.44 l per head.day^{-1}) than the renewed grass stands (18.95 l per head.day^{-1}) . The difference between the grass stands was 1.49 l.
The value of production milk potential PDI ,on perennial grass stand in the first utilization, in the second one and also in the third one, was higher than the production milk potential PDI on renewed grass stand (figure 1). The nitrogenous fertilization on perennial grass stand caused the higher value of production milk potential PDI (the nitrogen dose 180 kg.ha^{-1} proved to be significant). There were no significant differences of values of production milk potential PDI among the variants of fertilized by nitrogen, variants fertilized by PK fertilizer and non-fertilized areas.
The influence of the highest dose of nitrogen on production milk potential PDI on the renewed grass stand was not unequivocal. This phenomenon can be explained by the influence of mineralization of organic matter after the radical

renewal of grass stand by ploughing. The ploughing caused the reduction of the effects of nitrogenous fertilization of individual variants because of the released nitrogen. The effect of mineralization was evident especially in drier years (1993 and 1995) when the renewed grass stand developed mainly into the first and third utilization when values of temperature prevailed over the values of precipitation (Slamka 1998).

The statistical evaluation of results of production milk potential PDI confirmed statistically important differences in the years of utilization of the given grass stands. Fertilization did not have a statistically significant impact on the production milk potential PDI.

If we compare production milk potentials calculated according to the concentration of netto energy of lactation and according to the content of digestible nitrogenous substances in the dry matter of grass stands, we can find out that the values of production milk potential PDI are higher than the values of production milk potential NEL on the both grass stands.

The value of average production milk potential NEL on the perennial grass stand is 12.02 l per head.day^{-1} and the value of the production milk potential NEL on the renewed grass stand is 12.13 l per head.day^{-1}. The average value of production milk potential PDI is higher than the production milk potential NEL (19.11-21.27 l per head.day^{-1} on the perennial grass stand and 17.17-20.11 l per head.day^{-1} on the renewed grass stand).

In conclusion, we can say that it is possible to achieve the milk production which corresponds to the values of production milk potential NEL on the given grass stands because the energy value of dry matter of grass stands is considered to be a limiting factor of milk production. It can be explained by the fact that there is a surplus of nitrogenous substances in the dry matter of fodder plant from grass stands. The milk production can be influenced negatively because the surplus of nitrogenous substances must be excreted from the organism of animal and this process is connected with the losses of energy.

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THE APPLICABILITY OF GRASS ALFALFA MIXTURE FOR BIOMASS PRODUCTION AND LANDSCAPE SUSTAINABILITY.

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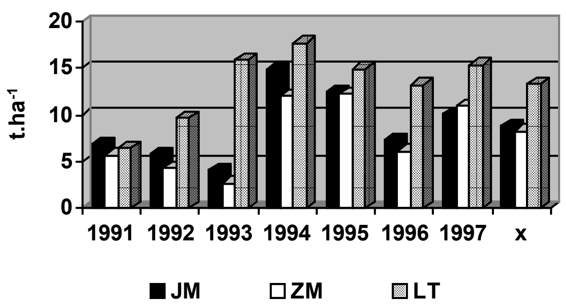
Summary

From many different registered legumes and grasses in Slovakia is possible to make grass clover mixture created for specific ecological condition and purposes without expectation of dramatic changes of grass clover pasture yield. The most productive are grass alfalfa mixture – 12,28 t.ha^{-1} followed by simple grass clover mixture – 8,80 t.ha^{-1} and composite grass clover mixture – 7,73 t.ha^{-1} (Figure 1).

***Keywords**: temporary grass clover mixture, biological, ecological, biomass, ad libidum feeding, simple and two -constituents mixture, fertilisation, production, landscape designing*

Fig. 1 The dry matter production for the year 1991 - 1997



Legend: JM = simple mixture
ZM = composite mixture
LT = grass alfalfa mixure

Introduction

In the frame of sustainable tendency of agriculture, share of fodder crops should be higher in the crop sequences. We have many good results from the past and present time, pointing to importance of grass clover mixture as a fodder resources contributed to sustainability of landscape. Each species have advantages and disadvantages for different situation. The growing simple grass clover mixture show up more suitable for Slovak condition. (Krajčovič et al,1968). Is better to used sowing mixture with different vegetation cycle for cutting, grazing, for ley, silage or seed production(Caputa et al,1970). The grass clover mixture are the most typical fodder plants of over the world (Krajčovič et al.,1995).

Material and methods

The field trial was establish on arable land in Nitra river valley ,145 m about sea level, with local position 48°14´ and 18°05´, average year temperature 9,7°C and 16,6 °C during vegetation period, 580mm or 323 mm year and vegetation precipitation, respectively. The soil is gley fluvisol. The aim of this study was to ascertained production capability, quality, persistence and ecological function of simple and composite grass clover mixture of some grasses, interspecific hybrids and following clover species – *Trifolium pratense L.* (variety SIGORD), *Medicago sativa* L.(PALAVA), *Lotus corniculatus* L.(POLOM), *Trifolium repens* L. (HUIA) and *Onobrychis viciifolia* SCOP.(VIGLAŠSKÝ). The crops were establish without cover crops, in dry land with three cuttings in 1991 –1997.

Results and discussion

Temporary grass clover mixture have been evaluated during 1971 – 1997.The biological and ecological relationship of grass and clover component and botanical composition of grass clover mixture and grass clover pasture yield have been studied. From this reason we included besides composite mixture (treatments 5-13) with 5-13 components(Table 2.) also simple two-components mixture. In the composite mixture the influence of the most competitive components, cockfood (*Dactylis glomerata* L., *Arrhenatherum elatius,* L. , interspecific hybrid FELINA, *Lolium perenne L.*), have been revealed. Total dry matter yield of grass clover mixture depends from sufficient amount of fertiliser, predominantly in composite mixture was significant decline of yield during time without nitrogen application (5,75 - 4,30- 2,70 tonne per ha).
At the present time dose of 120 kg of nitrogen is evaluated. In the seventieth higher dose of fertiliser(240 – 300 kg ha^{-1}) were used in trials due to favourable price Krajčovič et al.1968, Caputa et al,1970). The most productive are mixture with alfalfa(13,28 t/ha dry matter). The less yielding treatments from 22 evaluated simple or composite mixture were treatments No. 7, 10 and12. The *Lotus corniculatus L.* had a good share in composition of grass clover mixture No15 during hole experiment with 15 – 20% share. Maintain of clover part in sword after third year after seeding in treatments with 120kg ha nitrogen supported total dry matter yield in mixture of red clover *Trifolium pratense,* L. and *Festuca arondinacea L.* - 9,51 tonne dry matter per ha per year, red clover with interspecific hybrid FELINA (9,36 t ha^{-1} dry matter).The large research of simple and two components mixture(Krajčovič et. al,1995) documented, that varieties with low yield by single cropping are also less competitive with red clover mixture. The *Lotus corniculatus* L.as a complementary species in grass clover mixture can be used in all growing region of Slovakia due to adaptability and persistence and is recommended into temporary and perennial grass clover mixture, for undersowing, from arable land to grass pasture conversion, for interrows in orchards, vineyards and small fruits. There are aspects of landscape sustainability. Due to raising importance of *Lotus corniculatus* L.we solve also seed management production

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Table 1:The timing and fertilisation level

Years	Fertilisation kg.ha^{-1}			Spring application	N – application after first cutting
	N	P	K		
1991	6	35,2	83,0	60	-
1992	-	35,2	83,0	-	-
1993	-	35,2	83,0	-	-
1994	120	35,2	83,0	60	60
1995	120	35,2	83,0	60	60
1996	60	35,2	83,0	30	30
1997	120	35,2	83,0	60	60

Table 2 Solid production for the years of monitoring (years 1991 - 1997 in $t.ha^{-1}$).

Variant	1991	1992	1993	1994	1995	1996	1996	$\bar{x}$	Poradie
1	7,25	6,39	3,49	12,83	12,16	5,70	10,95	8,40	12
2	8,94	6,81	2,89	11,39	10,49	4,86	10,91	8,04	15
3	8,15	4,60	6,37	14,80	12,62	9,49	10,46	9,50	5
4	7,29	3,52	5,40	15,72	11,86	11,06	10,37	9,32	7
5	7,97	5,67	3,60	17,39	11,91	6,13	11,78	9,21	8
6	6,13	4,11	3,01	11,68	12,12	5,27	10,79	7,59	18
7	6,63	4,52	2,41	9,53	12,10	5,17	10,70	7,29	20
8	6,60	5,64	3,82	12,56	13,55	6,86	10,83	8,55	10
9	4,88	4,70	3,01	10,58	12,47	4,95	11,56	7,45	19
10	5,81	3,32	2,01	11,32	11,03	6,15	11,18	7,26	21
11	5,15	3,95	3,24	13,36	13,07	7,72	10,72	8,17	14
12	4,40	2,82	1,15	9,12	11,54	6,34	10,25	6,52	22
13	4,22	3,98	2,10	12,52	12,30	6,75	11,32	7,60	17
14	5,27	4,38	2,17	16,19	12,01	6,90	8,57	7,93	16
15	5,11	3,87	8,80	15,34	13,10	7,78	10,12	9,16	9
16	5,74	5,12	2,96	18,49	12,96	6,62	7,81	8,53	11
17	7,89	11,43	1,95	14,66	12,09	7,08	11,44	9,51	4
18	6,92	6,15	2,90	15,60	15,04	6,50	12,42	936	6
19	6,40	6,24	3,82	14,39	12,19	6,70	8,23	8,28	13
20	6,74	9,37	14,88	17,13	15,33	12,77	15,58	13,11	3
21	5,51	10,49	15,80	17,81	14,17	13,36	16,18	13,33	2
22	6,97	9,01	16,88	18,10	15,17	13,50	14,20	13,40	1
Spolu	139,97	126,09	112,66	310,51	279,28	167,66	246,37	197,40	-
$\bar{x}$	6,36	5,73	5,12	14,11	12,69	7,62	11,20	8,97	-
Poradie	5	6	7	1	2	4	3	-	-

EFFICACY OF CATTLE FARMYARD MANURE AS ORGANIC FERTILISER ON UPLAND MEADOWS

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Summary

The meadow treatment comprised the following variants: untreated control, mineral fertilisation dosed $P_{26}K_{66}N_{150} \cdot ha^{-1}$, farmyard manure dosed 12.5 t $\cdot$ ha^{-1}, farmyard manure dosed 12.5 t $\cdot$ ha^{-1} + mineral treatment with $P_{19}N_{110} \cdot ha^{-1}$ as supplementary to $P_{26}K_{66}N_{150}$ dose. Treatment of the meadow favourably influenced its sward botanical composition. Mineral fertilisation itself stimulated mainly *Arrhenatherum elatius* development. The effect of organic-and-mineral fertilisation was similar to mineral treatment. The untreated sward produced yield of about 5.87 dry mass per ha. Treatment only with farmyard manure increased the dry mass output till 8.34 t, i.e. almost by 2.5 t of dry mass. However, mineral and organic-and-mineral treatment effect on dry mass production was almost identical. The low crude protein output was characteristic of the control plot which produced annually on an average of 572 kg $\cdot$ ha^{-1}. The sward fertilised solely with farmyard manure, which was placed second, produced by 90 kg more protein. The utilisation of fertiliser components from farmyard manure was very high, higher than from mineral fertilisers. On an average, per 1 kg of PKN in farmyard manure the increases in dry mass yield was 21.5 kg and in crude protein 1.65 kg as compared to 19 kg dry mass and 1.70 kg crude protein with mineral and organic-and-mineral treatment.

Keywords: meadows, farmyard manure, dry mass, crude protein

Introduction

Prices of agricultural products, which are relatively low in comparison to means of production costs, limit the profitability of agricultural production (Kasperczyk and Radkowski, 1999). Thus farmers seek various ways to lower the costs of production. Especially in fodder production on grasslands many try to reduce expensive mineral fertilisation. Some studies reveal that mineral fertilisation constitutes between 55 and 60% of outlays on hay production (Szaro and Kuczek 1991). In this context farm produced fertilisers, particularly farmyard manure gain in importance. So, the authors undertook investigations to examine fertilising ability of cattle manure for permanent grassland treatment.

Material and methods

Studies were carried out in 1998-2000 on a permanent mountain meadow situated at 330 m above sea level, on brown soil with composition of medium loam. At the outset of experiment the meadow sward was rare revealing poor species diversity. Three species were prevalent, i.e. *Arrhenatherum elatius* – 35%, *Holcus lanatus* – 30% and *Plantago lanceolata* – 15%. The meadow treatment comprised the following variants:
- untreated control
- mineral fertilisation dosed $P_{26}K_{66}N_{150} \cdot ha^{-1}$
- farmyard manure dosed 12.5 t $\cdot$ ha^{-1}
- farmyard manure dosed 12.5 t $\cdot$ ha^{-1} + mineral treatment with $P_{22}N_{110} \cdot ha^{-1}$ as supplementary to $P_{26}K_{66}N_{150}$ dose.

The 12.5 t farmyard manure dose contained 7 kg P, 71 kg K and 40 kg N. The farmyard manure was applied every year in the early spring when snow disappeared. The meadow was cut twice. The first cut was in the initial period of *Arrhenatherum elatius* flowering, the second eight weeks later. In the second and fourth variants nitrogen was divided into two parts: 60% was applied under the first and 40% under the second cut. The sward composition was determined using Klapp's assessment method prior to the first cut gathering. Dry mass was assayed at 105^{o}C and crude protein content using Kjeldahl's method.

Results

Treatment of the meadow favourably influenced its sward botanical composition. Mineral fertilisation itself stimulated mainly *Arrhenatherum elatius* development. This plant proportion in the yield reached between 85 and 93%. On the other hand solely farmyard manure treatment increased mainly proportions of the papilionaceous: from trace amounts to 30% of *Trifolium pratense*, 5% of *Trifolium dubium* and 5% of *Lotus corniculatus*. The effect of organic-and-mineral fertilisation was similar to mineral treatment. The share of *Arrhenatherum elatius* in the yield approximated between 50-60% and the share of legumes between 5 and 7%.

The meadow productive potential was relatively high. The untreated sward produced yield of about 5.87 dry mass per ha. Treatment only with farmyard manure increased the dry mass output till 8.34 t, i.e. almost by 2.5 t of dry mass. However, mineral and organic-and-mineral treatment effect on dry mass production was almost identical. In the first case the yield reached 10.46 t and in the second 10.63 t · ha^{-1}. In comparison with the control the increase was about 80% and by 25% in comparison to farmyard manure treatment.

Table 1. Yields of dry mass

Treatment	1998	1999	2000	Mean
Unfertilised control	6.29	5.72	5.60	5.87
$P_{26}K_{66}N_{150}$ – mineral fertilisation	10.15	11.26	9.97	10.46
Farmyard manure 12.5 t · ha^{-1} ($P_7K_{71}N_{40}$)	7.90	9.52	7.61	8.34
Farmyard manure 12.5 t · ha^{-1} ($P_7K_{71}N_{40}$) + $P_{19}N_{110}$	10.36	11.70	9.84	10.63

The plant abundance in crude protein was generally low. It was due to two facts: fairly late harvest and high production of dry mass. Generally the control sward and the one receiving mineral treatment were the most abundant in protein. The plants of the two other plots had similar amounts of the component and were on an average by 5 g · kg^{-1} poorer than the sward for the first group.

Table 2. Concentration and yields of crude protein

Treatment	Concentration [g · kg^{-1}]				Yields [kg · ha^{-1}]			
	1998	1999	2000	Mean	1998	1999	2000	Mean
Unfertilised control	95.9	90.5	106.0	96.7	602	520	594	572
$P_{26}K_{66}N_{150}$ – mineral fertilisation	94.6	88.0	109.2	97.3	960	991	1087	1013
Farmyard manure 12.5 t · ha^{-1} ($P_7K_{71}N_{40}$)	104.2	81.9	90.0	92.0	822	780	685	762
Farmyard manure 12.5 t · ha^{-1} ($P_7K_{71}N_{40}$) + $P_{22}N_{110}$	86.7	93.5	99.1	93.1	898	110	974	991

The low crude protein output was characteristic of the control plot which produced annually on an average of 572 kg · ha^{-1}. The sward fertilised solely with farmyard manure, which was placed second, produced by 90 kg more protein. The greatest amounts of this component were collected from plots receiving mineral and organic-and-mineral treatments. The amounts were respectively 1013 and 991 kg · ha^{-1} and were by 441 and 419 kg higher than the control.

Discussion

The utilisation of fertiliser components from farmyard manure was very high, higher than from mineral fertilisers. On an average, per 1 kg of PKN in farmyard manure the increases in dry mass yield was 21.5 kg and in crude protein 1.65 kg as compared to 19 kg dry mass and 1.70 kg crude protein with mineral and organic-and-mineral treatment. Such high utilisation of fertiliser components from the farmyard manure by meadow plants should be viewed in connection with considerable rainfall over the vegetation period, when the many year average for this area was about 700 mm. As may be seen from other investigations of the same problem (Mikolajczak and Bartmanski 1992) conduced in drier areas of Poland the utilisation of fertiliser components from FYM was markedly lower, than with organic-and-mineral fertilisation. However, the results presented in the literature (Wesolowski 1995, Jankowska-Huflejt and Niczyporuk 1996) confirm that FYM treatment favours development of the papilionaceous and decreases meadow sward weed infestation.

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NITROGEN, PHOSPHORUS AND POTASSIUM BALANCE OF ALFALFA CROPPING IN CONDITIONS OF DIFFERENT NUTRITION INTENSITY LEVEL

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Summary

Research of the alfalfa, PALAVA variety, were solved in the polyfactorial stationary field trial at the Research Institute of Agroecology Michalovce – at experimental basis Vysoká nad Uhom over the years 1996 - 1998. The doses of nutrients were calculated at two different nutrition levels (V1, V2), the no-fertilized control (V3) were included too. At the evaluation of total balance, we were calculated with nutrient consumption and utilised amount of N from the mineral and inorganic fertilizers and soil resources, also. The evaluation shows, that balance is expressive negative. The alfalfa hay yield was achieved following amounts of N- content under different variants of nutrition level: V1 – 1064,13 kg. ha^{-1} , V2 – 970,70 kg. ha^{-1} and V3 – 796,27 kg. ha^{-1}. The values of the negative balance were increased upon the nutrition intensity. The evaluation of total balance of P – contents, which we calculated likewise as in N – case, was more temperate in comparison with N – balance. During three utility years, following amounts was comprised, under different variants of fertilizing: V1 – 102,78 kg. ha^{-1}, V2 – 94,80 kg. ha^{-1} and V3 – 91,84 kg. ha^{-1}. The values of negative balance as well as N – case increased by the nutrition intensity level. The total balance of K – contents were negative, too. This one was more temperate essentially (4,5 times more temperate) in comparison with N – balance, however, 4,5 times higher in comparison with P – balance. The yield of alfalfa was succeded following amounts of K contents, under different variants of fertilizing: V1 – 480,08 kg. ha^{-1}, V2 – 444,80 kg. ha^{-1} and V3 – 462,15 kg. ha^{-1}. The values of negative balance was the highest upon the most intensive variant of nutrition, likewise in N and P – cases, but the lowest values were in variant V2.

***Key words*:** alfalfa, nutrient balance, nutrition intensity level, nitrogen, phosphorus, potassium

Introduction

Growing of any crops, especially these ones that are economically important, isn't possible without intensification factors, that ensure adequate fertility and their needed qualitative indexes. At the same time it is necessary to take into account their availability in the relationship to the economy and environment. At growing the most common intensification measure is using fertilizers, in a new conception at the co-operation of a year effect (CIHACEK 1993, HANNAWAY and SHULER 1993, RAUN et al. 1999). These questions are studied by many authors in our country as well as abroad. Especially nitrogen is emphasised as very mobile nutrient, but also some other nutrients and agrotechnical measures (ANDREAS 1996, BURMESTER 1991, ALLEN and ENTZ, 1994, HORN and NEMETH 1991).
The aim of this work is to evaluate fertilizing and to check rationality by the influence of environment.

Material and methods

Research of the alfalfa, PALAVA variety, were solved in polyfactorial stationary field trial at the Research Institute of Agroecology Michalovce – at experimental basis Vysoká nad Uhom over the years 1996 - 1998. The base is situated in the central part of East Slovak Lowland. Field trials were stood on Eutric fluvisol, without irrigation.
The crop stands was established by spring sowing, the sowing rate: 7 million of germinating grains per hectare. The direct forecrop of the alfalfa rape was winter wheat.
Soil conditions: Eutric fluvisol (EF) - is a middle soil, sandy – loam up to loamy soil. The topsoil has bean shaped structure. According to tests made in autumn 1997 followed characteristics were found out: average C_{org} contents 2,073%; $pH_{(KCl)}$ 7,14; H_o (bulk soil density) 1532 kg.m^{-3}; P 41,85%; cont. part. I. cat. (clay content) over 30%; $CaCO_3$ 0,28%; average "S" value 24,1 mmol.100g^{-1}; "T" value 24,9 mmol.100g^{-1}; "V" value 96,72%. Nutrient supply N- 0,130%; P- 47,7 mg.1000g^{-1}; K- 153 mg.1000 g^{-1}; Mg- 122 mg.1000g^{-1}.
Nutrient contents of soil samples was evaluated by using special methods: N-contents by colorimetric analysis; P- contents by EGNER method; K- contents by SCHACHTSCHABEL method.
Climate conditions: The East Slovak Lowland is situated in the warm, semidry to dry area with the average annual air temperature 9,0 °C, the average air temperature in the growing season is 15,2 °C. Annual total precipitation is 557 mm, in the growing season it is 397 mm.
Characteristic of years over the trial: 1996 – temperature expressively under normal, precipitation moderate above normal; 1997 – temperature in normal, precipitation gently under normal; 1998 – temperature expressively under normal, precipitation expressively under normal.
The information about basic climate values were acquired at the station of the Slovak Hydro-meteorological Institute that is situated near the field stationary. The detailed meteorological characteristics of the region were published by TÓTH (1998).

The nutrition (Table.1) was followed in three variants under different intensity (including no-fertilized control) in four repetitions. Mineral fertilizers were fully applied before sowing and heavy scuffler was used. The doses of nutrients were calculated at two different nutrition level, the no-fertilized control were included too.

Table 1: The nutrition intensity according to variants (kg.ha^{-1})

Variant – nutrient	N	P	K
V1 (fertilizing at level 15 t)	30*	36	115
V2 (fertilizing at level 12 t)	30*	32	102
V3 (no-fertilized control)	-	-	-

*...application of nitrogen only in the 1st utility year (1996)

Tillage treatment: The basic and foresowing soil tillage was made by machines and tools common used. We were used the **conventional agrotechnics:** after forecrop harvest we made autumn plough – depth 220-240 mm. The next autumn operation was a ploughed field treatment by hard harrows. At spring soil bed preparation we used middle harrows. The sowing depth was 20-25 mm. At every soil treatment variant we used a roller after sowing.
Herbicides application: Herbicides were applied postemergently: Basagran 600 + Aminex Pur (2,5 l.ha^{-1} + 1,0 l.ha^{-1}), but only on stands in the 1st utility year before first cutting.
The size of variants: 5 m x 10 m, number of repetitions: 4
Nutrient contents of alfalfa dry matter was evaluated by using special methods: N- contents by KJELDAHL method; P-contents by colorimetric analysis; K-contents by spectrophotometric analysis.
At nutrient balance we calculated with N-exhaustion of 50% from soil and equally from mineral fertilizers, P-exhaustion of 13% from soil and 20% from mineral fertilizers, K- exhaustion of 60% from mineral fertilizers.

Results and discussion

The purpose of the polyfactorial stationary field trial was found out the selected chemical parameters, which review is part of the valuable tables. In the field trial conventional variant of agrotechnics and three variants of nutrition were observed. According to information about temporal course of basic nutrition regime and the others watching parameters, expressing as empiric values, it's evident, that these were very different (Table 2).

Table 2: Contents of nutrients over the three utility years and over the year of stand liquidation, according to followed nutrition variants

Nutrition	V1	V2	V3	V1	V2	V3
Year		$N (NH_4+)$ (mg.kg^{-1})			P (mg.kg^{-1})	
1996	10.16	12.13	10.30	52.00	48.60	10.10
1997	9.16	9.06	9.59	49.30	51.20	14.20
1998	11.03	10.90	10.52	55.80	53.60	13.70
1999	9.30	9.84	9.62	52.30	54.30	15.30
		$N (NO_3^-)$ (mg.kg^{-1})			K (mg.kg^{-1})	
1996	4.15	3.62	4.05	176.00	173.80	121.00
1997	2.19	3.08	2.89	180.60	183.10	130.80
1998	4.19	3.32	3.84	176.30	178.90	133.80
1999	3.93	4.06	3.62	180.60	189.30	140.30

Evaluation shows, that nutrition balance is expressive negative. The crop yield of alfalfa was explained following amount of N- contents under different variants of fertilizing: V1 – 1064,13 kg. ha^{-1} , V2 – 970,70 kg. ha^{-1} and V3 – 796,27 kg. ha^{-1}. Table 3 represents time development of nutrient balance of total nutrient contents as empiric values.

The negative balance of N (inorg.) contents was ascertained. The values of negative balance were increased under different nutrition intensity level. Evaluation of total balance of P – contents calculated likewise as in N – case confirmed, that correlation was more temperate in comparison with N – balance. During three utility years following amounts of P were recorded: V1 – 102,78 kg. ha^{-1}, V2 – 94,80 kg. ha^{-1} and V3 – 91,84 kg. ha^{-1}. The values of negative P- balance as well as in N – case were increased under raising of nutrition intensity level.
The total balance of K – contents was negative, also. This one was more temperate essentially (4,5 times more temperate) in comparison with N – balance, however, 4,5 times higher in comparison with P – balance. The alfalfa yield explained following amounts of K contents during three utility years, under different variants of fertilizing: V1 – 480,08 kg. ha^{-1}, V2 – 444,80 kg. ha^{-1} and V3 – 462,15 kg. ha^{-1}. The values of negative balance was the highest under the most intensive variant of nutrition likewise in N and P – cases, but the lowest values were in variant V2.
This investigation can be explained by mighty developed radical system and competence of alfalfa to draw nutrients from more inaccessible forms and by presence of nitrogenous bacteria, also (CIHACEK, 1993; KUNCL ET AL., 1995). The

negative balance of phosphorus and potassium we gave to be connected with competence of alfalfa to draw these nutrients from deeper forms, especially on intensive nutrition variants (BURMESTER ET AL., 1991).

Table 3: Time development of pure nutrient balance N, P, K f (t) = $\sum$ P f (H) + $\sum$ P f (Hz) - $\sum$ P f (Ys)

Nutrition variant	V1	V2	V3
Utility year	N (inorg) (kg.ha^{-1})		
I. (1996)	-315,26	-310,53	-268,12
II. (1997)	-415,57	-354,74	-293,81
III. (1998)	333,30	-305,43	-234,34
Total	-398,53	-971,7	-797,27
Utility year	P (kg.ha^{-1})		
I. (1996)	-30,70	-31,34	-30,81
II. (1997)	-40,94	-34,49	-34,01
III. (1998)	-31,14	-28,97	-27,02
Total	-103,78	-95,8	-92,84
Utility year	K (kg.ha^{-1})		
I. (1996)	-144,15	-147,54	-155,88
II. (1997)	-189,60	-161,66	-169,03
III. (1998)	-146,33	-135,60	-137,24
Total	-481,08	-445,8	-463,15

Used symbols: $\sum$ P f (H) – function of mineral fertilizers use, $\sum$ P f (Hz) – function of inorganic fertilizers use, $\sum$ P f (Ys) – function of nutrients exhausted by yield, f (t) – time function

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THE SPECIFICS OF THE WATER REGIME OF THE SOILS ON THE EAST-SLOVAKIAN LOWLAND

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Summary

The specificity of the soil relations on the East-Slovakian Lowland reside in the predominance of the soils with the glei soil-forming processes which include up to 65% of the agricultural soil.
The results of the dynamics of the supply of soil humidity and its influence on the yields of the field crops hint at the limiting effect of the high supply of the soil humidity at the beginning of the vegetation period as well as at the limiting effect of its deficiency in the second half of the vegetation period on the same soil stand.
The respect of the specifics of the economy with the soil humidity require the increase of the function efficiency of the built hydromelioration plants, the restructuring of exploitation of agricultural soil, the restructuring of the plant production and the differentiated agricultural procedure in the case of respect of the soil conditions.

Key words: soil conditions of the East-Slovakian Lowland, the supply of soil water, the economy with the soil humidity

Introduction

The characteristic phenomenon of the East-Slovakian Lowland is the representation of soil types. The older works mention relatively high representation of Eutric fluvisol (up to 29%) as well as Albic luvisol (9%). However, the latest data from the soil evaluation (VILČEK, 1998) demonstrate that the acreage of the typical Eutric fluvisols is only about 7%. The predominance of the soils with the glei soil-forming processes (Fluvi-eutric gleysols, Fluvi-mollic gleysols, Gleic planosols, Eutric gleysols). The mentioned soil representatives cover up to 65% acreage of the agricultural soil of territory. The dynamics of the soil water as a result of the activity of natural factors, which has in time and space characteristic course, is termed a water regime of the soil (FULAJTÁR 1986, BEDRNA 1977, ŠÚTOR et al. 1982). It is influenced by antropogenic factors, e.g. hydromelioration, plant cover and the systems of tillage (ŠÚTOR et al., 1995).

Material and methods

In the contribution demonstrated outputs and results were obtained as a result of the solution of several scientific and technological projects coordinated by the Research Institute of Agroecology in Michalovce. The long-term stationary field trials have been established since the year 1970 on the prevalent soil types of the East-Slovakian Lowland - Eutric fluvisol, Fluvi-eutric gleysol and Albic-gleic luvisol. The arrangement of the trials makes possible to evaluate production environment and the resultant production from the point of view of the quantity of experimental variants.

Results and discussion

The limiting factor of the yield level of the field crops on the East-Slovakian Lowland are the delayed terms of seeding of the spring crops not only in the damp year. The similar situation was observed in the case of heavy rainfalls in the spring (especially in March) in the years which are in the next course of the vegetation period typical as the dry years eventually very dry (e.g. 2000) as far as the rainfall conditions is concerned.
The influence of the delayed terms of seeding on the reduction of the crop yields of spring barley, peas, sugar beat and maize for grain from the statistical set of 25-years is demonstrated in

Table 1: The dependence of the reduction crop yields on the term of seeding (t/ha)

crop	optimal term of seeding	delay of the term of seeding in comparison with the optimum (days)						
		5	10	15	20	25	30	35
spring barley	10.3.	0,02	0,32	0,68	1,02	1,32	1,72	2,08
peas	15.3.	0,23	0,57	0,95	1,37	1,82	2,30	
sugar-beet	10.4.	0,81	2,55	8,07	25,46			
maize for grain	20.4.	0,53	0,96	1,40	1,83	2,27	2,70	3,14

There was observed the limiting effect of the long term decrease of the content of soil water below the values of the optimal supply of plants with the water in the second half of vegetation period. As far as the time duration and absolute

values is concerned, the higher decrease below the mentioned values was observed not only in the dry years, but also in the years with the rainfall conditions at the level of the long-time normal (Fig. 1).
The water mode of the soils is significantly influenced by the grain composition of the soils which is a stabile sign of the soil fertility. It is possible to change it only at the expense of excessively high financial costs. The grain composition is the decisive factor of the hydrophysical characteristics of the soils as well as many others phenomenons which cause their space and time variability.

Fig. 1: Time course of the soil water supply on the East-Slovakian Lowland in the typical years

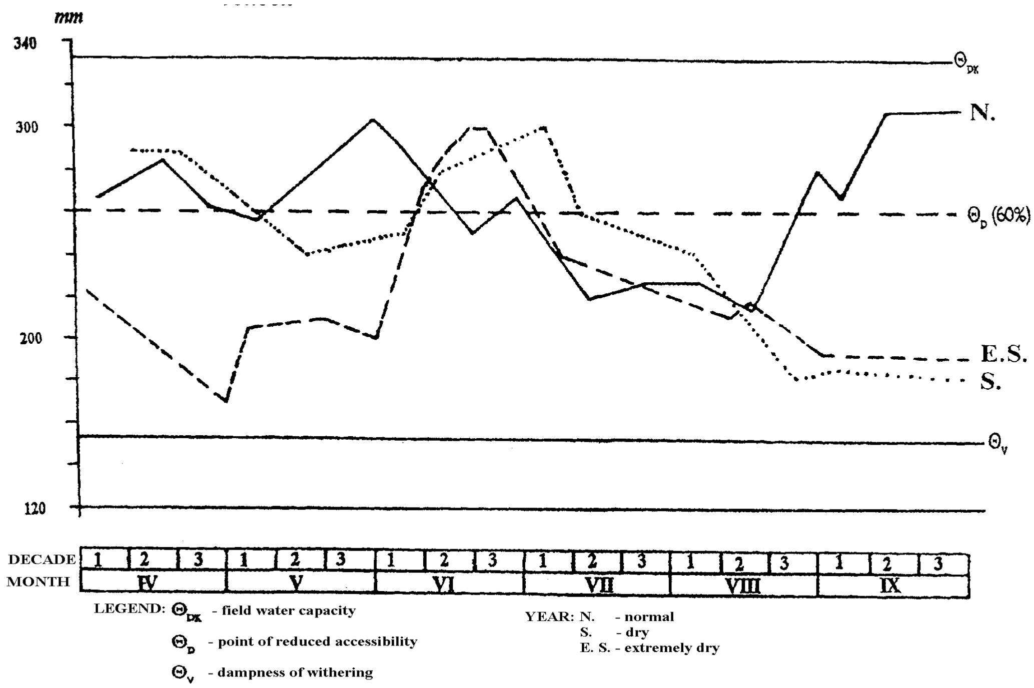

Table 2 The grain composition of the decisive soil types on the East-Slovakian Lowland

Soil type	Soil Type	microstructure in %			
		∑ I-II	III	IV	V
Fluvi-eutric	Mould	37,543-65,761	22,316-39,587	6,819-21,001	0,414-4,655
Gleysol	Undermould	33,196-65,696	22,199-42,500	8,962-30,793	0,185-8,335
Eutric	Mould	21,482-40,573	24,286-34,286	28,410-48,963	0,011-5,024
Fluvisol	Undermould	8,957-46,488	9,919-46,053	10,609-77,470	0,002-31,157
Albic-gleyic	Mould	32,551-45,456	37,658-54,613	7,333-22,950	1,367-5,944
Luvisol	Undermould	31,943-49,514	33,949-53,401	6,122-20,484	0,878-7,855
Eutric	Mould	78,482-86,767	6,164-13,446	6,353-7,887	0,558-0,775
Gleysol	Undermould	85,102-90,305	5,055-11,914	1,802-5,550	0,124-0,564

As far as the hydrophysical characteristics of the selected soil types on the East-Slovakian Lowland is concerned, there is resulting that the limiting effect of the surplus as well as deficiency of the soil humidity on their fertility in the very heavy soil (Fluvi-eutric gleysols and Eutric gleysols) is manifesting via the low to very low values of the utilizable water capacity of the high values of the point of withering, the low values of the minimal air capacity, the low till very low conductivity of the soil saturated with water as well as unsaturated soil and the low to very low drainage ability. On the contrary the Eutric fluvisols are considerably lighter as far as the grain structure is concerned and they belong to the light up to medium heavy soils. In the case of Eutric fluvisol in the whole soil profile and Albic-gleic luvisol in the mould the values of the utilizable water capacity are significantly higher. However, in the case of Albic-gleyic luvisol more expressively is manifesting the insufficient air capacity. The hydraulic conductivity is in these soil types increased up to high and the dewatering ability is good up to very good.

In the case of intensive agricultural exploitation of the territory of the East-Slovakian Lowland the decisive task play the waterworks regulations not only in the protection against flood, but especially for taking the internal waters in the required level mode as well as time mode and the systematic drainage and the irrigation at the regulation of the conditions of humidity in the soil.

In continuity with the rational exploitation of the production potential of the soils the most important claim is the covering of the very heavy Pseudogleysols and Eutric fluvisols with the grass vesture to coherence with their unfavourable water mode. The localities of the peripheral regions represent particularly Albic luvisols, Eutric cambisols and Plano-gleyic luvisols. Typical is the late start of the spring field works and significant shortage of the soil water supply in the summer period. Therefore, they require the specific structure of the plant production with the orientation to winter cereals and winter rape.

Concerning the complex natural but especially economic conditions it is not possible the universal recipe as far as the optimalization of the relation between water and air is concerned as well as the whole system of farming on the East-Slovakian Lowland. However, the worked-out programme of the agricultural development on the East-Slovakian Lowland up to 2005 indicate the possible aim and the efficiency.

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ECONOMICAL ASPECTS OF ALFALFA CROPPING (*MEDICAGO SATIVA L.*) UNDER DIFFERENT TILLAGE AND NUTRITION INTENSITY

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Introduction

Raising production of the vegetal mode is in simultaneity fastens in essentially composite economy stipulation, as it was 80-s. In practise it means to make more with scarceness of working powers, on low acreage soil and with a little cubage intensificated resources. From this point of view the growing of whichever crops, mainly economically eminent, isn't actual without respecting intensificated factors, with provide suitable harvest and its qualitative indicators.

A matter of fact sits about the economic stature perennial fodder crops, that form the orientation acreage cca 1.500.555 ha arable soil in Slovakia steady engaged 10-14 % (table 1), along there is a visible acreage decline in after-transformation period against before-transformation. By its 45 -59 % alfalfa stands as a dominating crop within the frame of perennial fodder crops, by relatively deuces productions. Despite of its biological strangeness, thus meaning monumental and profound radical system with nitrogen – assimilating bacteria competent to swab and release some nutrients also from and from the lesser accessible forms and more profound layers as well as to bind the airy nitrogen, is nourishment, e.j. a yearly phosphorus and potassium requirement as well as startup nitrous amount, the most intensificated factor for alfalfa growing. In latter conception besides there is also tillage system of soil, which confirms a manifest interest in about economy or minimum alternatives also in a case "garden set-out exigent" alfalfa.

Material and methods

In this work, we to decline the exact scientific results gained by the variant growing of alfalfa, considering more extensive and intense style growing, in sense of nutrition as well as processing system soil, heading to the fall in value or to the increase in value of the true profitability and profit, or to the loss formation. This work also shows the real production figures of the alfalfa, the variety PALAVA of seeding 5 mil. germine grains.ha^{-1}, as well as the levels of own costs under three tillage system:

1, Conventional – ploughing 24 cm + classic seedbad preparation
2, Reduced - without ploughing + in spring by tiller rotor depth 10 cm
3, No-tillage - seeding to untilled and uncultivated soil seedbad preparation nourishment level (allowances pure nutrients NPK in kg^{-1})
1, intensive (V1) - N - 30, P - 36, to - 115
2, effective V2) - N - 30, P - 32, to - 102
3, nonfertilized control (V3) - with out nutrition

Table 1: Time development of perennial fodder crops and alfalfa acreage and production in structure of plant production in Slovakia (1989-1998)

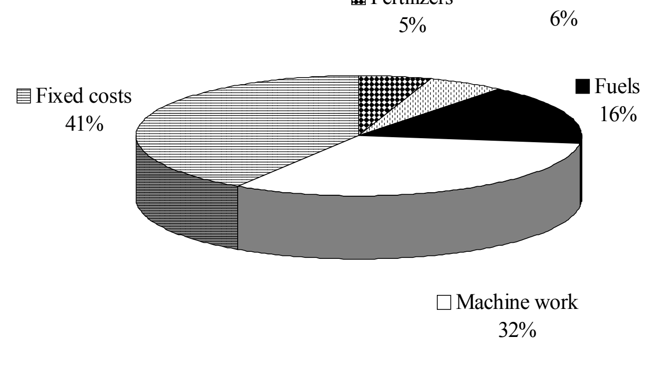
Year	Arable soil (ha)	Perennial fodder crops		Alfalfa	
		Area (% a.s.)	Production(t.ha^{-1})	Area (% pfc)	Production(t.ha^{-1})
1989	1 542 335	13,87	8,98	57,69	9,56
1990	1 543 516	13,27	8,06	58,54	8,35
1991	1 545 330	12,64	8,55	58,94	9,39
1992	1 538 780	13,17	6,81	54,81	8,19
1993	1 513 301	12,19	6,13	55,22	7,58
1994	1 512 290	11,68	6,73	54,57	8,28
1995	1 514 528	10,96	6,15	52,81	7,48
1996	1 507 997	10,48	6,30	49,57	8,02
1997	1 495 450	10,15	6,13	47,38	7,75
1998	1 495 653	10,16	6,00	45,37	7,47

Achievement in with irrigate conditions of a field stationary experiment of Research Institute of Agroecology on Eutric fluvisol markedly continental climate character on the eastern Slovak lowland. What should be added is, that evaluate triennial exploitage of stand alfalfa during 1998 – 2000, when in every year we had some vestures primary, from the first, second and third utility year.
At the valuation of some agronomic and economical indicators which in influence the measure of marginal profit we came out from growth of yields per hectare aside and adequate growth of material inputs in the other side.
Items quantificated different input value at the same time we indicate as variable, others we consider as fixed (table2). Expressing the value of alfalfa production we calculated with incorporate realization price 950,00 Sk.ha^{-1} and the like a homogeneous altitude own costs on secondary product 2178,00 Sk.ha^{-1}.

Result and discussion

From the registration analyses of the own cost structure (table.2) it is evident, that variable cost were the most significant on the conventional classic variant of arrangement soil (average CA - 14786,67 Sk.ha^{-1}), less significant on the variant reduced agrotechnics (RA - 13900,00 Sk.ha^{-1}) and the least significant on the variant no-tillage system of seeding (NT - 13300,00 SK.ha^{-1}). This fact shows the financial severity slash of the inputs by falling intensity of arrangements soil, bunk the distinction among individual variant as following: CA-RA 886,67, CA-NT 1486,67 and RA-NT 600,00 Sk.ha^{-1}. From the registration in table.2 it is evident, that variable costs produce one with another 59,03% on average from general costs. The important print of variable costs is an item quantificated machine labour generating on average 32,17% from general weight (54,50% variable) and fuel item, generating on average 16,14% from general weight (27,34% variable). Low, on average 5,56% share from all general and 9,42% variable weight engaged chemical prophylactic, which fall in the neighbourhood of equilocus level by the shop manure (5,16% total and 8,74% variable costs). Individual uncollected items of variable weight are with the intensity processing soil and nourishment shaky.
Adequately by the distinction in inputs, the distinction in income sink decrease of tillage intensity level: CA - 15507,73, RA - 15326,7, NT - 11349,05 SK.ha^{-1}. Distinctions among the individual processing system are as following: CA-RA 181,03 Sk. ha^{-1}, CA-NT 4158,68 and RA-NT 4158,68 Sk ha^{-1}. The average expense profitability level was on the variant CA 63,10, RA 64,75 and NT 49,07%, so at the variation span 15,68%.
Similar, but more expressive relations are at economy of the following nourishment variants. Variational span of expense

Fig.1: The share of selected items on structure of own costs level



measure profitability (14,11%) is in comparison with an adequate registration of arrangements soil variant in the neighbourhood level. Variant nourishment profitability V1 is 64,92%, V2 61,19 and V3 50,81 %. The Average altitude of the

variable costs, according to variants nourishment following: V1 14925,33, V2 14708,00 and V3 12383,33 67 Sk. ha^{-1}, the economic correspond income with : V1 16004,72, V2 14951,90 and V3 11226,97 Sk. ha^{-1}. Distinctions income intervene between individual nourishment variantsare as following: CA-RA 1052,82 Sk. ha^{-1}, CA-NT 4777,75 and RA-NT 3724,93 Sk. ha^{-1}.

The variational span of expense measure profitability (29,25%) trots in he expressive distinction of profitability, according to the fertilisation variant and also arrangements soil in comparison with the effect of individual inputs. Relations between the costs of attained harvest according the differentiated intensity make orientation possible primer by searching for the optimal production grades.

Table 2 Economical analysis of alfalfa cropping at different tillage and nutrition intensity level (1998-2000)

Tillage variant	CA			RA			*NT*		
Nutrition variant	V1	V2	V3	V1	V2	V3	V1	V2	V3
Yield per hectare (tone)	45,41	43,79	37,01	43,83	42,80	36,20	38,98	37,62	31,88
Costing formula entriens	Sk/ha								
Fertilizers	1982,00	1810,00	0,00	1982,00	1810,00	0,00	1982,00	1810,00	0,00
Pesticides	900,00	900,00	900,00	900,00	900,00	900,00	2100,00	2100,00	2100,00
Fuels	4416,00	4378,00	4224,00	4128,00	4094,00	3936,00	3136,00	3072,00	3040,00
Machine work	8450,00	8450,00	7950,00	7850,00	7850,00	7350,00	6950,00	6950,00	6750,00
Variable costs	15748,00	15538,00	13074,00	14860,00	14654,00	12186,00	14168,00	13932,00	11890,00
Fixed costs	9672,00	9672,00	9672,00	9672,00	9672,00	9672,00	9672,00	9672,00	9672,00
Total costs (TC)	25420,00	25210,00	22746,00	24532,00	24326,00	21858,00	23840,00	23604,00	21562,00
TC of secondary product	2178,00	2178,00	2178,00	2178,00	2178,00	2178,00	2178,00	2178,00	2178,00
TC of main product	23242,00	23032,00	20568,00	22354,00	22148,00	19680,00	21662,00	21426,00	19384,00
Yield per hectare (tone)	45,41	43,79	37,01	43,83	42,80	36,20	38,98	37,62	31,88
TC per tonne	511,81	526,02	555,68	510,02	517,43	543,59	555,78	569,58	607,95
Realization price (Sk / t)	950,00	950,00	950,00	950,00	950,00	950,00	950,00	950,00	950,00
Income	43140,45	41595,75	35163,30	41638,50	40663,80	34393,80	37027,20	35736,15	30289,80
Profit per ha	17720,45	16385,75	12417,30	17106,50	16337,80	12535,80	13187,20	12132,15	8727,80
Profit per tonne	390,22	374,23	335,48	390,29	381,69	346,25	338,34	322,52	273,74
Zero rentability yield	26,76	26,54	23,94	25,82	25,61	23,01	25,09	24,85	22,70
Cost rentability level (%)	69,71	65,00	54,59	69,73	67,16	57,35	55,32	51,40	40,48

MICROPROPAGATION OF *PAEONIA ARBOREA* DONN., SYN. P. *SUFFRUTICOSA* ANDR.

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Summary

Woody peony belongs to the ornamental species with problematic propagation therefore micropropagation in “*in vitro*” conditions should be one of the suitable methods to overcome this problem. In this study, the effect of growth regulators for inducing the axillary buds of woody peony cv. Comtesse de Tuder in culture medium is described. On Murashige & Skoog

(1962) medium supplemented with 1.0 mg.l^{-1} BAP and 0.2 mg.l^{-1} NAA the multiplication coefficient reached the maximum value 4.7 per explant. The BAP concentration significantly increased the number of axillary shoots and the NAA concentration significantly increased in length. The higher concentration of NAA increased the number of vitrified axillary peony shoots in "*in vitro"* culture.

Key words: woody peony, growth regulators, axillary shoots, coefficient of multiplication

Introduction

Many factors e.g. the physiological status of the mother plants, the cutting positions and growth regulators used are limiting for the peonies propagation. Peonies micropropagation described Youlong (1984) and Constantine (1986). Kamenická and Valka (1997) published three possibilities of peonies propagation by using following methods: 1. Generative (the seed dormancy; stratification; the plants from the seeds blossom are later than from vegetative propagation). 2. Vegetative (the mother plant cultures; cuttings taken; limited amount of rare and menaced species; the growth regulator applications). 3. Tissue cultures (the fast clone propagation; the high multiplication coefficient; continuous propagation during the whole year; cultivation of the healthy regenerants; the long term of the storage at the low temperatures). Woody peonies belong to the ornamental shrub plants propagated mostly by the cuttings but this is less effective in the large-scale production. From this point of view using the plant tissue cultures seems to be perspective one.
The objective of our experiments was to study the influence of BAP (6-benzylaminopurine) and NAA (a-naphtaleneacetic acid) in different concentrations and combinations. The number and length of the axillary shoots, formation of the vitrified shoots and the multiplication coefficient of cuttings from 5 years old woody peony cv. Comtesse de Tuder propagated in " *in vitro"* conditions were tested.

Material and methods

Internodal stem segments from 5 years old woody peony cv. Comtesse de Tuder were used during the spring 1996 and 1997 for the axillary shoots induction. The stem segments were sterilised by autoclaving (PS 20-A) 30 minutes at 120 ^{o}C, all laboratory items were sterilised by hot air, 70 % alcohol or using UV lamp. As a control modified Murashige & Skoog (MS) medium was used (MS + 7 g.l-1 agar + 0.5 mg.l-1 nicotine acid + 0.1 mg.l-1 thiamine + 0.5 mg.l-1 pyridoxine + 2 mg.l-1 glycine + 100 mg.l-1 myo-inositol and 30 g.l-1 sucrose). Further experiments were carried by adding 0.5, 1.0 and 2.0 mg.l-1of BAP or by adding 0.1, 0.2 and 0.5 mg.l-1 of NAA, each in the combination with 1.0 mg.l-1 BAP. pH of all media used was adjusted to pH 5.6 -5.8 before autoclaving. Peony stem segments were placed in a large test tubes/ glass jars and cultured in a growth chamber with a photoperiod of 16 h (100 μEm^{-2} s^{-1}) white fluorescent light at 22 ^{0}C. After 5 weeks of cultivation the number of axillary shoots and their length, the number of vitrified shoots and the multiplication coefficients were evaluated, as well as. The obtained experimental data were statistically analysed using the general method of ANOVA (SPSS for Windows, vers. 6.0).

Results

On MS medium without growth regulators usually was formed one axillary shoot with an average length 13.04 mm. The number of axillary shoots increased up to 4.25 (per stem segment) by increasing BAP concentration to 1.0 mg.l-1 but when BAP concentration 2.0 mg.l-1 was used number of the axillary shoots decreased to 3.75 (see Table 1.).
Analysis of variance validated the high significance of differences in the number of shoots between the treatments (see Table 2.). Analysis of variance validated high significance of differences in number of shoots between treatments – table 2. Influence of BAP on the lengths of the axillary shoots became negative, but statistically not significant. Analysis of variance validated also high significance of differences in % of the vitrified axillary shoots. The most of vitrified shoots (61.79 %) was found at the concentration 2.0 mg.l^{-1} BAP, i.e. 528.57 % in comparison with the control MS medium. The highest efficiency of the axillary shoots 34.00 (an average length in

Table 1 Ifluence of BAP Concentration on Multiplication of *P. suffruticosa* cv. Comtesse de Tuder

mg.l^{-1} of BAP	Number of Shoots (pieces)	% to Control	Length of Shoots (mm)	% to Control	Vitrification (%)	% to Control	Efficiency (pieces x Ø length)	% to Control
0.0	1.00	100.00	13.04	100.00	11.69	100.00	13.04	100.00
0.5	2.75	275.00	10.14	77.76	10.02	85.71	27.89	213.88
1.0	4.25	425.00	8.00	61.35	15.03	128.57	34.00	260.74
2.0	3.75	375.00	7.80	59.82	61.79	528.57	29.25	224.31

Table 2 Analysis of Variance of BAP Effect on the Axillary Sshoot Numbers

Source	Sx^2	N	V	F
Cultivation medium	159.0000	3	32.4375	25.6700**
Repetition	3.1875	3	1.0625	0.2920
Residual	29.3750	9		
Total	191.5625	15		

*** = high significance $F_{0.05} = 3.9$ $F_{0.01} = 7.0$

mm multiplied by number of shoots) was found at the concentration 1.0 mg.l-1 BAP that was 160.74 % higher than control treatment. Table 3. shows results from the follow-up experiment in which the best treatment from the first experiment (MS+1.0 mg.l-1BAP) was used as control. The highest number of axillary shoots 4.75 was found at the concentration 0.2 mg.l-1 of NAA. In comparison with the control experiment (MS+BAP) these results mean increase by 18.75 % but in comparison with control from the first experiment (MS) by 375 %. However, statistically high significant differences were found between the lengths of axillary shoots (Table 4.).

Table 3 The Influence of NAA Concentration on the Multiplication of *P. suffruticosa* cv.Comtesse de Tuder

mg.l-1 of NAA	Number of Shoots (pieces)	% to Control	Length of Shoots (mm)	% to Control	Vitrifica-tion (%)	% to Control	Efficiency (pieces x Ø length)	% to Control
0.0	4.00	100.00	8.20	100.00	18.37	100.00	32.80	100.00
0.1	4.00	100.00	10.92	133.17	15.03	81.82	43.68	133.17
0.2	4.75	118.75	12.47	152.07	16.07	87.48	59.23	180.58
0.5	3.75	93.75	7.90	96.34	50.01	272.24	29.63	90.34

Table 4 Analysis of Variance of NAA Effect on Axillary Shoots Length

Source	Sx^2	N	V	F
Cultivation medium	1620.5384	3	61.0783	88.0345**
Repetition	0.9683	3	0.3228	1.4664
Residual	1.9810	9		
Total	1623.4876	15		

** high significance
F 0.05 = 3.9
F 0.01 = 7.0

The longest axillary shoots (12.47 mm) were obtained on MS-medium supplemented with 0.2 mg.l-1 NAA, that means they were longer by 52.07 % in the comparison with the control shoots. The concentration of 0.5 mg.l-1 NAA had negative effect on the length of the axillary shoots. Vitrification reached 272.24 % in comparison with the control after 5 weeks in culture. With increased NAA concentration (up to 0.2 mg.l-1) the efficiency of the axillary shoots induction increased as well. In comparison with the control treatment (MS+BAP) it was higher by 80.58 % and with the other one (MS-hormone free medium) even higher by 354.22 %.

Discussion

The concentration of 1.0 mg.l-1 BAP in MS medium can be recommended for the induction of the axillary shoots for *P. suffruticosa* in "*in vitro*" conditions. The low BAP concentrations for multiplication of *P. suffruticosa* were used also by Bouza et al. (1993) and Harris & Mantell (1991). In our experiments where BAP was applied induction of the adventive buds were occurred on the basipetal side of the internodal peony stem segments. These basipetal stem segments became swollen and here calli was produced. Later adventive buds there regenerated in this area of the explants. The similar way of the regeneration published Yulong et al. (1984), Harris & Mantell (1991) and Bouza et al. (1993) after application cytokinins to the culture medium for *P. suffruticosa.* Krejcí & Franc (1997) and Franc (1998) recommend for more woody species to add auxins in the low concentrations to the medium. In our experiments an increased apical dominance effect occurred at the presence of NAA in medium and it manifested by axillary shoots longer by 52.07 % in comparison with MS+BAP medium. In our experiments the higher number of the vitrified explants was recorded at higher BAP and NAA concentrations. Harris & Mantell (1991) and Buchheim & Meyer (1992) discussed this problem, too. Kyte & Kleyn (1996) recommended to decrease the content of cytokinins and to increase the content of agar in the culture medium at the first appearance of the vitrification fenomena. Franc (1996) published that the multiplication coefficient has to be higher than 2.0 in orders to secure commercial utilisation of the multiplication method. Constantine (1986) reached the multiplication coefficient 2.5 - 3.5 in 4 weeks production cycle. In our experiments the multiplication coefficient of peony axillary shoots was 4.25 on MS medium supplemented with 1.0 mg.l^{-1} BAP and 4.75 on medium supplemented with 1.0 mg.l^{-1} BAP + 0.2 mg.l^{-1} NAA after 5 weeks in culture.

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THE APPLICATION OF THE INTER -GENERIC HYBRIDS AT AGROECOLOGICAL CONDITIONS OF THE EAST – SLOVAKIAN LOWLAND

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Summary

Productive parameters of the inter-generic hybrids of grasses in the monocultures and clover –grasses mixtures were investigated. The field trial with the grasses monocultures and clover-grass mixtures was carried out on the experimental basis of Research Institute of Agroecology Michalovce at Milhostov. Over the three crop years evaluation of the total dry matter production was confirmed, that the clover-grass mixtures were the most productive. Perspective inter-generic hybrids, marked "HŽ 7DK", was the most productive before the inter-generic hybrids marked "PERUN". So the inter-generic hybrids were confirmed the convenience of it's ones growing at the conditions of the East-Slovakian Lowland.
***Key words*: inter-generic hybrids, monocultures, clover-grass mixtures, dry matter production, the East-Slovakian Lowland**

Introduction

An intensification of the fodder crop production presents a measure at raising of plant production and connected animal production, also. The East-Slovakian Lowland has favourable assumes to effective fodder crops production in monocultures, as well as in mixtures. Apart from generally growing clovers and grasses, the inter-generic hybrids can be taken to reflections, too. According to Knotek et al. (1996), from the fodder point of view, the inter-generic hybrids mean the quality overturn, because they are sufficient productive, they have higher sugar contents and they are good ensilaged. At Nitra region, Volosin et al. (1997) reached upon inter-generic hybrid "FELINA" and HYKOR higher yield like were upon the productive grass – fescue (*Festuca arundinacea Schreb*.) and dew-grass (*Dactylis glomerata L.*). Krajčovič, Knotek et al. (1995) suggest to use inter-generic hybrids to clover grass mixtures at the individual regions of Slovakia. According to Gejguš (1997), Gejguš and Kováč (1998) inter-generic hybrids found out their application at regions of the East-Slovakian Lowland.

Material and methods

Over the years 1997 – 1999, the field trial with the grasses monocultures and clover-grass mixtures was carried out on the experimental basis of Research Institute of Agroecology Michalovce at Milhostov, on Efluvi-Eutric Gleysol with high clay particles content. Average composition of arable layer is following: contents of available phosphorus 60 mg.kg^{-1}, contents of available potassium 160 mg.kg^{-1}, contents of available magnesium 230 mg.kg^{-1}, humus contents 2,9 %, pH $_{(KCL)}$ 7. Average year temperature is 8,9 °C and average year total precipitation is 559 mm at Milhostov.
Table 1 shows twelve variants of grass monocultures and clover-grass mixtures integrated in the field trial. Before seeding mineral fertilizers were applied at the doses N- 30 kg.ha^{-1} p.n., P- 30 kg.ha^{-1} p.n. and K- 80 kg.ha^{-1} p.n.. Nitrogen was applied

in form ammonium saltpetre with limestone, phosphorus in SUPERPHOSPHAT form and potassium as potash salt. The forecrop was spring barley, after barley harvest the skimming was made and the plough was made in autumn 1996. In spring 1997 soil was tilled by cultivator. Sowing was made by seeding machine OYORT. The grass stands were began accrue from in may 10 and it one made use of cutting during three observed crop years.

Results and discussion

The dry matter production of grass monocultures and clover grass mixtures obtained over the crop years is recorded in table 1. In field trial perspective inter-generic hybrids from breeding station Hladké Životice were applied as well as an verificated inter –generic hybrids "PERUN" and "BECVA", Italian rye-grass (*Lolium multiflorum L.*) "LUBINA" and perennial rye-grass (*Lolium perenne L.*) "MUSTANG". Using of the inter-generic hybrids at two and three-component mixtures with clover were investigated apart from single seeded grasses.

In the 1st crop year (1997) variants of monocultures as well as mixtures were provided high hay yields. At grass monoculture grass hay yields were moved from 7,99 t.ha^{-1} ("PERUN") to 9,71 t.ha^{-1} ("HŽ 12DK"). Production of dry matter at mixtures was lower, apart from mixtures in variant 10 and 12 (8,72 t.ha^{-1} respectively 9,17 t.ha^{-1}).

In the 2nd crop year (1998) clover grass mixtures were more productive as grass monocultures, yet. High increased sum of precipitation was influenced the dry matter production level. There was achieved total precipitation 739 mm in 1998 against long-term sum of precipitation (559). During vegetation season (IV.-IX.) it was rainfall 535,6 mm, that was more about 187,6 mm as long-term normal. This utility year was sharing the most evidently on total yield. The inter-generic hybrid "HŽ 7DK" was the most productive from grass monocultures (18,63 71 t.ha^{-1}) before of inter-generic hybrid "PERUN" (17,03 t.ha^{-1}). At clover mixtures the highest yield was in variant "BESKYD" + "HZ 7DK" (21,63 t.ha^{-1}), only about little below yield offered variant "BESKYD" + "PERUN" (21,34 t.ha^{-1}).

In 1999 - the 3rd crop year – dry matter production was decreased evidently in comparison with last crop year. At monocultures of inter-generic hybrids yield differences were not important (5,15 - 5,77 t.ha^{-1}). At Italian rye-grass "LUBINA" and perennial rye-grass "MUSTANG" the yields were under level 5 t.ha^{-1}. At clover grass mixtures dry matter production was the most significant (9,21 t.ha^{-1}) in variant 12 ("MARGOT" + "LOFA" + "LUBINA"). The highest dry matter production was reached in variant 12 (39,15 t.ha^{-1}).

Table 1 Single variants and dry matter production v t.ha^{-1}

Variant	Species	Variety	1997 I. crop year	1998 II. crop year	1999 III. crop year	Total	Order
1.	IGH	HŽ 7DK	9,33	18,63	5,76	33,72	6.
2.	IGH	HŽ 8DK	8,57	15,58	5,13	29,28	10.
3.	IGH	HŽ 12DK	9,71	15,50	5,48	30,69	9.
4.	IGH	Perun	7,99	17,03	5,77	30,79	8.
5.	IRG	Lubina	9,00	15,33	4,67	29,00	11.
6.	PRG	Mustang	9,16	13,76	4,03	26,95	12.
7.	IGH Clover	HŽ 7DK Beskyd	6,06	21,63	8,37	36,06	4.
8.	IGH Clover	HŽ 8DK Beskyd	6,50	16,65	8,52	31,67	7.
9.	IGH Clover	HŽ 12DK Beskyd	7,67	19,06	7,85	34,58	5.
10.	IGH Clover	Perun Beskyd	8,72	21,34	8,92	38,98	2.
11.	IGH Clover IRG	Bečva Margot Lubina	7,07	20,50	8,90	36,47	3.
12.	IGH Clover IRG	Lofa Margot Lubina	9,17	21,13	9,21	39,51	1.

Legend: IGH – inter-generic hybrid,

CY – crop year, IRG – Italian rye-grass,
PRG – Perennial rye grass

The second most productive mixture was 10 ("BESKYD" + "PERUN") 38,98 t.ha^{-1}. At grass monoculture inter-generic hybrid "HŽ 7DK" was the most productive (33,72 t.ha^{-1}). The second one was inter-generic hybrid "PERUN" (30,79 t.ha^{-1}) and third one inter-generic hybrid "HŽ 12DK" (30,69 t.ha^{-1}). Achieved hay yield of dry matter were confirmed the high productive parameters of inter-generic hybrids and their good representative device to clover grass mixtures, that is consisted with results by Volosin et al. (1997). The notions for suitable of their exploitation in condition of the East-Slovakian Lowland were confirmed too (Gejguš, Kováč 1997) not only in the field trial, but also at large-scale production of condition at agricultural farms Tušice, Nižný Hrušov, Staré and Choňkovce.

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THE INFLUENCE OF NUTRITION ON THE CHANGES OF QUANTITATIVE AND QUALITATIVE PARAMETERS OF SUGAR BEET

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Summary

he influence of fertilization on the changes of quantitative and qualitative parameters of sugar beet cultivation was observed in the yield stationary experiments accomplished in 1996–1998 on the Eutric Fluvisol and Fluvi - Eutric Gleysols. The problems was followed at the variety Ibis on the followed variants of fertilization: 1st-method of balance, 2nd-method of electro-ultrafiltration, 3rd-variant without fertilization. The quantitative and qualitative parameters of roots were statistically significantly dependent from variant of fertilization, soil types and year of cultivation. The effect of fertilization was reflected in increasing root yield from 9,34 to 9,78 t.ha^{-1}, the production of polarizing sugar from 1,26 to 1,66 t.ha^{-1} and the production of refined sugar from 0,51 to 0,96 t.ha^{-1} in comparison to the control without fertilization. The higher digestion and refined sugar yield were obtained at the 2nd and 3 rd variants. At reciprocal comparison of fertilizing variants were higher yield and superior qualitative parameters roots were found on the 2nd variant.

***Keywords*:** sugar beet; fertilization; root yield; digestion; ash; α-amino N; refined sugar yield; production of polarizing sugar; production of refined sugar

Introduction

The nutrition and fertilization of sugar beet are specific because they have to ensure not only high yield but as well as suitable the qualitative parameters. Realized of fertilization system must be economic advantageous and has to hold the nature soil fertility.

The sugar beet fertilization is made by the methods which may be to save the harmony relations between nutriment in soil environment and their requirement of stand (KOVÁČOVÁ,1997; ŠOLTYSOVÁ, 1999). To control of fertilization is important because high offer of the soil nutrition lower qualitative parameters of sugar beet. The fertilization of nitrogen lower digestion root of sugar beet and it cause increase nitrogenous matter and ashes.

The aim of the contribution presented was to evaluate the influence of rationally fertilization on the quantitative and qualitative parameters of sugar beet cultivated on the soils of East Slovakian Lowland.

Material and metods

The problems of sugar beet nutrition was followed in years 1996-1998 by stationary experiments of Research Institute of Agroecology in the condition of Eutric Fluvisol (EF) in Vysoká nad Uhom and Fluvi-Eutric Gleysols (FEG) in Milhostov. The detailed characteristic of the place is described in the thesis of Šoltysová (1999).

The sugar beet variety Ibis was grown in the crop rotation at the traditional tillage. The forecrop of sugar beet was winter wheat. The quantitative and qualitative parameters of sugar beet were observed at three different variant of nutriment: 1st-method of balance, 2nd-method of electro – ultrafiltration, 3rd-variant without fertilization.

Sugar beet was rationally fertilized. The average doses of industrial fertilizers are shown in the table 1.
The quantitative and qualitative parameters of sugar beet were followed at the 1st - 3rd variants. The qualitative parameters roots were determined by the analytical methods.
The obtained results were evaluated statistically by the analysis of variance and are shown in the tables.

Results and discussion

The quantitative and qualitative parameters of sugar beet were dependent from different system of fertilization. The root yield moved in the interval of 53,80 to 79,33 $t.ha^{-1}$ (table 2). The root yield was statistically significantly dependent from variant of fertilization, soil types and year of cultivation. On the fertilization variants were obtained significantly higher yield of roots over from 9,34 to 9,78 $t.ha^{-1}$ in comparison to control without fertilization. The positive influence of fertilization on the yield of sugar beet was also pointed STRNAD (1995).
Significantly the highest yield were obtained in the 1996. In this year were best climatic conditions for cultivation of sugar beet. The lowest yield of sugar beet were obtained in the 1998, when plenty of areas sugar beet were wet in the East Slovakian Lowland.
The nutrition of sugar beet together with weather are factors significantly influence to technological quality roots. The qualitative parameters roots of sugar beet (digestion, ash content, α-amino N, refined sugar yield) are shown in the table 3. The digestion of sugar beet were moved in the range 14,50 – 20,20 %. Significantly higher digestion were obtained at the 2nd and 3 rd variants.

Table 1 Average doses of fertilizers for sugar beet

Variant of fertilization	EF				FEG			
	N - 1 $kg.ha^{-1}$	N - 2 $kg.ha^{-1}$	P $kg.ha^{-1}$	K $kg.ha^{-1}$	N - 1 $kg.ha^{-1}$	N - 2 $kg.ha^{-1}$	P $kg.ha^{-1}$	K $kg.ha^{-1}$
1st	93,2	26,7	29,3	104,7	82,7	35,0	28,0	115,0
2nd	44,5	30,0	33,7	113,0	40,0	33,3	47,4	116,7
3rd	-	-	-	-	-	-	-	-

Where: N - 1 = fertilization before sowing, N - 2 = nutrition by foliar application

Table 2: Quantitative parameters of sugar beet ($t.ha^{-1}$)

Variant of Fertilization	Year	Root yield		Production of polarizing sugar		Production of refined sugar	
		EF	FEG	EF	FEG	EF	FEG
1st	1996	79,33	75,20	15,07	10,90	12,667	8,97
	1997	70,19	65,50	12,07	11,14	10,270	9,31
	1998	66,13	68,04	10,75	10,82	9,064	8,72
	Average	71,88	69,58	12,63	10,95	10,67	9,00
2nd	1996	78,00	74,60	15,13	10,97	13,07	8,91
	1997	72,06	66,08	13,26	11,56	11,50	9,81
	1998	68,70	67,54	11,23	11,08	9,30	9,10
	Average	72,92	69,41	13,17	11,20	11,29	9,27
3rd	1996	70,15	64,80	14,17	10,17	12,48	8,60
	1997	64,30	53,80	10,93	9,58	9,23	8,04
	1998	59,15	56,14	9,76	8,56	8,05	6,89
	Average	64,53	58,25	11,62	9,44	9,92	7,84

Table 3 Qualitative parameters of sugar beet

Variant of Fertilization	Year	Digestion (%)		Ash content (%)		α-amino N (mmol.100g^{-1})		Refined sugar yield (%)	
		EF	FEG	EF	FEG	EF	FEG	EF	FEG
1st	1996	19,00	14,50	0,558	0,442	3,57	4,28	15,968	11,932
	1997	17,20	17,00	0,442	0,498	4,28	4,64	14,632	14,208
	1998	16,25	15,90	0,436	0,573	2,86	3,11	13,706	12,808
	Average	17,48	15,80	0,479	0,504	3,57	4,01	14,769	12,983
2nd	1996	19,40	14,70	0,460	0,490	3,21	5,35	16,760	11,940
	1997	18,40	17,50	0,412	0,462	3,57	4,11	15,952	14,852
	1998	16,35	16,40	0,502	0,533	3,03	3,07	13,542	13,468
	Average	18,05	16,20	0,458	0,495	3,27	4,18	15,418	13,420
3rd	1996	20,20	15,70	0,403	0,406	3,21	4,28	17,788	13,276
	1997	17,00	17,80	0,460	0,516	4,28	4,46	14,360	14,936
	1998	16,50	15,25	0,524	0,546	2,86	3,39	13,604	12,266
	Average	17,90	16,25	0,462	0,489	3,45	4,04	15,251	13,493

Content of soluble ash was moved in the range 0,403 - 0,573 %, α-amino nitrogen 2,86 - 5,35 mmol.100 g^{-1} and refined sugar yield 11,932 – 17,788 %. Also values of these parameters were dependent from variant of fertilization, soil types and the year of cultivation.
The influence climatic condition is reflected not only in yield roots but at the values qualitative parameters of sugar beet too. These results are in the harmony with literature (Pačuta, Černý, Karabínová, 2001).
Production of polarizing sugar and production of refined sugar is shown in table 2. The fertilization of sugar beet caused the average increase of the production of polarizing sugar from 1,26 to 1,66 t.ha^{-1} and of the production of refined sugar from 0,51 to 0,96 t.ha^{-1} in comparison to the control without fertilization.
At reciprocal comparison of fertilizing variants were higher yield and superior qualitative parameters roots were found on the 2nd variant (method of electro-ultrafiltration).

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INFLUENCE OF TILLAGE SYSTEMS ON SOIL MOISTURE DYNAMICS UNDER WINTER WHEAT CULTIVATION.

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Summary

The soil moisture by different cropping systems and conventional and reduced soil tillage management have been evaluated at Ortic Luvisol near Nitra during 1998–2000. The soil moisture in soil profile under winter wheat canopy was determined to the depth 0.6 m with 0.1 m interval layers by gravimetric analysis at different cropping systems No significant differences in soil moisture between evaluated conventional and reduced tillage treatments have been noted. The average soil moisture was in range 14.28 – 15.99% (conventional) and 14.30 – 16.12%(reduced) in favour of shallow loosening. The seasonal dynamics of soil moisture in spite of different rainfall characters within the space of three years was very similar. The significant differences between date of sampling during vegetation period and years were determined.

Keywords: soil moisture, tillage management, winter wheat.

Introduction

Tillage options must include profitability gains and environmental benefit of soil management. The identification of alternative practices requires field studies of crop responses to provide appropriate information before new practices are widely accepted. The advantages of tillage options may include increased crop establishment and yields(Cigľar, Smatana, 1988) , weed control (Bartošová et al.,2000), physical and chemical soil characteristics (Líška, Smatana,1985; Smatana, 2000a) and environmental aspects of reduced soil tillage (Kováč, Antal,1999). Tillage system may influence soil microbial activity via soil hummidity (Pospišil et al.,1999) but the longevity of these all effects may be short.
The purpose of this study was to asses influence of conventional and reduced tillage on soil moisture under winter wheat cultivation.

Material and methods

The experimental site belongs to warm and moderate arid climatic region in the south – west of Slovakia. The main soil type is Orthic Luvisol, with 2.3 % of humus content. The soil moisture was observed in different farming systems and different tillage by winter wheat cultivation during 1998 – 2000. The investigated basic tillage treatments were: B1 – conventional cultivation mouldboard plough tillage to a depth 0.2 m and surface cultivation of topsoil ; B3 – reduced cultivation – shallow loosening. Balanced fertilising to the designed yield level of 6 tonne per ha was used. The soil moisture (gravimetric analysis) in soil profile was determined to the depth 0.6 m with 0.1 m interval layers with three replications, five- times during vegetation period. The date of sampling was determined by tillage management practices and wheat growing stage.

Results and discussion

The soil moisture and soil moisture dynamics under winter wheat canopy have been assessed. The three year trials confirm no significant differences between two evaluated tillage treatments. The soil moisture in average of investigated soil profile(0,6m) was 14.28 – 15.99% in mouldboard tillage treatment and 14.30 – 16.12% in shallow loosening treatments. The seasonal dynamics of soil moisture in spite of different rainfall characters within the space of three years was very similar.(Table 1). The significant differences between date of sampling during vegetation period and years were determined. The high significant differences between top and bottom layers were noted in all evaluated years. The highest soil moisture was in 0.5 –0.6 m layer.

Table 1 Soil moisture in winter wheat cultivation , under conventional and reduced cultivation in profile 0 – 0.6m, during 1998 – 2000 years.

Cultivation	Moisture %					Average
Year/date 1998	25.3.	24.4.	27.5.	13.7.	31.8.	
B1	21.84	18.84	11.54	9.53	9.66	14.28
B3	22.19	19.24	11.05	9.13	9.87	14.30
Year/date 1999	24.3.	21.4.	26.5.	6.7.	18.8.	
B1	18.47	16.99	13.00	15.81	15.70	15.99
B3	18.49	17.43	12.76	16.42	15.50	16.12
Year/date 2000	20.3.	25.4.	3.6.	28.7.	7.9.	
B1	22.10	16.67	9.16	12.81	10.79	14.31
B3	22.03	16.29	9.74	14.00	12.59	14.93

B1 conventional tillage – mouldboard ploughing
B3 reduced tillage – shallow loosening

The wettest period of soil condition was a spring and the driest was an autumn. Spring soil samples have from 18.47 %(B1-1999) to 22.19%(B3-1998) soil moisture. In March, April and May we can noted relatively narrow range of soil moisture with similar decrease in soil moisture in all evaluated years. July and August/ September samples had broad range of soil moisture 9.13%-16.42%/ 9.66%-15.70% respectively. Under winter wheat cultivation we can note tendency towards higher moisture in shallow loosening treatment rather than in mouldboard ploughing due to winter crop character and covering index of winter wheat . Also Smatana (2000b) did not note significant differences in three year trials of different tillage treatments of the soil profile by winter wheat cultivation. The soil moisture of different date of sampling was influenced predominantly by distribution and amount of precipitation and air temperature. The variability of soil moisture with relationship of deep soil and different tillage was also noted. Similar results received Gnatenko (1992). He noted in deep layers (1.0 – 1.5m) the high moisture of soil samples in loose treatments with comparison to mouldboard ploughing, in dry weather condition only.

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INFLUENCE OF CROPPING TECHNOLOGIES ON BIOLOGICAL SOIL CHARACTERISTICS.

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Summary

Field experiment started in 1994, in order to determine effect of tillage and residue management in different crop sequences on microbial activity and dynamic of soil organic carbon, at Experimental station of Slovak Agricultural University in Nitra - Dolná Malanta on Orthic Luvisol. No significant differences between fertilizer treatments in basal respiration of topsoil have been noted under any growing crops : maize (*Zea mays* L.) – spring barley (*Hordeum vulgare* L.) –common pea (*Pisum sativum* L.) – winter wheat (*Triticum aestivum* L.). The soil tillage management has a significant influence on microbial activity with basal respiration intensity of the soil under mouldboard ploughing - 22.7 mg CO_2 and 26.7 mg CO_2 per kg of the soil under shallow loosening soil. The same tendency was noted in organic carbon content in soil after seven years mouldboard ploughing - C_{org} 1.21 % with comparison of C_{org} 1.36 % by reduced cultivation using – shallov loosening.

Keywords: basal respiration,organic carbon, tillage management, crop sequences

Introduction

In a mature natural ecosystem or a stable agroecosystem, the release of carbon as carbon dioxide by oxidation of soil organic matter (mostly by microbial respiration) is balanced by the input of carbon into the soil as a plant residues. Agroecosystem has some perturbation, results in a net loss of carbon from the soil system. Crop rotation has an important role in sustainable agriculture from aspect of biodiversity of agroecosystem in place and time Kováč et al.(1977) . Industrial cropping system and lack of farm yard manure have negative impact on soil biological activity. Cash crop production with high share of grain crops may influence soil biological activity (Pospišil et al.,1999). Respiration activity indicates the intensity of metabolic processes and it is an important characteristic of the carbon dynamics in soil (Kubát et al.,1999).
Material and Methods
The aim of this study was to evaluate the crop management practices on the biological activity of the soil and soil organic mater. The field trial was conducted at the Experimental station of Slovak Agricultural University in Nitra - Dolná Malanta, during 1994 – 2000 years. The experimental site belongs to warm and moderate arid climatic region in the south – west of Slovakia, the average rainfall is 561 mm, for the growing season 327 mm. Average air temperature is 9.7 ^{0}C, for the growing season 16.2 ^{0}C. The main soil type is Orthic Luvisol,. with 2.3 % of humus content and pH 5.7 in average, the parent material is silt loess. Maize (*Zea mays* L.) – spring barley (*Hordeum vulgare* L.) –common pea (*Pisum sativum* L.) – winter wheat (*Triticum aestivum* L.) were under different crop management practices. The impact of three fertilization levels and tillage treatments growing in different crop sequences have been studied. The crop rotation treatments were as follows: single cropped – maize rotation, double cropped - maize for corn – spring barley rotation, three crops rotation - maize for

corn – common pea – winter wheat rotation, four crops rotation – maize for corn – spring barley – common pea – winter wheat rotation.
Three basic tillage treatments were: B1 – conventional cultivation mouldboard plough tillage to a depth 0.3 m (maize), moldboard plough tillage to a depth 0.2 m and surface cultivation of topsoil(winter wheat, barley, common pea); B2 - offset disc ploughing(0.15m deep) and combined cultivator; B3 – reduced cultivation – shallow loosening (winter wheat, barley, common pea), twice times shallow loosening(maize).
Each tillage treatments had three fertilizing levels: O – zero level without organic or inorganic fertilization, respectively; PH – balanced fertilizing to the designed yield level, specifically to the crop; PZ – incorporating all above-ground plant material and crop residues as a source of organic matter and inorganic fertilizer for the balance equilibrium level.
Common pest and disease control practices were applied. For weed control there were used both herbicides and stick harrow. Plots for tillage system were implemented in a split plot design. Plots were divided into subplots(11 x 40 m) non randomized within main plots and were subjected to fertilization treatments with four replications. The soil samples were collected from the 0 - 0.25 m topsoil profile, four or five times from April to November. The soil samples were incubated at 28 °C 35 days and basal soil respiration had been measured six times a week according Bernát and Seifert method (Seifert, 1977) and total soil organic carbon according to Tyurin method.

Results and discussion

Carboneum organic content (C_T) has a close relationship with soil microbial activity. Changes in C_T towards decreasing or increasing level of soil organic matter take many years to appear. After seven year trials of using differen crop mamagement practices soil reach a new equilibrium level of soil organic matter (SOM) . From starting level of 1.1 % C_T to 1.28 % soil in average, for all tillage and fertilizer treatments of four crop sequences: maize- spring barley -common pea and winter wheat. Differences in C_T content , predominantely between soil tillage treatments have been noted. The average value of C_T content in soil under mouldboard ploughing and incorporating all above-ground plant material and crop residues as a source of organic matter and inorganic fertilizer for the balance was 1.23 % with comparison of 1.36 % by reduced cultivation using – shallov loosening. No significant differences between O and PH treatments in four crop rotation have been noted, but we are able to note tendency of appreciable increasing of C_T content in treatments with incorporating all above ground material The rate of soil carboneum: nitrogen content from starting rate 8:1 has actual value 7.46 : 1, with seasonal dynamics: spring – 8.91:1, autumn - 6.57:1. The incorporation of common pea aboveground material influenced total nitrogen content in soil (O– 1577 mg. kg^{-1}, PZ - 1928 mg. kg^{-1}) in both tillage treatments last year. No significant differences between fertilizer treatments in basal respiration of topsoil have been noted under any growing crops. The highest differences in daily CO_2 production was on winter wheat mouldboard ploughing plots O - 2.21 mg.CO_2 100 g^{-1} soil and PZ – 2.34 mg.CO_2 100 g^{-1} soil. The soil tillage management has a significant influence on microbial activity. See Table 1.

Table 1 Daily basal respiration intensity in mg CO_2 per 100g of the soil, average 1994-2000

treatments	maize for corn	barley	common pea	winter wheat
mouldbord ploughing	2.27	2.29	2.23	2.31
shallow loosening	2.65	2.62	2.76	2.63

Due to enhance microbial activity, basal respiration of the soil was in conventional tillage soil in average 2.27 mg CO_2 100 g^{-1} soil and 2.67 mg CO_2 100 g^{-1} in shallow loosening soil. The soil microbial activity and turnover of organic material have been assessed. After seven year trials incorporation of aboveground material has no significant effect on basal respiration intensity of topsoil but increasing tendency of total carbon content to average value 1.28 %. The differences in C_T on the same type of the soil in ecological system(1.31 %) and integrated system (1.25 %) noted also Szombathová (1999) and C_T used for C pool index calculation, but more susceptible carbon fraction mentioned labile carbon. Zaujec and Kováč (2000) revealed positive tendency and statistical signification of increasing soil organic carbon content only in different cultivation treatment. Also in this trial the relationship between soil microbial activity and C_T content revealed benefit of minimum tillage treatment -shallow loosening for improving soil fertility due to increasing of total carbon content (1.36 %) with comparison by seven year mouldboard ploughing 1.21 %. The assessment of basal respiration indicated the changed tendency in soil organic mater status. In the same way Mühlbachová and Rüžek (2000) mentioned correlation between content of total organic carbon and basal respiration of soil. Nitrogen level by plough in plant material as a source of organic matter has been depleted. Imobilization of N, due to incorporating cereals straw positively affected N loses by leaching during autum. Conversaly shallov incorporation of common pea plantmass supported leaching of nitrate during autumn.

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ENERGY BALANCE AND SUSTAINABLE AGRICULTURE

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Summary

Ffour different crop production systems were evaluated at the Experimental station of Slovak Agricultural University In Nitra-Dolná Malanta, during 1994 – 2000. From comparison of energy balance parameters(total energy input, energy output of dry matter of plant biomass, an energy gain and efficiency) resulted that the highest energy inputs are by single cropping system of maize. By using this method we defined the energy flow with aim – to reduce energy consumption. The four crop sequences cropping system saved 39% of total energy consumption and works with higher energy efficiency(9.97 %). For acceptable energy input and energy efficiency we recommende more diverse crop rotation than double crop sequences .

Keywords: energy balance, cropping systems, crop management practice

Introduction

Food production systems must be environmentally sustainable and their products must be accesseble and safe.The yield production and input of direct and indirect fossil energy and its agri-environmental causalities is especially important in view of the ongoing EU accession proces. Purposeful assert of saving energy consumption requires analysing of cropping technologies and their impact and sustainability(Pospišil, Vilček,2000). Present cropping technologies are energy and economical demanding with comparison to price of agricultural products.The basic tillage systems have a big share of total energy input into Agricultural systems (Pospišil,Macák,1999). Sustainable agricultural practices are under scrutiny by researches and producers. The advanced agricultural production system requires to solve many questions with direct impact on crop production and environment like reducing fossil energy (Rumpel,1992). In addition to stable yield production - account of energy balance is required for assessment of fossil energy saving technologies (Hančárová,1989).
Material and Methods
The objective of this study was to evaluate productivity of four cropping systems with focus on cash crops and to design cropping technology with aims: to produce foodstuff of nutritional quality and sufficient quantity and to reduce the use of fossil energy in agricultural practice. The experimental site is located at the Experimental station of Slovak Agricultural University in Nitra - Dolná Malanta. During 1994 – 2000 years,
three fertilization and tillage treatments in four agricultural systems have been studied.
The crop rotation treatments were as follows: single cropped – maize rotation, double cropped - maize for corn – spring barley rotation, three crop rotation - maize for corn – common pea – winter wheat rotation, four crop rotation – maize for corn – spring barley – common pea – winter wheat
Three basic tillage treatment were:
B1 – conventional cultivation mouldboard plough tillage to a depth 0.3 m (maize), moldboard plough tillage to a depth 0.2 m and surface cultivation of topsoil (winter wheat, barley, common pea)
B2 - offset disc ploughing(0.15 deep) and combined cultivator
B3 – reduced cultivation – shallov loosening (winter wheat, barley, common pea), twice times shallov loosening(maize)
Each tillage treatments had three fertilizing levels:
O – zero level without organic or inorganic fertilization, respectively

PH – balanced fertilizing to the designed yield level, specifically to the crop
PZ – incorporating all above-ground plant material and crop residues as a source of organic matter and inorganic fertilizer for the balance equilibrium level.
Common pest and disease control practices were applied. For weed control were used both herbicides and stick harrow. In common pea herbicides only. Energy balance was calculated according to Preininger(1987) in gigajoule(GJ). Plots for tillage system were implemented in a split plot design. Plots were divided into subplots(11 x 40 m) non randomized within main plots and were subjected to fertilization treatments with four replication.

Results and discussion

The examples of the of basic energy balance factors assessment in total, during 1994 – 2000 years in the investigated agricultural systems under dics ploughingh and inorganic fertilizers only are shown in the table.

The comparison of some energy balance factors by growing maize for corn,common pea, winter wheat and barley in four crop sequences with interaction of B2 PH treatments, average for 1994 – 2000, H.Malanta.

Crop rotation	energy input GJ ha^{-1}	energy output GJ ha^{-1}	energy gain GJ ha^{-1}	energy efficiency in %
Single cropped	33.87	230.95	197.08	6.81
Double cropped	21.61	190.09	168.48	8.79
Three crops rotation	22.93	215.01	192.08	9.37
Four crop rotation	20.66	206.07	185.41	9.97

The highest total energy input, which comprises human and technological work and part of operating inputs – fertilizers, seeds, pesticides,fuel , have been noted in single crop system(maize for corn). The growing system of four crop rotation demands– only 20.66 GJ per hectare. The lower energy input in more diverse crop management system saved 39% of total energy consumption .The highest output of energy and total mass of plant material produced maize for corn like single crop, the less output of energy has been noted in double crop system (maize/ barley rotation). The highes efficiency of fossil energy transformation was in four crop rotation(common pea/ winter wheat/ maize/ barley rotation). On the basis of seven year trial we suggest that the most effective agricultural system of transformation of direct and indirect energy is four crop rotation , with declination of effectivity by three crop sequences - double cropped - single cropped. The industrial agriculture production being maintained by large amounts of external input that results in “waste problems “ for the surroundings. Industrial agriculture also utilises non-renewable resources to a greater extend than that which is returned (Šarapatka et al., 1999). The analysis of crop production systems and designing of crop management systems towards sustainable agriculture is a big challenge for agricultural science in transition period of Slovakia. During this seven year trial we noted the highest energy efficiency with lower energy input in four crop sequences due to benefit of more sustainable cropping technology. The energy evaluation of different crop management practices or more specifically crop production practices belongs to the group of exact methods for assessment of energy consumption and energy balance. Significant differences in energy efficiency between single crop technology and double crop technology with comparison to four crop sequences have increased values - 46.4% or 15%, respectively. The accurate assessment of energy input – output system, energy gain, and efficiency lead to identify more energy consumption crop management process for determination of critical uses of farm inputs.

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INFLUENCE OF PASTURE ON THE SUCCESSION AND BIODIVERSITY IN THE NATIONAL PARK MALÁ FATRA

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Summary

The experimental pasture area Strungový príslop (110 ha) is situated on the territory of The National Park Malá Fatra on the altitude 1,150 m. The pasture vegetation was formed by the association *Agrosti-Festuceum rubrae* with up to 56 species. In the lower part the animals relaxed after the free grazing, and spent the nights on the area of 0.5 ha. After their long-lasting stay on the stand the soil was eutrophised and the above-ground biomass was badly ruderalised. The amounts of nitrogen and potassium were three times higher than the values of the control group. They varied from 2,680 to 4,928 $mg.kg^{-1}$ in case of nitrogen and from 165 to 527 $mg.kg^{-1}$ in case of potassium. Changes in the soil and destruction of turf by trampling of the cattle caused the gradual regressive succession of the original phytocoenosis. The group of ruderal weeds *Rumicetum obtusifolii* with the dominance of *Rumex obtusifolius* (27.2%) was formed on the area. There were from 12 to 27 species in the ground cover. The empty spaces comprised up to 29%. The replace of the young cattle by the flock of sheep (450 – 500) with at least 5 goats is proposed to affect by their grazing the top parts of *Rumex obtusifolius*. The areal application of the herbicide Roundup-Bioaktiv (3 $l.ha^{-1}$) and following reseeding of *Dactylis glomerata* and *Trifolium repens* is most advantageous to form the cover of vegetation and to draw the redundant nutrients from the soil. Other species will gradually appear in the cover and the richness of the plant species in the vegetation will rise.

Key words: National Park Malá Fatra, young cattle, grazing, euthrophisation, revitalization

Introduction

Ground cover belongs to the most rich European ecosystems as far as the number of species is concerned. They are the source of the plant species, natural resources of the country and their biodiversity is the highest on the agricultural land. Their ecological stability is relatively high. Their appearance and existence depends on the farming activity of people (mowing and grazing). If young cattle relax and spend the night, or stay for a longer time on one stand, the soil of the pasture ground cover is eutrophised and above-ground biomass ruderalised under the influence of excrements (Novák 1992).
Grass ground cover in the area of The National Park Malá Fatra belongs among the valuable biotops, and from the point of view of the occurrence of the species it belongs among the irreplaceable ecosystems. Except for the productive function the soil-protective, water-management, bio-homeostatic, landscape-engineering, recreational and medicare, esthetical and cultural functions are most important in these conditions. These functions stress the protection of soil against erosion, preservation of genofond of vegetation and animal communities and their species.

Material and methods

Experimental pasture area Strungový príslop (110 ha) is situated in The National Park Malá Fatra on the altitude 1,150 m, on the north-east incline, not far from Malý Rozsutec, in the cadastraly zone of the co-operative farm Párnica.
The purposes of the ecologically aimed pasture experiment (1999 – 2000) were to detect negative influences of the grazing of young cattle (175 heads) on the pasture turf, to evaluate the changes of the floristic composition of the grass, and on the base of the results to propose the way of revitalisation, keeping the rules of ecological farming. The cattle was situated on the night stand in the period from 15 May to 15 October during several years. Soil-forming substrate was formed by crystalline core with granitoid parent rock, upper layer is formed by medium heavy- heavy, podzolized-podzolic, brown forest and unproductive land. The samples of soil were taken in the autumn period from the depth of 100 – 200 mm to set the total nitrogen (N_t) by Kjeldahl, available P by Schachtschable, available K by Egner, humus by titration (Tjurin) and pH/KCl.
Floristic analyses were made in the spring and autumn periods by the method of projective dominance by Klapp (1965), using the exact squares ($0.01m^2$) in 4 repeatings. From the floristic records ecological characteristic was calculated - (medium number of nitrogen M.No.N), and value of quality (valuation of vegetation V_v) according to the forage value by Klapp et al. (1953).

Table 1 Chemical analysis of the soil

Stand	Place of taking samples	N_t mg.kg-1	P mg.kg-1	K mg.kg-1	C_{ox} g.kg-1	Humus g.kg-1	pH/KCl	C : N
Strungový príslop	1	2,680.00	-	375.00	3.00	5.20	4.86	11.20
	2	2,492.00	10.00	417.00	2.50	4.30	4.45	10.03
	3	4,928.00	78.00	527.00	4.50	7.70	6.43	9.15
	4	2,632.00	-	165.00	2.90	4.90	4.34	11.02
	x	3,183.00	22.00	371.00	3.22	5.52	5.02	10.35
Control	5	1,200.00	-	102.00	1.85	3.20	4.20	15.42

Results and discussion

The vegetation cover of the original semi-natural ground cover on the stand Strungový príslop was created by association *Agrosti-Festuceum rubrae* (control) with the dominance of *Agrostis tenuis Sibht.* (19%) and side species *Festuca rubra L.* (8%). Floristic group of grasses constituted 41%, leguminoses 5%, other herbs 30%, and the rest 24%.

The animals except for trampling did not cause any visible damage. The trampled vegetation quickly regenerated. The cattle while moving to another side trampled narrow (200 – 250 mm) paths on the slopes with the direction of contour lines. On the steeper slopes the turf was during the grazing torn down by their hoofs to the height 50 – 70 mm.

On the lower part of the area near the shepherd's hut the soil was badly ruderalised because of the permanent movement of the cattle on the night stand during several years. The values of total nitrogen and potassium were three times lower comparing with the control, and they range from 2,680 to 4,928 mg.kg^{-1} of nitrogen, and from 165 to 527 mg.kg^{-1} of potassium (Tab. 1). The value 4.2 – 4.8 of the medium number of nitrogen (M.No.N) indicates detrimental content of available nutriments (overfertilised stand), except for the place of taking samples No.4, which is the farthest one from the shepherd's hut, and was not as badly eutrophised as the other sides. From the relation of C:N results, that the soil (except for the control) is richer in the organic bio-mass.

The changes in the soil and the damage of turf after the trampling of the cattle caused gradual regressive succession of the original phytocoenosis *Agrosti-Festucetum* and gradual ruderalisation of above-ground biomass. The association of ruderal weeds *Rumicetum obtusifolii* with the dominance of *Rumex obtusifolius L.* and side species *Urtica dioica L.* was formed on the site. Floristic group of grasses was represented only by 7 – 18%, *Poa trivialis L.* (5.2%) and *Agrostis tenuis Sibht.* (5.2%). Leguminoses were not found in the vegetation. From the floristic group of other herbs (share from 45 to 63%) *Rumex obtusifolius L.* (27,2%) dominated, the site species were *Ranunculus repens L.* (15.5%), *Urtica dioica L.* (8%) and *Anthriscus sylvestris L.* (1.5%). There were 12 – 27 species in the vegetation. The more nutrients there were in the soil, the less species there were in the vegetation cover. Empty spaces formed up to 29.5%. Compared with the control this association of herbs is very poor in the range of species. The quality of the vegetation (V_v = 1.66) was without any value, partially harmful and the cattle did not graze it.

The revitalization was necessary but as the stand is situated in The national Park, it should be done very cautiously. The protection of nature in national parks outranks all the other activities. It is necessary to follow the law of The Slovak National Council No.287/1994 of the Statute-book about the protection of nature and country § 14, par. 1. The replacement of the young cattle by the flock of sheep (45 – 500 heads) with at least 5 goats at least 5 goats is proposed to affect by their grazing the top parts of *Rumex obtusifolius*, and gradually avert its spreading. Radical solution by the application of the herbicide Roundup Bioaktiv (3 l.ha^{-1}) is the most advantageous (with the agreement of the superior authority in the field of the protection of environment). We agree with the authors Jiřište and Mládková (1998), who used the same herbicide for the similar vegetation cover, though with *Rumex alpinus L.* in the area of Krkonoše mountains, in the national park KRNAP. The reseeding of clover-grass mixture with the dominance of *Dactylis glomerata L.* and side species *Trifolium repens L.* supported the creation of the vegetation cover. With the spreading of the species of grasses, leguminoses and other herbs from the neighboring areas high reserve of nutrients, potassium mainly, will be within 10 years used up, biodiversity will grow, and the sustainable development of the country will be guaranteed.

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FLORISTIC CHANGES IN PRATOCENOSIS AFTER CESSATION OF FERTILIZING

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Summary

Field experiments were conducted to study the effect of fertilizing and its absence on floristic composition of semi-natural grasslands. Diversified grass community is changed during eight years of fertilization by gradated nitrogen rates into grassland with 71 to 84 % share of grasses. Phosphorus-potassium fertilization supports the development of dicotyledonous species and share of grasses is falling. After three-year cessation of fertilization unfertilized stand is typical by almost 50 % share of dicotyledonous species, grass species (*Festuca pratensis* Huds., *Festuca rubra* L.) are disappearing and moss (20 %) is spread in the stand. In the stand fertilized before cessation with PK-fertilizers the share of leguminous crops is significantly falling (by 24 %), and the representation of the other meadow herbs and grasses is increasing. Absence of fertilization affected minimally the stand with 240 kg $N.ha^{-1}$, though the stand was thinned due to a reduction in the representation of grasses (by 8 %) and the other herbs (by 2.5 %). Absence of fertilization affected negatively the development of floristic composition of grass pratocenosis. Minimum utilization of grassland starts as late as in the second year after cessation of the process of secondary succession.

Key words: semi-natural grassland, floristic composition, cessation of fertilization

Introduction

Fertilization increases production capacity of seminatural grasslands, but on the other side its biodiversity is falling. One of the potential assumptions of regeneration of biodiversity is absence of mineral fertilization (Jeangros, Bertola, 1997) with minimising of the other anthropogenic factors, but with such a possibility of cultivation of grasslands which will preserve their species variability (Jančovič, 1996). In conditions of Slovakia an attention was paid to the problem of absence of mineral fertilization and effect of its composition on floristic structure and productivity at the end of the 1960s (Lichner, et al., 1966) at increase of the utilization of mineral fertilizers and recently when their application fell significantly (Olff, Bakker, 1991; Jančovič, Holúbek, 1993; Gáborčík et al., 1997).

Material and methods

Experimental field trials with fertilization of grasslands (1986 – 1993) and after its absence (1994 – 1996) were performed on seminatural grasslands in the region Stražov Hills (Central Slovakia, locality Chvojnica). The territory of the trial site is situated at an altitude of 600 m above sea level, with geographic altitude 48° 53' and 18° 34' of longitude. Slope character of the terrain ranges between 17° to 20°.
The site belongs to the slightly warm region, into subregion slightly arid with dominantly cold winter. According to long-term measurements average annual temperature reaches here 6.5 °C and 11.1 °C in the growing season. The long-term average of the whole-year sum of precipitation is 848 mm, while it is 431 mm during the growing season. Soil-forming substrate of the site is geest of Jurassic schists with inserts of marls, on which acid cambisol was formed. Semi-natural grassland has been identified as an association of *Lolio-Cynosuretum R. Tx* 1937 in view of phytocenology.
Original treatments of fertilization and rates of nitrogen are presented in Table 1. Phosphorus and potassium fertilization was constant and determinated at 30 kg $P.ha^{-1}$ and 70 kg $K.ha^{-1}$ annually.

Table 1 Treatments and rates of nitrogen ($kg.ha^{-1}$)

Treatments	Nitrogen rates in year			
	1st	2nd	3rd	4th
1	–	–	–	–
2	PK	PK	PK	PK
3	PK + 60 N	PK + 60 N	PK + 60 N	PK + 60 N
4	PK + 120 N	PK + 120 N	PK + 120 N	PK + 120 N
5	PK + 240 N	PK + 240 N	PK + 240 N	PK + 240 N

The trial was established in four replications, an area of harvest plot was 10 m^2. In the years 1986 to 1989 all treatments were utilized in four cuts and in the years 1990 to 1993 differentially according to fertilization treatments (2 – 3 cuts). During the years 1994 to 1996 fertilization was omitted and only one cut was used based on the methodology after Rychnovská et al. (1987) in the time of maximum biomass production (end of June). Floristical analysis was performed by the method of projective dominance before each cut to find the changes in floristic composition of the stand in different treatments (Regal, 1956). Agrochemical properties of the experimental site prior for stand establishment are given in Table 2.

Table 2 Agrochemical soil properties of experimental site

Depth of soil sampling (mm)	0 – 100	101 – 200
pH / KCl	4.6	4.6
C_{ox} ($g.kg^{-1}$)	36.0	24.0
N_t ($g.kg^{-1}$)	4.0	2.8
P ($mg.kg^{-1}$)	15.7	4.3
K ($mg.kg^{-1}$)	66.0	120.0
Mg ($mg.kg^{-1}$)	113.7	91.9
Ca ($mg.kg^{-1}$)	850	750
Sum of exchangeable basis cations $mmol.kg^{-1}$)	48.1	44.8
Sorptive capacity ($mmol.kg^{-1}$)	138.0	133.0
Degree of sorptive saturation (%)	34.1	33.7

Results and discussion

The studied grass community before fertilization was floristically varied, with dominance of grass species (73 %) where the other meadow herbs formed 25 % share and leguminous crops were presented by 2 %. Already in the first year of fertilization and utilization representation of different floristic groups changed (Table 3), mainly in treatments with gradated nitrogen nutrition. Phosphorus-potassium fertilization applied in the initial year of the trial without nitrogen emphasised herbal character of the stand with distribution of dicotyledonous herbs (*Leontodon autumnalis* L., *Taraxacum officinale* Webb., *Alchemilla vulgaris* L., *Trifolium repens* L., *Lotus corniculatus* L. and *Vicia cracca* L.)

After eight years of mineral nutrition (Table 3) the share of grasses increased, except treatments 1 and 2, what is known from studies of many authors (Krajčovič et al., 1968; Lichner, 1972; Folkman, 1985; Holúbek, 1991 and others). Only in the treatment with 60 kg $N.ha^{-1}$ even after this period floristic composition similar to the first year of fertilization is preserved, but with slightly higher representation of leguminous plants (by 2.5 %) and decrease of other herbs (by 4 %).

After three-year elimination (1994 to 1996) of fertilization representation of floristic groups in all studied treatments (Table 3). Unfertilized stand is after absence of fertilization characteristic by almost 50 % representation of dicotyledonous species with dominance of *Leontodon autumnalis* L. (25 %), *Alchemilla vulgaris* L. (7 %) and *Achillea millefolium* L. (2.25 %). Recess of *Festuca rubra* L. (from 26 to 9 %) and particularly *Festuca pratensis* Huds. (from 17 to 2.5 %) is reported. The share of *Anthoxanthum odoratum* L. (7 %) and *Nardus stricta* L. (9 %) is increasing. More than 30 % decrease of grass species reflected in relatively high proportion of blank places (20 %) with distribution of moss (*Polytrichum commune* Hdw.), which modifies the moisture regime and suppresses mainly grasses by its aggression. In the treatment with phosphorus-potassium nutrition the proportion of leguminous plants fell significantly (by 24 %), previously affected by mineral nutrition, but according to Rabotnov (1974) also by periodicity of their occurrence. Such anthropogenically increased proportion of leguminous plants on originally oligotrophic sites is not a stable cha-racter, because their higher presence after elimination of fertilization is dependent on gradual withdrawal of applied nutrients (PK) and competitive relationships about these nutrients with wide-leaved herbs and aggressive grasses in the stand. In treatments fertilized before with gradated nitrogen rate (treatments 3 and 4) the proportion of grass species fell by 12 % during three years of elimination and representation of leguminous plants and other meadow herbs increased. The cessation of fertilization affected at least the floristic composition in the treatment with 240 kg $N.ha^{-1}$, though also here the proportion of grasses fell by 8 % and proportion of other herbs by 2.5 % and totally the stand was thinned (13.5 % of blank places). In grass phytocenosis priority belongs to low grass species less demanding for nitrogen (*Festuca rubra* L., *Agrostis tenuis* Sibth., *Anthoxanthum odoratum* L., *Poa pratensis* L.). The proportion of the other meadow herbs is low and occurs according to different species from 0.25 % to 2.5 %.

Table 3 Dominance and grassland composition

Treatment	Dominance (%)	Floristic groups			
		grasses	legumes	other herbs	blank places
1	dominance after one year of fertilization (1986)	70.0	0.8	28.5	0.7
2		68.0	4.0	28.0	–
3		70.0	1.5	28.5	0.5
4		62.0	2.6	34.5	0.8
5		71.5	1.0	26.9	0.6
1	dominance after long-term fertilization (1986 – 1993)	63.0	2.0	33.0	2.0
2		52.0	30.0	18.0	–
3		71.0	4.0	24.0	1.0
4		73.0	1.0	24.0	2.0
5		84.0	–	13.0	3.0
1	dominance after cessation of fertilization (1996)	31.5	2.0	46.5	20.0
2		54.0	6.0	36.5	3.5
3		59.0	3.0	34.0	4.0
4		61.0	3.0	31.0	5.0
5		79.0	–	10.5	13.5

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PRODUCTIVITY AND QUALITY OF AMARANTH ABOVE-GROUND BIOMASS

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Summary

During the years l994–l996 under conditions of southern Slovakia, production ability and some qualitative characteristics of amaranth (*Amaranthus hypochondriacus* L.) were investigated. There was found highly significant influence of years on the yield of dry matter and on the content of crude protein, fibre and mineral elements in above-ground biomass of amaranth. The influence of stand organization (row spacing and crop density) was not statistically significant. The yields of dry matter ranged from 7.57 to10.47 tons per hectare in experimental years. The above ground biomass contained 134.90 mg of crude protein, 217.50 mg of fibre, 3.70 mg of P, 34.46 mg of K, 19.15 mg of Ca and 10.27 mg of Mg in 1 g of dry matter on the average of experimental years.

Key words: amaranth, yield, crop density, row spacing, above–ground biomass

Introduction

High productional ability, tolerance against environmental conditions and quality of above-ground biomass made a stir for forage utilization of amaranth (Cervantes, l990; Černov, l992; Safarov et al., l997; Jamriška, l994; Škultéty et al., l993 and others). Forage amaranth can be grown in pure stand or in double–cropping with saccharide forage like silage maize or sorghum sudanese (Rešetov et al., l997). From the qualitative point of view, amaranth is valuable for high content of good–quality proteins and mineral elements (Cervantes, l990; Černov, l992).

Material and methods

The field experiments were performed in irrigation–free conditions of south-western Slovakia, experimental station of Slovak University of Agriculture Nitra–Dolná Malanta (maize productional region).
Amaranth (*Amaranthus hypochondriacus* 1008) was sown during the years 1994 to 1996 (1.6.1994, 5.5.1995 and 17.5.1996). Sowing was done with two row spacings (0.250 m and 0.375 m) and after full emergence the plants were thinned for two crop densities (300 and 400 thousand plants per hectare). The harvest was done at the stage of anthesis (second half of august). Plant samples for morphological analysis of yield structure, chemical analysis and for determination of dry matter content were taken before harvest. There were analysed: crude protein (Kjeldahl method), fibre (Fibertec system), Ca and Mg (Complexometrical method), K and Na (Fire photometer) and P (Spectral photometer).

Results and discusion

Speed of amaranth emergence in the individual years corresponded with average daily temperatures after sowing. At average daily temperature of 18 °C in l994 amaranth emerged during 9 days, at the temperature of 12.5 °C in l995 during 19 days. There was found out positive relation between the height of the amaranth cover at the end of slow growth period (after a month of vegetation) and average daily temperatures in this period. After the first month of vegetation amaranth reached the average height of 180 mm: the highest one ($\overline{x}$ = 293 mm) in l994, the lowest one ($\overline{x}$ = 100 mm) in l995. The sum of daily temperatures in the year 1995 was by 73 °C lower than in l994. Regardless of both the plant height and the weather conditions in the years, vegetative growth period lasted approximately the same time, that is 47 – 49 days. For generative organs formation, amaranth needed sum of temperature ranging from 1100 to 1200 °C.
On the average of experimental years, amaranth produced 8.99 ton of dry matter biomass per 1 hectare. Significantly highest yield of dry matter (10.47 $t.ha^{-1}$) was achieved in l994. The lowest yield in l995 (7.57 $t.ha^{-1}$) corresponded with slow emergence, the slowest growth in the first month of vegetation and the smallest height of plants at the date of harvest ($\overline{x}$ = 977 mm comparing with 1430 mm in l994 and 1157 mm in l996).
Crop density and row spacing had not statistically significant effect on yield. However, their interaction gave better results both with higher crop density under 0.25 m row spacing and, on contrary, with lower crop density under 0.375 row spacing (Table 1).
Amaranth contained 134.90 mg of crude protein, 217.50 mg of fibre, 3.70 mg of P, 34.46 mg of K, 19.15 mg of Ca and 10.27 mg of Mg in 1 g of dry matter on the average.
There was found statistically highly significant influence of years on the content of crude protein, fibre and mineral elements in above-ground biomass of amaranth. The highest content of crude protein, K and Ca and the lowest content of fibre in the year 1994 corresponded with the highest portion of leaves in the yield of amaranth, the highest content of P in the year 1996 with the highly portion of inflorescences in the yield of amaranth at that year. The influence of stand organization (row

spacing and plant density) on the content of mineral elements, crude protein and fibre was not statistically significant. Only content of crude protein was significantly higher at the density 400 thousand plants per hectare.

Table 1 The yield and quality of amaranth above-ground biomass (*Amaranthus hypochondriacus* L.)

Indicator	Year	Row spacing				Average
		0.250 m		0.375 m		
		D 300	D 400	D 300	D 400	
Dry matter yield $t.ha^{-1}$	1994	10.11	11.76	11.50	8.49	10.47
	1995	7.54	7.30	7.09	8.37	7.57
	1996	9.61	9.01	8.92	7.82	8.94
	$\overline{x}$	9.09	9.36	9.17	8.23	8.99
Crude protein $mg.g^{-1}$ of dry matter	1994	157.0	177.9	153.9	183.0	167.9
	1995	118.9	118.7	117.5	117.9	118.3
	1996	114.0	122.8	118.0	119.9	118.7
	$\overline{x}$	129.9	139.8	129.8	140.2	134.9
Fibre $mg.g^{-1}$ of dry matter	1994	202.7	172.0	185.1	202.7	190.6
	1995	235.5	194.5	215.2	204.2	212.4
	1996	251.5	239.4	249.1	257.8	249.5
	$\overline{x}$	233.2	201.9	216.4	221.5	217.5
P $mg.g^{-1}$ of dry matter	1994	2.60	2.92	2.50	3.38	2.85
	1995	3.62	3.17	3.53	3.05	3.34
	1996	4.77	5.16	4.68	5.05	4.92
	$\overline{x}$	3.66	3.75	3.57	3.83	3.70
K $mg.g^{-1}$ of dry matter	1994	37.02	39.22	40.95	43.60	40.20
	1995	32.15	27.94	26.99	27.07	28.54
	1996	34.69	34.65	34.30	34.88	34.63
	$\overline{x}$	34.62	33.94	34.08	35.18	34.46
Ca $mg.g^{-1}$ of dry matter	1994	28.77	27.84	23.91	27.51	27.01
	1995	17.42	22.94	18.08	18.37	19.20
	1996	10.67	11.30	12.13	10.90	11.25
	$\overline{x}$	18.97	20.96	18.04	18.93	19.15
Mg $mg.g^{-1}$ of dry matter	1994	11.96	9.73	10.17	12.13	11.00
	1995	9.41	9.79	7.20	8.50	8.73
	1996	10.97	11.64	10.95	10.72	11.07
	$\overline{x}$	10.78	10.39	9.44	10.45	10.27

D 300 – density of 300 thousand of plants per hectare; D 400 – density of 400 thousand of plants per hectare

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QUANTITATIVE CHARACTERS AND CHEMICAL COMPOSITION OF SPELT WHEAT CULTIVARS GROWN IN SOUTHERN SLOVAKIA

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Summary

During 1996-1999 a field experiment with different varieties of Triticum spelta (L.) was carried out of brown loamy arable soil within an ecological system in Nitra region. The yield formation characters and the crop yield itself were investigated by three spelt wheat cultivars (Bauländer Spelz, Schwabenkorn, Roquin) and compared with common wheat. The achieved results revealed that the agroecological conditions of Nitra region are most suitable for the Bauländer Spelz cultivar of German origin, with the highest crop yield of 6.06 $t.ha^{-1}$, i. e. 92.2% of common wheat yield. This cultivar reached the lowest percentage of glumes (26.13%), the highest TGW (49.29 g), the longest spike (112.45 mm), the highest number of fertile spikelets (14.32) and the highest weight of grains per spike (1.33 g). All of the spelt wheat cultivars had lower productive density of stand (501.3 to 518.7 productive stems per square meter) than common wheat (605.3 productive stems per square meter). Spelt cultivars mainly differed from common wheat cultivar for higher contents of P, S, some of them for Ca, Na. Spelt cultivars were higher in sugars, fat and lower in starch content.

Key words: cereals, spelt wheat, crop yield, yield formation characters, ecological farming system

Introduction

The spelt wheat is one of the oldest cultural cereals, which is originated from crossing of Aegilops squarrosa (L.) with Triticum dicoccon (Schrank.). Subsequent mutation resulted in the most spread and valuable Triticum aestivum (L.). Both have equal genomes, with 42 chromosomes.

Findings of carbonised pieces of spikes, spikelets and kernels are known in the region of Slovakia from the end of 5th millennium BC. The importance of *Triticum spelta* (L.), as grown cereals, was variable. During the Early Bronze Age its occurrence varied around 25% of grown cereals. At the end of Bronze Age, in Lusation culture, the share of *Triticum spelta* (L.) on growing cereals achieved as much as 60%. In Celts culture spelt wheat was grown in lowland regions and mountains basins of north Slovakia as well (Hajnalová, 1993). No evidence has been reported on growing spelt wheat to the beginning of 19th century.

Since the beginning of the 20th century, the spelt wheat has been bred. In Germany the first crossing is reported in 1903. The cultivar Bauländer spelz of pre-war time is the most famous. Originated from the selection of Muellers Gaiberger Landspelz. Further cultivar Schwabenkorn originated by screening of a land race, was registered in 1978. Belgian cultivar Roquin is crossing of spelt cultivar Ardenne and Altgold, and common wheat cultivar Lignee`24. It was registered in 1979. The European spelt cultivars are medium high to high, with good winter hardiness, with lower or medium lodging resistance, they are rather late, more resistant to sprouting, variously resistant to powdery mildew, rusts and foot-stem diseases (Vlasák, 1996).

In Slovakia, no cultivar has been registered since 1918. In the last 20 years, the growing area of *Triticum spelta* (L.) has been increasing due to higher demand of diversified food (whole-grain bread, specific flavour), increasing of ecological agriculture, also overproduction in western Europe. These trends influenced our interest in an experimental evaluation of some cultivars originated from Germany and Belgium in Slovakian conditions.

Materials and methods

The objective of this study was to evaluate the quantitative characters and basic chemical composition of three spelt wheat cultivars Bauländer spelz, Schwabenkorn, Roquin *(Triticum spelta* L.*)* and were compared with common wheat cultivar Samanta *(Triticum aestivum* L.*).*

The experiments were established in south region of Slovakia, in four replicate blocks, during 1996-1999 growing seasons, without fertilisation and any chemical treatments.

Pedo-climatic conditions: average air temperature during vegetative period 16.4°C, normal annual precipitation 532.5 mm, soil type: brownsoil, texture: clay-loamy. The level of nutrients in the soil was very good. Sowing rate: 210 $kg.ha^{-1}$ of both Triticum species.

The characters determined for every cultivar were: average year's yield, number of productive stems, weigh of 1000 grains, % of glumes, stem length, spike length, number of total spikelets, % fertile spikelets, weigh of grains per spike.

After ashing the flour samples, calcium, potassium and sodium were determined by flame emission spectrophotometry, total phosphorus was determined by spectrophotocolorimetry using Spekol, sulphur was measured by nephelometry, starch by polarimetry, sugars according to Somogyi, crude fat by extraction according to Soxhlet (in Davídek et al., 1985).

Results and discussion

All spelt cultivar were lower in yields of naked grains than comparative common wheat cultivar Samanta (Table 1). The highest yield reached German cultivar Bauländer spelz, 6.06 $t.ha^{-1}$, i. e. 92.2% of common wheat. The lowest yield achieved Belgian cultivar Roquin, 5.07 $t.ha^{-1}$, i. e. 77.2% of common wheat. Schwabenkorn was intermediate and reached 5.23 $t.ha^{-1}$, i. e. 79.6% of common wheat.
The stem length of spelt cultivars ranged from 0.79 to 1.08 m (Table 2). It is lower than in western Europe, because of more dry conditions of southern Slovakia. All of them showed good resistance to lodging. The highest differences in stem length reached Schwabenkorn, i. e. 0.24 m within years, Bauländer spelz 0.2 m and Roquin was the most stabilised one (0.95-1.05 m). The weight of 1000 grains (TGW) averaging for spelt wheat about 47.83 g, all of them exceeded common wheat cultivar Samanta. The highest TGW was observed in cultivar Bauländer spelz, some cultivar differences occurred within the years. The average % of glumes after harvest ranged from 26.13% for Bauländer spelz to 27.93% for Schwabenkorn. The length of spike was similar as in common wheat, ranged from 105.5 to 112.5 mm. The highest weight of grains per spike was achieved by Bauländer spelz, 1.33g. The density of stand was lower, with 501.3 productive stems per m^2 by Schwabenkorn cultivar, and the highest, with 518.7 by Bauländer spelz.
All spelt cultivars exceeded common wheat cultivar Samanta in phosphorus and sulphur levels, averaging about 479.2 mg/100g and 217.3 mg/100g respectively (Table 3). In potassium content spelt cultivar Bauländer spelz was at the same level as common wheat. The other spelt wheats were lower in potassium. Calcium ranged from 38 to 78 mg/100g, with Schwabenkorn having the highest concentration. Sodium also showed differences among spelt wheat cultivars, ranged from 4.6 to 6.1 mg/100g. All three spelt cultivars were lower in starch content than common wheat Samanta. Soluble sugars concentrations occurred in inverse proportions to starch levels. More crude fat was determined for spelt cultivars, averaging about 2.72%, suggesting that there may also be differences in proportion of germ in the kernels.
Considering the results of this study, preliminary recommendation of spelt wheat cultivar Bauländer spelz is possible. It reached the highest yield of naked grains, medium stem length, and highest stability within the years. This cultivar formed the yield mainly on the basis of spike productivity. Spelt cultivars mainly differed from common wheat cultivar for higher contents of P, S, some of them for Ca, Na. Spelt cultivars were higher in sugars, fat and lower in starch content.

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Table 1: Crop yield of spelt wheat and winter wheat from 1996 to 1999 [$t.ha^{-1}$]

Cultivar	Year				Average	Comparison with winter wheat [%]
	1996	1997	1998	1999		
Bauländer Spelz [a]	6.82	6.24	6.93	4.25	6.06	92.2
Schwabenkorn [a]	5.10	7.30	5.66	4.85	5.23	79.6
Roquin [a]	4.79	6.93	4.10	4.45	5.07	77.2
Samanta [b]	7.15	6.85	6.95	5.34	6.57	100.0

[a] *Triticum spelta* (L.); [b] *Triticum aestivum* (L.)

Table 2: Yield formation characters of spelt wheat and winter wheat from 1996 to 1999

Year	Cultivar	**No of productive stems.m^{-2}**	TGW [g]	% of glumes	Stem length [m]	Spike length [mm]	No of spikelets		Weight of grains per spike [g]
							Total	Fertile of total spikelets	
1996	Bauländer Spelz [a]	440.0	50.14	21.88	0.83	119.8	19.7	16.3	1.55
	Schwabenkorn [a]	392.0	46.70	24.99	0.84	93.4	16.5	14.3	1.30
	Roquin [a]	420.0	51.85	23.66	0.95	110.2	18.0	15.6	1.14
	Samanta [b]	752.0	35.41	-	-	-	-	-	0.86
1997	Bauländer Spelz [a]	600.0	47.09	29.81	0.79	99.4	13.4	7.4	1.04
	Schwabenkorn [a]	716.0	50.00	32.35	1.08	100.8	13.1	6.9	1.02
	Roquin [a]	788.0	42.58	32.22	1.05	103.3	13.1	5.9	0.88
	Samanta [b]	628.0	47.74	-	-	-	-	-	1.26
1998	Bauländer Spelz [a]	680.0	54.27	26.65	0.93	114.0	20.4	16.7	1.51
	Schwabenkorn [a]	524.0	47.46	26.52	0.97	102.0	18.9	14.0	1.08
	Roquin [a]	452.0	46.26	23.99	1.01	92.0	18.6	12.1	0.91
	Samanta [b]	556.0	43.82	-	-	-	-	-	1.25
1999	Bauländer Spelz [a]	354.7	45.64	26.18	0.99	116.6	21.4	16.9	1.20
	Schwabenkorn [a]	373.3	46.36	27.85	0.97	125.8	21.6	17.8	1.30
	Roquin [a]	362.0	45.61	28.20	0.95	124.3	20.9	17.8	1.23
	Samanta [b]	485.0	45.91	-	-	-	-	-	1.19
average 96-99	Bauländer Spelz [a]	518.7	49.29	26.13	0.89	112.5	18.7	14.3	1.33
	Schwabenkorn [a]	501.3	47.63	27.93	0.97	105.5	17.5	13.2	1.17
	Roquin [a]	505.5	46.57	27.02	0.99	107.5	17.6	12.8	1.04
	Samanta [b]	605.3	43.22	-	-	-	-	-	1.14

[a] *Triticum spelta* (L.); [b] *Triticum aestivum* (L.)

Table 3: Mineral content and chemical composition of spelt and common wheat's meals (on dry basis)

Cultivar	P	K	S	Ca	Na	Digestible carbohydrates [%]		Crude fat[%]
	[mg/100g]					Starch	Sugars	
Bauländer Spelz [a]	487	297	222	38	4.6	56.0	2.55	2.53
Schwabenkorn [a]	475	264	200	78	6.1	56.4	2.45	2.60
Roquin [a]	475	262	230	47	4.8	56.9	2.55	3.04
Samanta [b]	375	291	136	45	4.3	60.2	2.30	2.01

[a] *Triticum spelta* (L.); [b] *Triticum aestivum* (L.)

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INFLUENCE OF ARABLE FARMING SYSTEMS ON WEED INFESTATION

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Summary

The objectives of this study was to investigate the influence of an ecological and integrated farming system on development of weed seedbank in soil and actual weed infestation. According to the achieved results it is evident, that the farming system showed higher influence on development of weed infestation than the system of soil cultivation. The minimum soil cultivation in ecological system significantly enhanced the weed seedbank. Under conventional soil cultivation the differences in viable weed seeds between the systems were not significant. The highest weedstock in all years had *Amaranthus retroflexus L.*, which dominance was supported by ecological system and minimum soil cultivation. Significant differences in actual weed infestation were observed between the soil cultivation systems and farming systems. The farming system did not influence the total number of detected weed species, but changes in weed species composition were detected.

***Key words**:* ecological farming system, integrated farming system, weed seedbank, actual weed infestation, conventional soil cultivation, minimal soil cultivation

Introduction

The crop-weed system is dynamic and its behaviour may change with environmental and cropping conditions. Interactions between crop and weed flora are influenced by such factors as crop species, crop rotation, crop-weed competition, cultivation methods, water conditions, fertilisation, weed control methods and composition of the weed seedbank. From a practical viewpoint, weed seedbank studies aim to acquire information on the actual weed infestation which would possibly develop in the subsequent crops.

Material and methods

The aim of this study was to determine the influence of an ecological and integrated farming system on development of weed seedbank in soil and their relation with the weed infestation. Field experiment were established at the Slovak Agricultural University Research Station Dolná Malanta on brown clay-loamy soil in 1990. In ecological farming system the following crop rotation has been used: bean with alfalfa undersowing – alfalfa – winter wheat (intercrop) – silage maize – winter rape (intercrop) – common pea (intercrop) – grain maize – winter wheat. In integrated system the following crop rotation has been used: alfalfa (extrarotation plot) - grain maize – silage maize – winter wheat (intercrop) – sugar beet – spring barley (intercrop) – common pea – winter wheat. In both systems were examined two variants of soil cultivation: 1. conventional with ploughing to the depth of 0,24 m; 2. minimal with shallow cultivation to the depth of 0,12 – 0,15 m. Weed seedbank was determined in the years 1990, 1996, 1998 on two plots of each system, in the depths of 0,0 – 0,05 m; 0,2 – 0,25 m in seven replications. The actual weed infestation was evaluated two times in 1998 during vegetative period (spring and summer aspect) according to the EWRS method (species composition and number of weeds per m^2 was determined by counting).

Results and discussion

Weed seedbank in 1996 (tab. 2) in ecological system was significantly higher 7,5 times in the average per m^2 in comparison with the year 1990 (tab. 1). Soil cultivation had a significant influence on a weedstock and was expressed by higher number of weed seeds under minimum cultivation. In this case during the last two years, total number of viable weed seeds was 8,4 times higher as compared with the year 1990 (41 014 weed seeds per m^2).
There were no significant differences between the systems when using conventional cultivation. During evaluated years, 21 weed species were detected in the ecological system. Dominant weed species was *Amaranthus retroflexus L.* with the share of 67,4 % in 1990. After six and eight year period its share was 96,4 % and 95,1. The most frequent species were beside the above-mentioned *Chenopodium album L., Chenopodium polyspermum.* Weed species *Persicaria lapathifolia, Polygonum aviculare L., Atriplex patula L., Capsella bursa-pastoris, Papaver rhoaes L., Stellaria media, Veronica hederifolia L., Sinapis arvensis L.* did not occur any more, the other new species *Galium aparine L., Thlaspi arvense L., Fallopia convulvulus, Pesicaria maculata* were imported. Weed seedbank in integrated system significantly rose up in 1996. In comparison with year 1990 it was 2,5 times. The whole seedstock in both depths of soil reached the highest rate, 24 356 seeds per m^2 in 1996. The soil cultivation did not have a significant influence on changes of weed seedbank. *Amaranthus retroflexus L.*

dominantly represented all 22 of the determined weed species. Its ratio from the whole weed seedstock was 80,6 % in 1990. In 1996 its ratio rose to 87,7 % and in 1998 (tab. 3) *Amaranth* reached 94,7 %. There was no significant influence of integrated system on changes of the number of weed species.

Table 1

Number of weed seeds in soil per m^2 in 1990

Weed species	**Ecological farming system**				**Integrated farming system**			
	0,0-0,05 m		0,2-0,25 m		0,0-0,05 m		0,2-0,25 m	
	Con. (1)	Min. (2)	Con.	Min.	Con.	Min.	Con.	Min.
AMARE	1 250	1 969	1 438	1 250	2 969	4 625	4 313	2 938
ATRPA	125	188	-	188	63	156	-	-
CAPBP	-	31	125	-	31	-	-	-
CHEAL	219	188	63	63	344	344	125	63
CHEPO	-	31	-	-	-	-	-	-
CUSTR	-	-	188	-	-	-	-	-
ECHCG	31	94	188	313	376	375	313	63
PAPRH	-	94	-	-	-	-	-	63
PERLA	63	94	125	63	157	188	63	63
POLAV	32	32	-	-	31	63	-	125
SINAR	31	32	-	-	-	63	-	-
STEME	-	-	-	125	-	63	63	-
THLAR	-	-	-	63	125	-	-	-
VERHE	-	-	-	63	31	125	63	-
Total	1 751	2 753	2 127	2 128	4 127	6 002	4 940	3 315

(1) conventional soil cultivation, (2) minimal soil cultivation

Table 2

Number of weed seeds in soil per m^2 in 1996

Weed species	**Ecological farming system**				Integrated farming system			
	0,0-0,05 m		*0,2-0,25 m*		*0,0-0,05 m*		*0,2-0,25 m*	
	Con. (1)	*Min. (2)*	*Con.*	*Min.*	*Con.*	*Min.*	*Con.*	*Min.*
AMARE	11 125	21 917	8 667	21 933	11 042	13 250	5 389	13 056
ATRPA	-	-	-	-	-	-	-	-
CHEAL	750	375	-	-	667	417	-	83
CHEPO	-	-	458	84	-	-	320	764
CONAR	-	-	-	-	125	-	500	-
ECHCG	42	42	-	-	125	-	-	-
FALCO	-	-	42	-	250	-	-	-
GALAP	-	42	-	-	-	-	-	-
PERMA	125	42	42	292	583	292	167	250
RUMCR	-	-	-	-	125	-	167	222
THLAR	42	-	-	-	42	167	42	167
TRIIN	-	-	-	-	84	-	417	-
Total	12 084	22 418	9 209	22 309	13 043	14 126	7 002	14 542

In both farming systems variant with minimal cultivation had higher actual weed infestation than conventional one (tab. 4). This could be explained by the higher weed seedstock in the soil. Significant differences were observed between different soil cultivation and between farming systems. In ecological system was higher weed species competition than in integrated. Differences were also found in number of weeds per m^2, where in ecological system were determined about 26 % higher weed infestation than in integrated one. Dominant weeds species in the spring aspect were *Cirsium arvense, Capsella bursa pastoris, Tripleurospermum inodorum.* In summer aspect the most dangerous weed species was *Cirsium arvense.*

Table 3

Number of weed seeds in soil per m^2 in 1998

Weed species	**Ecological farming system**				**Integrated farming system**			
	0,0-0,05 m		*0,2-0,25 m*		*0,0-0,05 m*		*0,2-0,25 m*	
	Con. (1)	*Min.* (2)	*Con.*	*Min.*	*Con.*	*Min.*	*Con.*	*Min.*
AMARE	15 250	16 600	11 850	18 650	9 600	10 800	10 350	5 000
ATRPA	50	150	-	-	-	-	-	-
CAPBP	-	-	100	50	-	-	-	-
CHEAL	-	-	100	50	150	-	-	-
HELAN	-	-	-	-	-	100	-	-
MELAL	-	-	-	50	-	-	-	50
PERMA	50	300	250	400	50	400	50	-
POLAV	-	-	250	-	-	-	-	-
RUMCR	-	100	-	100	-	50	-	250
SCLAN	-	50	-	-	-	-	-	-
SINAR	-	-	-	100	125	-	150	50
THLAR	42	-	-	-	-	-	-	-
TRIAE	250	700	50	-	200	250	-	-
VERHE	-	-	-	-	-	-	-	100
Total	15 642	17 900	12 600	19 400	10 125	11 600	10 550	5 450

Table 4

Actual weed infestation in 1998

Weed species	**Ecological farming system**				**Integrated farming system**			
	Spring aspect		*Summer aspect*		*Spring aspect*		*Summer aspect*	
	Con. (1)	*Min.* (2)	*Con.*	*Min.*	*Con.*	*Min.*	*Con.*	*Min.*
CAPBP	6	8	-	-	6	8	-	-
CARDR	3	6	3	4	3	5	-	-
CIRAR	4	10	4	6	4	6	4	6
CONAR	3	2	-	-	-	-	-	-
FALCO	-	-	-	1	-	-	2	4
LAMAM	3	2	-	-	2	6	1	2
MEDSA	-	-	1	3	-	-	-	-
PAPRH	2	5	1	2	-	3	-	1
STEME	4	2	-	-	2	4	-	-
THLAR	2	4	-	-	4	6	1	2
TRIPE	6	8	4	8	4	6	-	-
VIOAR	2	2	-	-	2	3	-	-
Total	25	59	13	24	27	47	8	15

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THE INFLUENCE OF FERTILIZATION AND SOWING RATE WINTER WHEAT BAKING QUALITY

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Summary

From two year (1997-1998) field experiments realised on plots of the Experimental Basis of the Faculty of Agronomy on the Slovak Agricultural University in Nitra results, that assessed production factors (fertilization, sowing rate) have had a highly significant, res. significant influence on the technological quality in winter wheat and hard wheat grain (wet gluten content, volume weight, 1000-kernels weight, grain hyaliness, content of yellow pigments in the flour). The fertilization level assigned for the final yield of 5 tons and corresponding straw amount + Voba Unihum –N (full fertilizer rate - without regard to the soil nutrients supply) and the sowing rate of 2.5 mil, germinable seeds per hectare were often manifested in our experiments as the most suitable ones. Highly significant year influence with an year variability on the wet gluten content of 19.3% (hard wheat) and 35.3% (winter wheat), grain vitreousness 7.2% (winter wheat) and 11.3% (hard wheat), and 27.3% in the yellow pigments content (hard wheat) on the technological quality parameters were stated.

Keywords: fertilization, seed rate, technological quality, yield

Introduction

Besides the economical effectiveness also requirements on the quality of cereals are rising more and more in the market economy conditions. The biggest attention in the research and praxis of wheat for food purposes is paid to the problems of technological quality, which can be assessed according to the milling properties (milling suitability, grain hardiness, 1000-grain weight, etc.) and baking quality, especially gluten content and quality (PETR, 1999 and others). As to the less traditional wheat (*Triticum durum Desf.*) use in the non-egg pasta production with rising consumption in Slovakia it is important to take into account also the dough value which is can be assessed (besides the parameters of technological quality in hard wheat according to the STN – Slovak Technical Norm) according to the content of yellow pigments (ZALABAI, 1995).
The technological quality of winter wheat is a complex genetically determined value, i.e. by the variety and agroecological conditions
The aim of this work follows these facts and it was to analysed the influence of some cultivation factors on some technological quality in the summer and hard wheat, grain.

Material and methods

There problems were solved in 1997-1998 in the Department of Crop Production on the Slovak Agricultural University in Nitra, Slovakia in frame of the field polyfactor experiments in a maize production area, semiarid subarea belonging to a very warm agroclimatic area of an altitude 201m above sea level, and an average year temperature of 9.6 °C. Temperature of the evaluated period was almost normal (from 9.2 °C in 1997 to 10.8 °C in 1998) and precipitation were in 1997 almost at the normal level (94% of the normal level) and the year 1998 was extremely dry (69.6% of the normal precipitation level). The experimental plots were situated on medium heavy luvisols with low acid reaction, and a medium supply of phosphorus, good supply on potassium and humus content raging from 1.78% to 2.21%. Into trials were involved BREA /the winter form of a summer wheat/ and VENDUR /hard wheat, winter form/, three involved sowing rates (I. – 2.5 mil. germinating seeds per hectare, II. – seed rate recommended for single varieties by breeder, III. – 5.0 germinable seeds per hectare), four fertilization variants (a – nonfertilized control variant, b – reduced fertilizer rate + Microbion, c – rationalised fertilizer rate according to the Method of Diagnostics (MICHALÍK, LOŽEK, 1985), d – full fertilizer rate + Voba Unihum – N without regard to the soil nutrients supply – total 193.1 t.ha^{-1}).
We've evaluated the following technological quality parameters in the wheat grain (wet gluten content, gluten quality – gluten swelling, gluten extensibility, volume weight, 1000-kernels weight, yellow pigments content in the flour – in hard wheat only). The parameters on technological quality were stated according to methodics published in STN No. 46 11 00 – 2 (winter wheat) and STN No. 46 11 00 – 3 (hard wheat).

Results and discussion

The highest influence on the wheat grain quality from the point of view of food production plays the nutrition and fertilization which can be expressed also by two-year results of field trials (1997-1998) in winter form of a summer wheat (BREA variety) and a winter form of a hard wheat (VENDUR variety).

According to average results on baking quality parameters - the wet gluten content (tab. 1) related to different fertilization levels follows a positive, highly significant influence of fertilization on the wet gluten content (26.7% and 24.0%) in both wheat species. The highest values was stated in variant "d" (fertilization without regard to the soil nutrients supply - full fertilizer rate + Voba Unihum – N) when increase of the gluten amount compare with the control variant was 14.8% (winter wheat) and 12.8% (hard wheat) which was referred also by MUCHOVÁ (1989), KARABÍNOVÁ, PROCHÁZKOVÁ (1994) and others. Highly significant differences due to various fertilization levels were stated also in milling quality parameters (volume weight, 1000-kernels weight and grain vitreousness), the influence of different fertilization levels was positive but it have had a various tendency according in individual wheat species. The highest volume weight value (808.5 $g.l^{-1}$) in winter wheat was determined in variant "d" and the highest 1000-kernels weight (47.2%) and grain hyaliness (92.1%) in variant „c" (rationalised fertilizer rate), when differences comparing to the control variant ranged from 1.5% to 9.4%. The highest volume weight value (768 $g.l^{-1}$) in hard wheat was determined in variant "b" (reduced fertilizer rate + Microbion) and the highest value of grain hyaliness in variant „d" with an increase by 0.8% and 6.7% comparing with the control variant. Differences in evaluated characteristics on the milling quality of winter wheat were highly significant.

In order to assess the pasting properties of the hard wheat grain ZALABAI (1995) proposed to determine the content of yellow pigments (tab. 1) which influence the final product colour essentially. Following our results there was anexpressive increasing in the yellow pigments content due to single fertilization levels, the highest value were determined in variant "c" with an increase of 23.8% comparing with the control variant.

Another important factor influencing the technological quality formation is the seed rate evincing via the stand light regime (tab. 2). The content of wet gluten was determined by applied seed rates highly significant in winter wheat and significant in hard wheat, the highest wet gluten amount in both wheat species was stated at low sowing rates (2.5 mil. germinable seeds per hectare) when probably the most suitable conditions for protein biosynthesis were achieved (PRUGAR et. al. 1977).

Between species there were stated statistically significant differences in the technological quality parameters (without regard to the fertilization and sowing rate) when for two years higher values in average on wet gluten content and volume weight were stated in winter wheat with an increasing of 11.7% or 5.2% comparing with hard wheat values. Stated a higher hyaliness value (92.6%) and higher 1000-kernels weight (50.2 g) There was a higher hyaliness volue (92,6%) and higher 1000 kernels weight (50,2 g) stated which is for 3.8%, res. 6.8% higher comparing with winter wheat values. These values correlate with STN hard wheat requirements.

From our experimental results is stated that the most important reason for variability in technological quality parameters was the weather course in particular year confirmed by highly significant differences in evaluated characteristics (tab. 3). More favourable conditions for protein synthesis were stated in 1997 when the wet gluten content in winter wheat was higher then 35.3% and also 19.3% in the hard one. Compared with 1998 was in 1997 was the grain hyaliness higher for 7.2% in winter wheat and 11.3% in hard wheat, and the yellow pigments content for 27.3%. Similar results about the year influence on technological quality parameters are referred also by MUCHOVÁ (1989), ZALABAI (1995) and others.

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Table 1: *Influence of the fertilization on the technological quality parameters in the winter and hard wheat grain (for 1997-1998 in average)*

Wheat species	fertilization variant	yield of grain ($t.ha^{-1}$)	wet gluten content (%)	weight ($g.l^{-1}$)	1000-grain weight (g)	vitreousness (%)	yellow pigment content ($mg.kg^{-1}$ flour)
Triticum aestivum (BREA)	a	7,37	23,17	803,17	47,18	83,87	-
	b	8,55	23,83	806,50	47,18	89,17	-
	c	8,57	26,33	805,50	47,20	92,14	-
	d	8,53	26,67	808,50	46,48	91,79	-
	average	8,25	25,00	805,92	47,01	89,24	-
Triticum durum (VENDUR)	a	6,09	18,67	762,83	52,50	88,65	3,06
	b	7,29	20,00	768,00	49,67	92,73	3,62
	c	7,45	22,50	766,00	50,43	94,34	3,79
	d	7,51	24,00	766,17	48,23	94,56	3,68
	average	7,08	21,29	765,75	50,21	92,57	3,54

Table 2: *Influence of the seed rate on the technological quality parameters in the winter and hard wheat grain (for 1997-1998 in average)*

Wheat species	sowing rate	yield of grain ($t.ha^{-1}$)	wet gluten content (%)	weight ($g.l^{-1}$)	1000-grain weight (g)	vitreousness (%)	yellow pigment content ($mg.kg^{-1}$ flour)
Triticum aestivum (BREA)	I.	8,57	25,50	806,00	47,59	90,01	-
	II.	7,99	24,63	806,88	46,78	88,23	-
	III.	8,20	24,88	804,88	46,68	89,49	-
	average	8,25	25,00	805,92	47,01	89,24	-
Triticum durum (Vendur)	I.	7,40	21,63	767,50	50,24	93,13	3,27
	II.	7,00	21,00	766,63	50,11	92,76	3,85
	III.	6,85	21,25	763,13	50,28	91,82	3,50
	average	7,08	21,29	765,75	50,21	92,57	3,54

Table 3: Mathematically and statistical evaluation on the influence of investigated factors on the technological quality parameters

Wheat species	source of variability	F calculated				
		yield of grain	wet gluten content	weight	1000-kernels weight	hyialiness
Triticum aestivum (BREA)	year (A)	107,48^{++}	5586,21^{++}	723,46^{++}	114,84^{++}	78,83^{++}
	fertilization (B)	13,92^{++}	307,13^{++}	7,86^{++}	26,66^{++}	29,72^{++}
	sowing rate (C)	5,02^{+}	26,90^{++}	2,07^{-}	73,51^{++}	2,25^{-}
	repetition (D)	0,73^{-}	0,04^{-}	0,12^{-}	0,05^{-}	0,08^{-}
	interaction					
	A x B	1,31^{-}	59,77^{++}	3,51^{+}	2,35^{-}	1,13^{-}
	A x C	3,24^{+}	2,07^{-}	47,79^{++}	13,16^{++}	5,06^{+}
	B x C	0,91^{-}	11,26^{++}	5,65^{++}	12,93^{++}	2,89^{+}
Triticum durum (VENDUR)	year (A)	324,32^{++}	409,09^{++}	398,53^{++}	513,83^{++}	275,02^{++}
	fertilization (B)	30,12^{++}	168,28^{++}	9,33^{++}	52,52^{++}	20,83^{++}
	sowing rate (C)	8,22^{++}	3,84^{+}	15,33^{++}	0,15^{-}	1,69^{-}
	repetition (D)	0,38^{-}	0,03^{-}	0,85^{-}	0,06^{-}	0,76^{-}
	interaction					
	A x B	3,77^{+}	121,41^{++}	53,93^{++}	3,61^{-}	4,75^{++}
	A x C	25,93^{++}	1,82^{-}	121,63^{++}	3,02^{-}	2,80^{-}
	B x C	1,20^{-}	2,22^{-}	3,29^{+}	2,22^{-}	3,77^{++}

Table 4: Limit values

Wheat species	source of variability		yield of grain	wet gluten content	weight	1000-kernels weight	hyialiness
Triticum aestivum (BREA)	year	Hd 0,05	0,31	0,20	1,62	0,14	1,42
		Hd 0,01	0,41	0,27	2,17	0,19	1,90
	fertilization	Hd 0,05	0,58	0,38	3,05	0,26	2,66
		Hd 0,01	0,72	0,47	3,77	0,32	3,29
	sowing rate	Hd 0,05	0,46	0,30	2,40	0,20	2,09
		Hd 0,01	0,58	0,38	3,04	0,26	2,65
Triticum Durum (VENDUR)	year	Hd 0,05	0,25	0,38	1,43	0,50	1,21
		Hd 0,01	0,34	0,50	1,92	0,67	1,63
	fertilization	Hd 0,05	0,47	0,70	2,69	0,93	2,28
		Hd 0,01	0,58	0,87	3,33	1,16	2,82
	sowing rate	Hd 0,05	0,37	0,55	2,11	0,73	1,79
		Hd 0,01	0,47	0,70	2,68	0,93	2,27

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PERFORMANCE OF TWO THERMAL WEEDERS IN APPLE ORCHARDS

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Summary

During 2 years, two methods field trials to investigate the efficacy of flame weeding and hot-steaming were conducted in apple orchards, in Nova Scotia-Morristown, Canada. At Flaming the most resistant perennial weeds were *Taraxacum officinale* Weber and *Leontodon autumnalis* L.. From annual weeds the most vigorous species was *Polygonum aviculare* L.. Flame weeding gave good reduction of annual species in early growth stages (to 6 true leaves) and at lower driving speeds. In 1999, the hot-steam treatments were less effective at perennial weeds. The efficiency of the 2nd treatment was higher 1 week after treatment, than 2 weeks after treatment. The most resistant species were *Linaria vulgaris* Mill. and *Polygonum aviculare.* In 1998 this technology wasn't effective, too. An exposure time of 540 s at 150ºC of the steam wasn't sufficient to control weeds.

Key words: weed control, apple orchard, flame, hot-steam.

Introduction

Weeds are a major problem in the agricultural production throughout the world and according to Rasmussen *et al.* (1995) especially in organic farming systems. It is difficult to quantify the impact of weeds on crop yields, a risk of high crop losses (20%) from high weed pressure is possible. Problems with herbicides, including underground and surface water contamination, pesticide residues in food, has sparked public awareness and restrictions of herbicide use.
Flame weeding is one of the alternatives to chemical weed control. Thermal weed control, which relies on heating plants until the cells burst (at 70-80ºC), is particularly valuable for pre-em. weeding in crops such as carrots, parsley and leeks, that are slow to germinate. Another alternative for non-chemical weed control is hot–steam based technology. Two companies have developed equipment that delivers superheated water from a boom or spray nozzle attached to a diesel – fired boiler. According to Riley (1995) this equipment can be used in windy or rainy conditions with no concern about drift, run off or loss of efficacy. The high pressure and hot water damages the cellular structure and kills weeds within several hours or a few days. First signs of the effectiveness are change of leaf colour and plant withering. The objectives of these studies are to determine the effectiveness for flaming and hot–steaming on weed regulation in apple orchards.

Material and methods

This study was initiated in 1998 for 2 years period as a co-operative project of Agricultural Engineering Department, in Truro, Nova Scotia and the Slovak Agricultural University in Nitra – Department of Agricultural systems. Field experiments were carried out on Apple Lane farm /ALF/ and Mountain Crest farm /MCF/ in Morristown, Nova Scotia. The experimental layout was a randomised blocks design, with three replicates for each experiment. At assessment, number of weeds were recorded in area of 0,5 m^2 (converted on the 1 m^2, later), which was randomly placed within each plot. Control plots with no weed control were included in each experiment.

Experiment I.

Post-emergence flaming

The flame treatments were performed with Reinert gas - propane weeder (made in Germany) in tree rows from both sides, at a gas pressure of 0,3 MPa. Flaming was conducted in 7 day intervals, three times (treatments T_1-first, T_2-second, T_3-third). The gas propane doses of single treatment were regulated by the tractor driving speed (2, 3, 4 km.h^{-1}) and were 35,0; 23,0 and 17,0 kg.ha^{-1} respectively. Angle of burners position was adjusted at 40º to ground surface (4 burners parallely–closely one by one). Above ground level of burners was 0,14 m.

Experiment II.

Post-emergence hot-steaming

In 1999, the treatments were realised with prototype hot-steam machine (developed in Nova Scotia College-Agricultural Engineering Department in Truro, Canada), at the temperature of 150ºC and 1 km.h^{-1} driving speed and above ground level was 0,15 m. Hot steam applications were carried out in 7 day intervals (altogether two treatments were applied in each plot). After 2nd treatment two weed counts were done in 7 and 14 days interval. In 1998, the treatments were performed with the Easy Kleen hot steam unit, at a pressure of 1 MPa and temperature of 150ºC. The exposure time was increased from 2 to 6 and 9 min in six day intervals (three treatments were applied in each plot). The effectiveness of each application on prevalent weed species was assessed before and after each treatment.

Results and discussion

Experiment I.: Total reduction of perennial weeds after three treatments was 45,1% at driving speed of 2 km.h^{-1} and total gas dose (TGD) of 105 kg.ha^{-1}. There was almost no difference in weed reduction between driving speeds of 3 and 4 km. h^{-1}, where 4,6% and 4,0% efficacy was achieved, at TGD of 69,0 kg.ha^{-1}and 51,0 kg.ha^{-1}respectively. At driving speed of 2 km.h^{-1} the 3rd treatment with 34,7% weed reduction was the most effective. The most resistant perennial weeds were *Taraxacum officinale* and *Leontodon autumnalis* L.. Excellent results were achieved with annuals, in particular at lowest speed, with reduction from 61,9 to 100,0%. The efficacy of single treatment depends on the driving speeds and decreases in the order of 2, 3 and 4 km.h^{-1}. The driving speed of 4 km.h^{-1} and the lowest TGD (51,0 kg.ha^{-1}) was less effective. The most sensitive species was *Lamium amplexicaule* L. (100,0% of reduction), however the most resistant weed was *Polygonum aviculare* L. with 62,0% reduction at lowest speed and 0,0% reduction at highest speed and growth stage of 8 and more true leaves. According to Ascard (1995), the tolerance of different plants towards flaming depends on factors such as the presence of protective layers of hair and wax, lignification, conditions of water status, developmental stage, type of plant habit (upright, prostrate, creeping), protection of growth points. Weed species with prostrate and creeping habit (*Capsella bursa pastoris*, *Poa annua*, *Chamomilla suaveolens*) at later developmental stages (five leaves and more) could not be controlled with one treatment regardless of the gas rate, because of their capacity for regrowth.

Experiment II.: In 1999, it is clear that hot-steam treatment was less effective technology, because total reduction of all species was lower – 58,2% after T_1 and 67,7% 1 week after T_2. At perennial weeds - *Epilobium ciliatum* Raf., *Malva rotundifolia* L. and *Plantago major* L. was minimum 70,0% reduction achieved, what can be explained by young growth stage of plants. The 1st treatment was at about of 33,5% more effective than the 2nd. Efficiency of the 2nd treatment was higher 1 week after treatment, than 2 weeks after treatment. The most resistant species were *Linaria vulgaris* Mill. and *Polygonum aviculare*. Low reduction of *Amaranthus retroflexus* was influenced by the extent of weed re-emergence before 2nd treatment and at *Chenopodium album* by the older growth stage. The results showed, that for higher reduction of vigorous weeds and for a longer time effect, the repetition of treatment is necessary, already 2 weeks after previous treatment. In 1998, the hot steam treatment was ineffective as an alternative method of weed control. Though the weeds were stunted after treatment, they were not killed. Perennial weeds (*Taraxacum officinale*) were hardly affected by hot steam in spite of their quite early stage of growth. After the 1st steam application and an exposure time of 120 s, only a 12,1% reduction of weeds was achieved. The 2nd application was even less effective, only 5,3% of weeds were eliminated, and after the 3rd treatment there was germination and young plants developed. Daar (1994) writes, that one hot-steam treatment kills most annual weeds and young perennials. Top growth of older perennials can be killed in one or two treatments, but impact on roots may be minimal unless repeated kill of top growth is employed to starve roots of nutrients. Riley (1995) pointed out, that the use of a hot steam machine may not be practical or ecologically sound in dry areas. The hot steam system is most effective when used within an integrated programme using a variety of cultural, physical, mechanical and biological tactics to solve the weed problem.

This study on the use of flame weeding and hot-steam technique in apple orchards have shown the following results during 2 years:

– very flame tolerant perennial weeds were *Taraxacum officinale* Weber and *Leontodon autumnalis* L. in which very low weed reduction (44,9% and 30,3%) was achieved at 2 km.h^{-1}, after 3rd treatment (T_3) and at total gas dose of 105,0 kg.ha^{-1}. The most vigorous annual species was *Polygonum aviculare* L., in which 0,0% reduction was at higher speeds, because this weed was in growth stage of 8 to more true leaves,
– in 1999, the most resistant species against the hot-steam were *Linaria vulgaris* Mill. (24,2% reduction after T_1; 54,5% 1 week after T_2) and *Polygonum aviculare* (9,1% reduction); in 1998, the most resistant species against the hot-steam was *Amaranthus retroflexus* L., in which 0,0% reduction was achieved after the 3rd treatment and an exposure time of 540 s,
– weed effect of flaming and hot-steaming depends on the weed species and their growth stage, propane dose, ground speed, adjustment of gas pressure, angle of burners position, uneven of soil and on a driver ability to drive machine without tree damage, on the actual atmospheric conditions etc.,

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EVALUATION OF WEED SPECIES SUSCEPTIBILITY TO FLAMING

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Summary

Flaming method trial to investigate the efficacy and susceptibility of different weed species was conducted at the Department of Agricultural systems (Slovak Agricultural University in Nitra). The lowest efficacy of flaming was achieved at *Tripleurospermum perforatum*. For more effective of flaming we can recommend at least two treatments at ground speed of 4 km.h^{-1}, angle of burners position adjusted at 40° to ground surface, above ground level of burners 0,14 m, gas pressure of 0,2 MPa at the gas propane doses (consumption) of single treatment of 27 kg.ha^{-1}. At the other weed species very good reduction was achieved at 5 km.h^{-1}, but max. to growth stage of 8 true leaves. We can't recommend ground speed of 6 km.h^{-1}, because at this speed can be controlled only some weed species at growth stage of max. 4 true leaves (*Polygonum aviculare, Chenopodium hybridum, Atriplex patula*).

Key words: weed control, flaming, weed susceptibility, ecological farming.

Introduction

Weeds are a major problem in the agricultural production throughout the world and according to Rasmussen *et al.* (1995) especially in organic farming systems. It is difficult to quantify the impact of weeds on crop yields, a risk of high crop losses (20%) from high weed pressure is possible. Problems with herbicides, including underground and surface water contamination, pesticide residues in food, has sparked public awareness and restrictions of herbicide use. Flame weeding is one of the alternatives to chemical weed control, which relies on heating plants until the cells burst (at 70 - 80ºC). It is used in organic farming for pre-emergence control in slow germinating row crops, in some heat tolerant crops, selective post-emergence flaming is also used. Selectivity in post-em. treatment depends on the differential sensitivity of the crop and the weeds, and timing in relation to the stage of growth of the crop is critical, particularly for overall use in crops such as maize and leeks (Morelle, Thomas, 1994). Although flame weeding has been used for many decades, the method is often associated with problems such as high energy consumption, low driving speed, irregular weed control (Ascard, 1994).
The objectives of this study was to determine the weed susceptibility to flaming and effectiveness of this method on weed regulation.

Material and methods

This study was initiated in 1999 for 2 years period as a pot experiment of Department of Agricultural systems - Slovak Agricultural University in Nitra. The flame treatments were performed with Reinert DA 211/511 tractor mounted gas – propane butane weeder. Chosen weed species were transplanted at defined growth stages (GS) from field conditions to pots and after overcome of replanting shock (cca 5 days) was realized flaming. The treatment efficacy was evaluated visually, 3 days after flaming. Weeds were replanting in monoculture, each species separately in numbers of 7 – 10 pcs at the one pot. Flaming was performed with gas pressure of 0,2 MPa, angle of burners position was adjusted at 40º to ground surface (4 parallel burners), above ground level of burners was 0,14 m. The gas doses of single treatment were regulated by the tractor driving speed (4, 5 and 6 km.h^{-1}) and were 27, 21, and 17 kg.ha^{-1}. Growth stages of weeds were: < 6 true leaves, 6 – 8 true leaves, > 8 true leaves. Weed species: *Amaranthus retroflexus* L. (AMARE), *Chenopodium hybridum* L. (CHEHY), *Chenopodium album* L. (CHEAL), *Tripleurospermum perforatum* (Mérat) M. Laínz (TRIPE), *Thlaspi arvense* L. (THLAR), *Polygonum aviculare* L. (POLAV), *Atriplex patula* L. (ATRPA).

Results and discussion

The lowest efficacy of control was achieved at *Tripleurospermum perforatum*, because there wasn't achieved very good reduction (more than 90%) even at lowest driving speed and GS 2 – 4 true leaves, which is required for satisfactory weed control. After second treatment, at 4 km.h^{-1} was obtained 95 and more percent of reduction. *Polygonum aviculare* was less susceptible species at higher GS (> 8 true leaves) too, and repetition of treatment was needed at each speed. Driving speed of 6 km.h^{-1} and gas dose of 17 kg.ha^{-1} wasn't sufficiently effective even at double treatment. *Thlaspi arvense* was regulated very good at all observed GS at driving speeds of 4 and 5 km.h^{-1} (gas doses 27 and 21 kg.ha^{-1}). Lower gas doses and higher speeds caused it´s insufficient regulation and repetition was necessary. *Chenopodium hybridum* was regulated very good at all speeds, but only to GS of 8 true leaves. Older weeds were regulated insufficiently and those next treatment was necessary. *Amaranthus retroflexus* and *Chenopodium album* were controlled very good (> 90%) at lower driving speeds to GS of 6 – 8 true leaves. Older weeds and higher speed (6 km.h^{-1}) resulted in unsatisfactory weed control. The similar results were achieved at *Atriplex patula*, which was controlled very good, but only to GS of 8 true leaves and at speeds of 4 and 5 km.h^{-1}. Summarised results are presented in graph, which contains averaged data according to weed species regardless of GS. Parish (1989), Thomas and Juncker (1996) mentioned, that efficacy of flaming is variable and depends on weed species and density, crop and weed growth stage, on gas burner design, angle to the horizontal, and the height of the burner above the ground. According to Ascard (1995), the tolerance of different plants towards flaming depends on factors such as the presence of protective layers of hair and wax, lignification, conditions of water status, growth stage, type of plant habit (upright, prostrate, creeping), protection of growth points. *Chenopodium album* L. is considered as sensitive species, with unprotected growth points and thin leaves. This species at a stage of 1 - 4 leaves can be completely killed at rates of 20 - 50 kg.ha^{-1}, but at later stages considerably higher rates are required (50 - 200 kg.ha^{-1}). The weed species with prostrate and creeping habit (*Capsella bursa pastoris*, *Poa annua*, *Chamomilla suaveolens*) at later growth stages (five leaves and more) could not be controlled with one treatment regardless of the gas rate, because of their capacity for regrowth. The propane dose and number of treatments have to be adjusted to the weed flora present, the growth stage of weeds and the desired control level. Similarly (Rifai *et al*. 2000) found that to control weeds at later growth stages (> 6 true leaves), single flame treatment with a propane dose of 40 - 45 kg.ha^{-1} was not sufficient.

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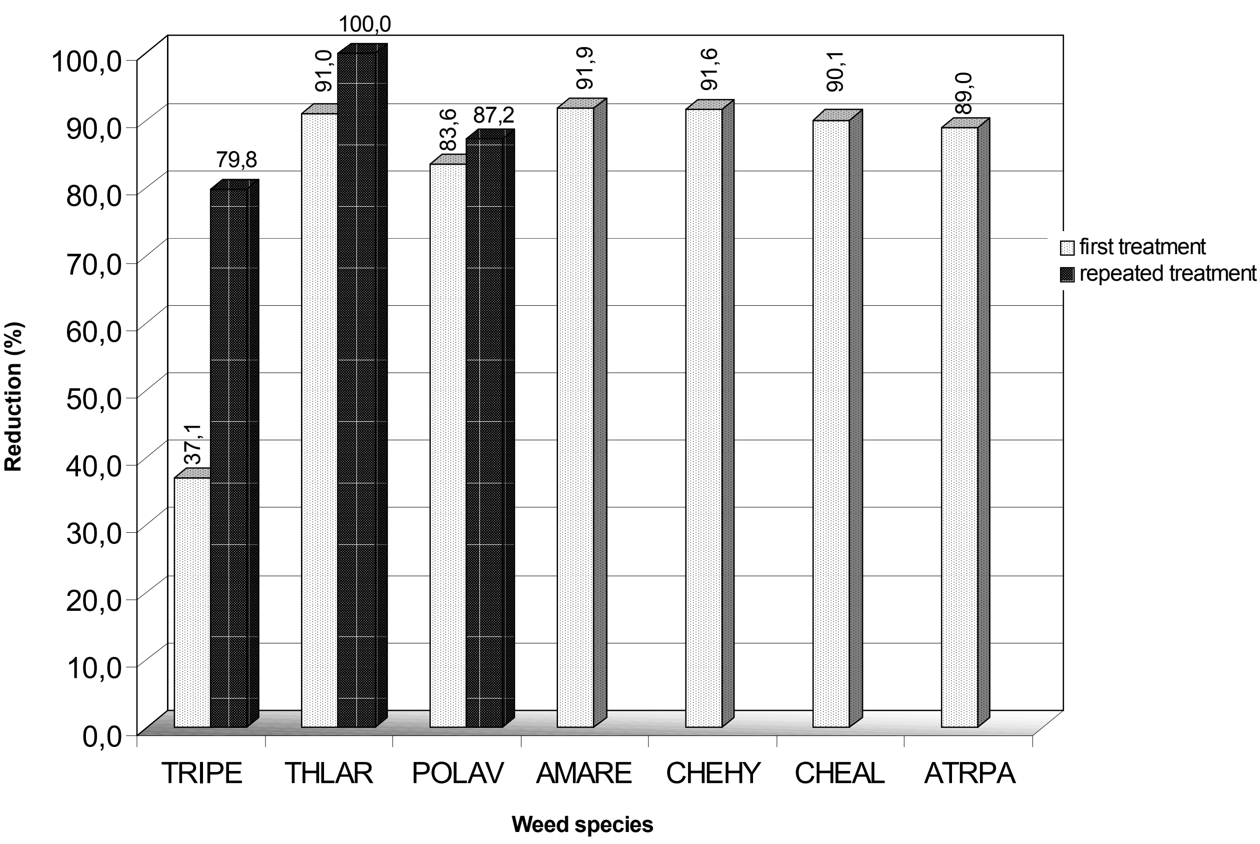
Graph: **Average efficacy of flaming on the different weed species**



BIOCHEMICAL CHARACTERISTICS OF FIVE SPELT WHEAT CULTIVARS (TRITICUM SPELTA L.)

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Summary

Five winter spelt cultivars Bauländer Spelz, Franckenkorn, Holstenkorn, Rouquin, Schwabenkorn and one common winter wheat variety Samanta were analysed. The wheats were grown in 1998/99 growing season, without fertilization and any chemical treatments. Composition of amino acids, hydrolytic enzymes and storage proteins in wheat flour and HMW glutenin subunits in wheat grains was traced. Values for amino acids ranged comparable in both spelt and common wheats. Values for alfa-amylase, endoproteases and exoproteases ranged in the normal physiological limits for full mature grains. Lower spelt wheat value for alfa-amylase and endoproteases activities refer to the higher sprouting resistance of analysed cultivars. The highest technological quality presented cultivar Schwabenkorn. No of analysed spelt wheat cultivars were homogeneous in the HMW glutenin subunits composition.

Key words*: amino acids, enzymes, storage proteins, SDS-PAGE, *Triticum spelta L.

Introduction

Wheat is the most widely grown crop in the word because of its unique protein characteristics. While most of the world wheat crop arises from production of common and durum cultivars, there is increasing interest in ancient wheat species, especially spelt (*Triticum spelta L.*) ones, particularly with regard to use in special bakery products, heatlth and organic foods.
Spelt wheat shows a higher resistance to enviromental influences than common wheat. This currently has limited use, except as animal feed, because of the retention of hulls on the grain after threshing (Vlasák, 1995). After dehulling, the grains are promoted as being more nutritious than current commercial species and potentially nonallergenic. It is reported to have a unique flavour and high vitamin content. Spelt wheat is a coeliac-toxic cereal and has to be avoided by coeliac patients (Forssell et.al., 1995).
The objective of the present study was to evaluate the amino acids, enzymes and storage proteins composition of five winter spelt wheat and one comparative common winter wheat.

Material and methods

The accessions evaluated in this study were five winter spelt cultivars Bauländer Spelz, Franckenkorn, Holstenkorn, Rouquin, Schwabenkorn and one common winter wheat variety Samanta. The wheats were grown in 1998/99 growing season, without fertilization and any chemical treatments. Flour samples were analysed by standard AACC procedures for moisture and crude protein was extracted using condidtions of Osborne extraction methods (Chen et.al, 1970). Alfa – amylase (Kruger, 1972, Spofa test, Slovakofarma a.s. Hlohovec, Slovak Republic, Bradford, 1978), exoproteases (Preston, 1978, Whitaker et.al, 1980) and endoproteases (Preston, 1978, Bradford, 1976) were quantified. Amino acids content was determined by hydrolyzing flour samples in 6 mol/l HCl and analysed on T339 M automatic amino acid analyzer.
For identification and characterization of wheat varieties the standard vertical discontinuous electrophoretic reference method by ISTA organization was applied (Wrigley, 1992). Glutenin wheat proteins were extracted from individually ground kernels and separated on 10% polyacrylamide gels in the presence of SDS. The gels were stained with Coomassie Brilliant Blue solution and destained with de-ionized destilled water. The stained bands were qualified by scanning densitometry (LD-01 Instrument).

Table 1 Storage proteins composition of flours of five winter spelt cultivars and one winter wheat variety

Cultivar	Proteins[a] (%)	Proteins fractions[b] (%)				Gli+Glu [c] (%)	Gli/Glu
		Alb+Glo[d]	Gliadins	Glutenins	Residue		
Bauländer Spelz	10.40	24.62	35.69	32.29	7.40	67.98	1.11
Franckenkorn	10.40	27.78	35.48	29.32	7.42	64.80	1.21
Holstenkorn	9.91	26.03	37.39	27.65	8.93	65.04	1.35
Rouquin	9.75	27.41	36.29	28.06	8.24	64.35	1.29
Schwabenkorn	10.48	23.23	39.15	31.52	6.10	70.67	1.24
Samanta	9.12	25.85	33.98	30.08	10.09	64.06	1.13

[a] % of dry basis, [b] % of flour proteins, [c] Gliadins and glutenins, [d] albumins and globulins

Results and discussion

The results from the analyses of the storage protein composition of flours of analysed spelt wheat cultivars with the comparison to common wheat cultivars are given in Table 1. There exist differences in the content of total proteins between varieties. The highest content of proteins was determined by cultivar Schwabenkorn (10.48%) and the lowest one showed Samanta (9.12%). The content of protoplasmatic proteins – albumins and globulins, varied from 23.23% (Schwabenkonr) to 27.78% (Franckenkorn). Some differencies were established in the content of gliadins and glutenins too. Generally we can say, that the highest technological quality presented cultivar Schwabenkorn, which showed 70.67% content of storage proteins.

Table 2 Amino acids composition of flour proteins of five analysed winter spelt cultivars and one winter wheat variety.

Culti var	Bauländer Spelz		Francken- Korn		Holsten- korn		Rouquin		Schwaben- korn		Samanta	
Amino acids	mg/g[a]	(%)[b]	mg/g[a]	(%)[b]	mg/g[a]	(%)[b]	mg/g[a]	(%)[b]	Mg/g[a]	(%)[b]	mg/g[a]	(%)[b]
Asp	6.31	4.47	6.02	4.44	6.45	4.61	5.11	3.94	6.39	4.87	6.25	5.73
Thr	3.80	2.69	3.69	2.72	4.01	2.87	3.58	2.76	3.68	2.81	2.64	2.42
Ser	6.54	4.63	6.48	4.78	6.37	4.55	6.14	4.73	6.02	4.58	5.05	4.63
Glu	50.42	35.72	47.14	34.77	50.17	35.84	45.68	35.20	46.60	35.50	38.25	35.07
Pro	18.34	12.99	18.39	13.56	16.84	12.03	17.82	13.73	16.24	12.37	14.14	12.96
Gly	5.42	3.84	5.32	3.92	5.30	3.79	4.97	3.83	4.88	3.72	3.84	3.52
Ala	4.99	3.54	4.73	3.49	5.12	3.66	4.59	3.54	5.01	3.82	3.51	3.22
Val	5.72	4.05	5.62	4.14	5.97	4.27	5.38	4.14	5.76	4.39	4.60	4.21
Ilu	4.45	3.15	4.40	3.25	4.70	3.36	4.27	3.29	4.69	3.57	3.79	3.47
Leu	9.71	6.88	9.29	6.85	9.96	7.12	8.77	6.76	9.28	7.07	7.14	6.55
Tyr	5.01	3.55	4.79	3.53	4.86	3.47	4.80	3.70	4.46	3.40	3.23	2.96
Phe	6.37	4.51	6.47	4.77	5.94	4.25	6.03	4.64	5.83	4.44	5.11	4.69
His	3.45	2.44	3.67	2.70	3.73	2.67	3.12	2.40	3.20	2.44	2.44	2.24
Lys	3.77	2.67	3.64	2.68	3.77	2.69	3.42	2.63	3.49	2.66	3.58	3.28
Arg	6.89	4.88	5.96	4.40	6,78	4.84	6.10	4.70	5.77	4.39	5.51	5.05
total	141.2	100.0	135.6	100.0	140.0	100.0	129.8	100.0	131.3	100.0	109.1	100.0

[a] mg/g of dry basis, [b] % of flour proteins,

Values for amino acids ranged comparable in analysed spelt and common wheat (Table 2). Cultivar did not affect their content significantly. Some small differences were determined in the arginine, asparagic acid, valine, leucine, tyrozine, arginine. Values for lysine, the most limiting amino acid in the Triticum spesies ranged widely from 2,63 % to 3,28 %. This content corresponds to literature infomation (Michalík, 1992).

Hydrolytic enzymes, alfa-amylases, endoproteases and exoproteases are the first enzymes which are activated in the germinating wheat grains. This enzymes is becoming important from the technological aspects. The high activity of them has negative influence on the baking properties. Value for hydrolytic enzymes ranged in the normal physiological limits for full mature grains. Lower spelt wheat values for alfa-amylase and endoproteases activities refers to the higher sprouting resistance of analysed cultivars (Table 3).

Every cultivar breadmaking quality qualitative biochemical analysisi presents the specification of the basic biochemical cultivar characteristics – the determination of the individual HMW glutenin subunits composition and the Glu-score calculation (Table 4). The evaluation of the 100 individual grains analysis obtained electrophoreograms showed that the common comparative cultivar Samanta is homologeneous, with 0, 7+8, 5+10 HMW glutenin subunits and the value Glu-score 8. No one of analysed spelt wheat cultivars are homogeneous. Three or four, respectively, electrophoretical profiles groups with a different HMW glutenin subunits composition were determined by all of them.

Table 3 Activity of enzymes in the winter spelt and winter wheat grain cultivars.

Cultivar / Enzymes	Bauländer Spelz[a]	Franckenkorn[a]	Holstenkorn[a]	Rouquin[a]	Schwabenkorn[a]	Samanta[b]
α-amylase (μkat/g)	1.31	0.70	0.57	0.69	0.80	1.80
Exoproteases (U/mg.100)	0.00	0.00	0.00	0.00	0.00	0.00
Endoproteases (U/mg.100)	13.79	14.34	12.76	11.05	13.37	19.32

[a] *Triticum spelta* L., [b] *Triticum aestivum* L.

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EFFECT OF N-NUTRITION ON GAS EXCHANGE CHARACTERISTICS OF WHEAT (*TRITICUM AESTIVUM* L.)

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Summary

Wheat plants grown under two N-nutritional regimes were used to determine the effect of N-nutrition on the regulation of $C0_2$ assimilation rate (A) and stomatal limitation to A under drought stress. Drought stress reduced leaf water potential (-0.5 to -1.92 MPa) and A (23 to 0 μmol.m^{-2}.s^{-1}). Gas-exchange measurements indicated greater sensitivity high-N plants compared to low-N plants as water stress developed. Daily range of stomatal related changes was greater in high-N plants, as well. WUE was changing with increasing water limitation. Osmotic effect of N-nutrition was mediated by increasing concentration of prolin during the water stress.

***Key words*: winter wheat, N-nutrition, gas exchange, water stress**

Introduction

Both stomatal and metabolic factors have been shown to limit gas exchange rates in lives (Lawlor, 1995, Cornic, Massacci, 1996). Water limitation and N-nutrition has numerous effects on photosynthesis. While physiological responses of plants to either water stress or N nutrition have been extensively investigated, the interaction of these two factors has received little attention (Morgan, 1984). N-nutrition has both the nutritional and osmotic effect in plants (McIntyre, 1997). Osmotic effect of N via amino acids, mainly prolin is known (Kameli, Lösel, 1993). In two experiments the effect of N-nutrition on photosynthesis and water regimes were investigated.

Material and methods

Two experiments were done. Plants of wheat (*Triticum aestivum* L. cv. Samanta) were grown in 15 1 containers containing a soil substrate. No N-fertiliser was supplied to low-N plants. High-N plants have two nitrate treatments (1gN/SkgSoil): first before sowing, second at the end of tillering. Plants grown outdoors were placed in the glasshouse to be drought stressed just before anthesis.

In the first experiment portable photosynthetic system Li-Cor 6250 was used to measure a gas exchange parameters. Daily measurements were done always in the same time (10 AM) and the same photosynthetic photon flux density 1000 $\mu mol.m^{-2}.s^{-1}$.
Leaf water potential (WP) was determined by leaf dew point thermocouple psychrometry using Wescor microvoltmeter.
In a second study similar N and water treatment were imposed. Abaxial and adaxial stomatal resistance were measured using a diffusion porometer (Delta-T) calibrated every day before measurement.

Nitrogen concentration of the oven dried flag leaf was determined using Kjeldahl technique Kovačik, 1997). Prolin concentration was detected by photocolorimetric method (Bates, 1973). Osmotic potential values were obtained psychometrically using leaf sections that were first frozen in liquid nitrogen. For determining leaf water potential were used the same technique as in the first experiment.

Results

In the first experiment $C0_2$ assimilation rate of the drought stressed plants decreased gradually during the stress (figure 1.). However high-N plants (SH) were more affected by drought. Well-watered plants had a relatively stabile rate of assimilation and high-N (NH) plant had a greater value of assimilation in this case. Differences in water potential between stressed and unstressed became apparent only after 6 days of withholding water (figure 2). Water use efficiency WUE calculated $C0_2$ assimilation rate (A)/stomatal conductance (g_S). The changes in $C0_2$ assimilation rate (A) were mainly due to limitation by the stomatal conductance (g_S) and dependencies are similar for all variants. The variations in WUE are in a relation with the water status but they are still not too clear.
Second study was focused on the water regime and actions occurring in plants subjected to the same conditions. Nitrogen concentration decreased form 2nd to 7th day in the all variants but mostly in the low-N variant (figure 3.). Concentration of the prolin increased in drought stressed leaf (figure 4.) that means prolin play a role in osmotic adjustment (figure 8-9.) and concentration of prolin is N dependent. From the figure 5 can be seen the differences in the water management of low-N and high-N plants.

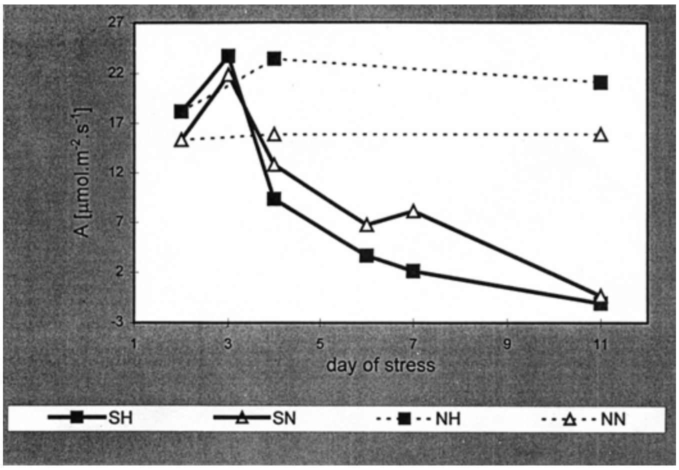

Figure 1. CO_2 assimilation rate (A) of the flag leaf of wheat *(Triricum aestivum)* during the water stress *(***SH** – stress, high N, **NH** – no stress high N, SN – stress, low N, **NN** – no stress, low N)

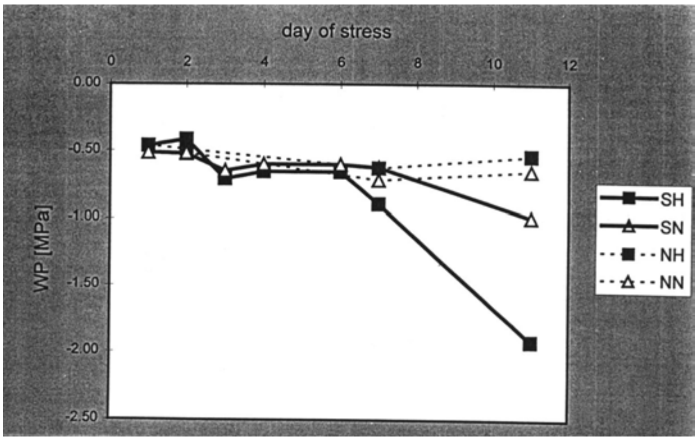

Figure 2. Water potential (WP) of the flag leaf of wheat *(Triricum aestivum)* during the water stress *(***SH** – stress, high N, **NH** – no stress high N, SN – stress, low N, **NN** – no stress, low N)

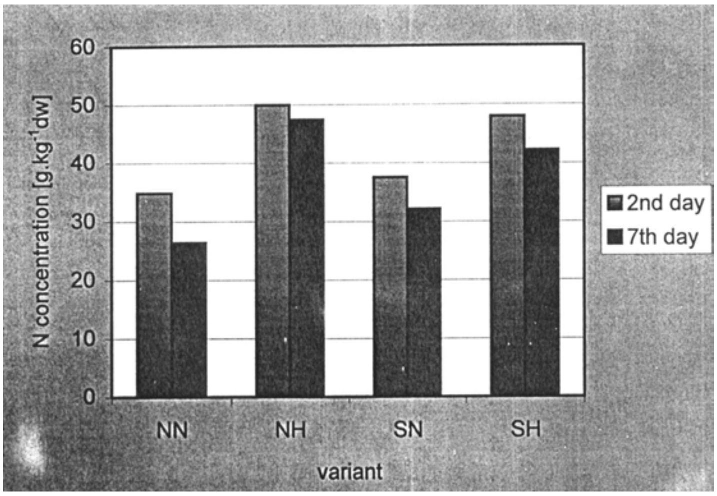

Figure 3. N concentration of the flag leaf of wheat (*Triricum aestivum* at the 2nd and 7th day of the water stress *(***SH** – stress, high N, **NH** – no stress high N, SN – stress, low N, **NN** – no stress, low N)

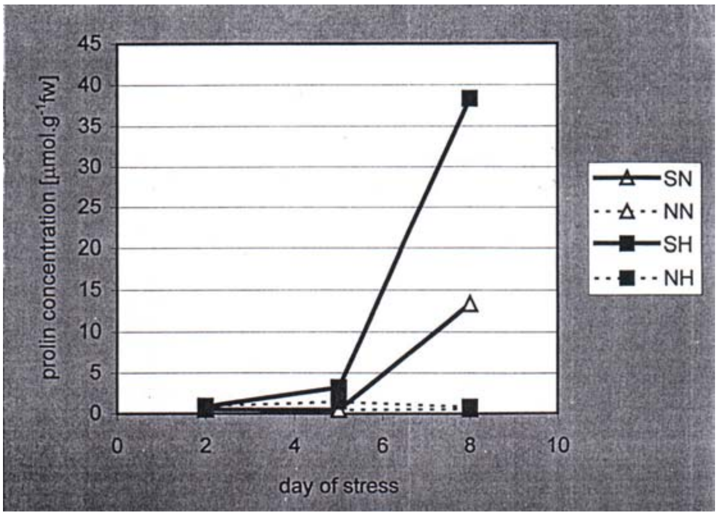

Figure 4. prolin concentration of the flag leaf of wheat *(Triricum aestivum)* during the water stress (**SH** – stress, high N, **NH** – no stress high N, SN – stress, low N, **NN** – no stress, low N)

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TECHNOLOGICAL PARAMETERS OF SUGAR BEET INFLUENCED BY LIQUID FERTILIZERS

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Summary

During years 1998 and 1999 the effects of two varieties: (Fox, Zenith) and different fertilizing: V_1 – NPK (100 % N – control), V_2 – NPK (50 % N + Avit 35), V_3 – NPK (100 % N + Avit 35), V_4 – NPK (50 % N + Humix universal), V_5 – NPK (100 % N + Humix universal) on the technological parameters of sugar beet were studied. The better results were gained at variety Zenith (digestion, potassium, sodium) but variety Fox obtained better results of alpha-amino-nitrogen. The influence of leaf liquid fertilizers (Avit-35 and Humix universal) positively affected some variants of observed parameters of sugar beet.

Key words: sugar beet, variety, liquid fertilizers, technological quality

Introduction

The technological value is defined by the properties of the beet which determine the extraction of sugar. The influence of variety, site, agronomic factors, harvest techniques and storage on parameters: content of sugar, potasium, sodium and alpha-amino-nitrogen are considerable. (Eigner, 2000). The leaf fertilizers used in sugar beet cropping systems and produced on the base of humate can improve the utilization of basic nutrients N P K etc. (Pačuta, Peťková, 1999). These fertilizers contain bioactive natural substances which are essential for growth and development of plants and they have a stimulating effect on the yield and quality of crops (Ložek, Varga, 1998). Avit 35 is a liquid fertilizer produced on organomineral basis. Its synthetic organic composition is based on macro and micro active nutrients. Hudec, Bystrická (1998) found that it can positively affect yield formation under relatively low level of nutrients.

Materials and methods

Field multifactorial trials were conducted during the years 1998 and 1999 on medium heavy luvisol in warm and temperature arid maize – growing region in the South – Western part of Slovak Republic at the Experimental site of the Slovak Agricultural University in Nitra - Dolná Malanta. The effect of two varieties: (Fox, Zenith) and five different fertilizations on chosen technological parameters was studied. Variants of fertilizing: V_1 – NPK (100 % N – control), V_2 – NPK (50 % N + Avit 35), V_3 – NPK (100 % N + Avit 35), V_4 – NPK (50 % N + Humix univerzal),V_5 – NPK (100 % + Humix univerzal). The NPK rate was calculated on the basis of agrochemical analysis of soil for targeted root yield 50 t per hectare. Avit 35 and Humix univerzal are liquid fertilizers made on the base of bioactive components. The treatment of sugar beet was done in the stage of 9 – 11 th leaves. Avit 35 was used in the total rate 18 $l.ha^{-1}$. Humix univerzál was applied in the total rate 10 $l.ha^{-1}$ in two doses. Preceding crop was winter wheat.

Table 1: Observed parameters of sugar beet (1998 - 1999)

Parameter	Variety	Variants of fertilizing					x
		V_1	V_2	V_3	V_4	V_5	
Digestion (°S)	Fox	16,48	15,97	15,19	16,31	15,82	15,96
	Zenith	16,95	16,87	16,46	16,90	16,83	16,81
	x	16,72	16,45	15,83	16,60	16,33	16,38
Content of K^+ mmol.100 g^{-1}	Fox	4,88	4,51	4,68	5,04	4,85	4,79
	Zenith	4,80	4,61	4,58	4,91	4,77	4,74
	x	4,84	4,56	4,63	4,97	4,81	4,76
Content of Na^+ mmol.100 g^{-1}	Fox	1,00	0,81	1,13	0,80	0,77	0,85
	Zenith	0,65	0,61	0,67	0,61	0,59	0,63
	x	0,65	0,61	0,67	0,61	0,59	0,63
α amino nitrogen mmol.100 g^{-1}	Fox	5,19	4,91	4,90	4,55	5,31	4,97
	Zenith	5,22	5,11	5,04	4,95	5,20	5,10
	x	5,21	5,01	4,97	4,75	5,26	5,04

Results and discussion

During observed period (1998 and 1999) the better results in digestion were gained at variety Zenith 16,81 °S with difference to Fox: + 0,85 °S and variabiality was 5,33% (table 1). It was statistically high significant difference (table 2). The highest recorded value of digestion was on control variant V_1 but diferences to variant V_2 (an application of Avit 35) and variant V_4

(an application of Humix univerzal) where were applicated half doses of nitrogen were comparable. Our results corespond with results of Pačuta, Peťková (1999). The difference to V_2/V_1 : - 0,27 °S, rel. 1,64 %, resp. V_4/V_1: - 0,12 °S, rel. 0,72 %.
The next observed parameter was content of K^+. We recorded lower (preferable) content of K^+ at variety Zenith comparing to Fox. Variety had significant and fertilization had high significant influence on the content of K^+ in the roots but their interation was not significant. An application of organo – mineral fertilizer Avit 35 positevely affected content of K^+ on both variants (V_2 and V_3) comparing to control (V_1): (V_2/V_1 - 0,28 mmol.100 g^{-1}, rel. 6,14 %, V_3/V_1 - 0,21 mmol.100 g^{-1}, rel. 4,54 %). Humix univerzal positively affected content of K^+ on variant V_5 : V_5/V_1 - 0,03 mmol.100 g^{-1}, rel. 0,62 %.
The higher value of Na^+content was recorded by variety Zenith with difference to Fox - 0,22 mmol.100 g^{-1}. The difference was statistically high significant. Both leaf liquid fertilizers Avit 35 and Humix univerzal high significantlly influenced content of Na^+ in sugar beet root. Favourable (the lowest) values of this parameters were recorded on variants V_2 and V_4 and their evaluation is followed: V_2/V_1 - 0,04 mmol.100 g^{-1} rel. 6,56 %, V_4/V_1 - 0,04 mmol.100 g^{-1} rel. 6,56 %. The similar tendency was found out also in interaction between variety and variants of fertilizing except V_3 variant in both varieties. Our results correspond with results of Hudec, Bystrická (1998).

Table 2: Analysis of variance (1998-1999)

Source of variation	df	Parameter			
		Digestion	K^+	Na^+	aN
		F – ratio			
Year	1	1295,949**	45,225**	345,818**	1190,215**
Variety	1	132,323**	4,505*	124,997**	3,775
Fertilization	4	17,246**	14,911**	10,090**	7,123**
Replication	2	0,042	0,325	2,209	0,107
(Y) x (V)	1	0,430	32,680**	17,284**	23,960**
(Y) x (V)	4	25,614**	12,916**	5,528**	1,544
(Y) x (V)	4	3,788*	1,865	3,920**	1,614
Residual	42				
Total	59				

Unfavourable parameters of internal quality of sugar beet is alpha-amino- nitrogen (aN). In the field trial was also investigated the influence of above mention sources of variation on aN in sugar beet roots. Lower aN was gained at variety Zenith with difference to Fox: - 0,13 mmol.100 g^{-1} rel. 2,62 %. It was not statistically significant difference. But aN was high significantly influenced by leaf liquid fertilizers. We recorded favourable values of aN on variants V_2 and V_3 (an application Avit 35) with difference to V_1: - 0,20 mmol.100 g^{-1} rel. 3,99 %, resp. 0,24 mmol.100 g^{-1} rel. 4,83%.

Tab. 3: Tukey test

Source of variation	Limits	Parameter			
		Digescion	K^+	Na^+	aN
Year	0,05	0,153	0,084	0,048	0,139
	0,01	0,206	0,113	0,065	0,187
Variety	0,05	0,153	0,084	0,048	0,139
	0,01	0,260	0,113	0,065	0,187
Fertilization	0,05	0,343	0,188	0,109	0,312
	0,01	0,422	0,231	0,134	0,263

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QUALITY OF SUGAR BEET IN RELATION TO WEATHER CONDITIONS AND GROWING FACTORS

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Summary

In the field trials with sugar beet carried out from 1994 to 1996 the effect of weather conditions, varieties (Intera, Hilma), different fertilizing (0 – without fertilization, A-cattle farmyard manure (FYM) + NPK, B-Ekofert + NPK, C-Mikrobion + NPK) and sowing spacing (157 mm, 210 mm) on the digestion and refined sugar was studied. From given three-year results it is evident the effect of weather conditions of the year, fertilization variants and seed spacing on digestion and refined sugar yield was statistically significant. However, the application of both substrates Ekofert and Microbion did not influence either digestion or refined sugar yield in roots.

Key words : weather conditions, variety, fertilizing, sowing spacing, digestion, refined sugar

Introduction

Sugar beet is very sensitive to drought during the critical growth period from June to August in which beet is forming a huge leaf system.Precipitation in autumn rises root yields but the root quality is reduced especially in colder weather (Švachula, 1998). The sugar beet quality is very influenced by nutrition especially by nitrogen and potasium (Šroller, Pulkrábek, Chochola, 1997). Except of conventional fertilizers there have also been tested the alternative organic fertilizers, substrates and growth stimulators (Pulkrábek, Šroller, Zahradníček, 1999, Šoltýsová, 1999). The sugar beet quality is influenced also by plant spacing (Minx, 1990).

Material and methods

Field trials were established in the years 1994 - 1996 on medium heavy luvisol soil type in warm and temperate arid maize-growing region in the South - Western part of the Slovak Republic at the Experimental site of the Slovak Agricultural University in Nitra-Dolna Malanta. The effect of weather conditions (table 1) and selected anthropogenic factors on the root quality of sugar beet was studied. Factors: two varieties: Intera and Hilma, four fertilizer management system: 0-without fertilization, two sowing spacing: 157 mm and 210 mm.The NPK rate was calculated on the basis of agrochemical analyses of soil (table 2) for the targeted root yield 50 $t.ha^{-1}$. Cattle FYM was used in the rate of 25 $t.ha^{-1}$. Ekofert (ecological organic substrate rich in organic components and active humic acids) application rate was 5 $t.ha^{-1}$ and treatment by Mikrobion (product of industrial microbiology) was done in the rate of 25 $l.ha^{-1}$. Both Ekofert and Microbion were incorporated into the soil together with stubble after harvesting of the preceding crop - winter wheat within the autumn soil cultivation.

Results and discussion

The highest mean of digestion value in the roots was found out in the most favourable year 1996 (table 3). Comparing to 1994 the following differences in digestion were observed: + 3,84 %, rel. 32,1 % and comparing to 1995 it was + 1.29 % relatively 8.9 %. More favourable weather conditions (1995, 1996) resulted in the higher sugar content (Bajči, Pačuta, Černý, 1998, Švachula, 1998). Cultivar Hilma had a higher digestion than cultivar Intera (+ 0.2 %, rel. 1.42 %) within the three-year period. However, this difference has not been statistically significant. Differences in digestions were found out between cultivars and years. In the less favourable year (1994) cultivar Intera had a higher sugar content (+ 0.88 %, rel. 7.6 %) while in the more favourable years (1995, 1996), as regards to the temperatures and rainfall, cultivar Hilma had a higher sugar content (+ 0.98 %, rel. 7.0 % and + 0.5 %, rel. 3.2 %. These results show better adaptability of cultivar Intera into less favourable (drier and warmer) conditions.
We also investigated the effect of four fertilizer management systems on the sugar beet root quality (table 3). Three-year results show a significant influence of fertilization variants on the sugar content (Bajči, Pačuta, Černý, 1997). From our trials it is also clear that Ekofert (B) and Mikrobion (C) did not influence the sugar content significantly. In both Ekofert and Microbion variants we found out similar digestion as with variant of cattle FYM application (A). Remarkably the higher sugar content was observed in case of 0 variant compared to A variant (difference: 0.93 %, rel. 6.7 %). Comparing two seed spacing (157 mm, 210 mm) the higher sugar content (+ 0.61 %, rel. 4.4 %) was found out at the lower seed spacing and this difference was statistically significant. The weather conditions had highly significant influence also on the refined sugar yield (Bajči, Pačuta, Černý, 1997).The highest values of this parameter were found in 1996 (table 3). The differences comparing to 1994 and 1995 were + 3.75 % rel. 42.0 % and + 0.89 % rel. 7.6 %. In case of the less favourable weather 1994 the better results in refined sugar yield were achieved by Intera cultivar (+ 0.66 % rel. 7.6 %). However, in the more favourable weather

(1995, 1996) the higher refined sugar yield gave cultivar Hilma (+ 1.4 % rel. 12.7 %, + 1.16 % rel. 9.6 %). Ekofert (B) and Mikrobion (C) did not influence the refined sugar yield (table 3) in comparing to cattle FYM application (A). We found out very close values in all three variants. The highest values of the refined sugar yield were found out at the variant without fertilizing

Table 1: Pattern of weather condition

Month	Sum of weather precipitation (mm)				Average temperatures (°C)			
	1994	1995	1996	30-year average	1994	1995	1996	30-year average
IV.	93,7	73,5	103,3	43,0	10,6	10,7	11,0	10,1
V.	109,9	63,0	143,0	55,0	15,2	14,6	16,4	14,8
VI.	29,4	88,5	49,8	70,0	18,7	17,7	12,2	18,3
VII.	32,9	0,1	69,4	64,0	23,1	22,9	18,3	19,7
VIII.	59,8	62,2	59,4	58,0	21,4	19,8	19,4	19,2
IX.	110,0	83,5	78,1	37,0	17,1	14,2	11,9	15,4
X.	111,6	3,3	33,0	41,0	8,3	11,0	10,5	10,1
Sum	547,3	374,1	536,0	368,0	114,4	110,9	106,7	107,6
Average	78,1	53,4	76,6	52,6	16,3	15,8	15,2	15,4

Table 2: Agrochemical soil analysis (mg.kg^{-1})

Year	N_{an}	P	K	Mg	Zn	% of humus	pH/KCl
1994	6,07	95	383	255	11	2,30	6,25
1995	9,10	60	210	222	11	2,04	5,31
1996	18,90	42	195	200	4,60	1,89	5,88

Table 3: Results of sugar beet quality

Fertilization variant	Year							
	1994		1995		1996		Average	
	Seed spacing (mm)							
	157	210	157	210	157	210	157	210
Digestion (°S)								
I N T E R A								
0	12,95	13,40	15,69	14,96	15,03	15,88	14,56	14,75
A	12,75	11,05	13,96	13,95	15,45	15,45	14,05	13,48
B	12,80	11,55	12,57	12,93	15,74	15,43	13,70	13,30
C	11,60	13,20	14,62	13,59	16,32	15,19	14,18	13,99
x	12,53	12,30	14,21	13,86	15,64	15,49	14,12	13,88
H I L M A								
0	14,25	11,25	16,44	15,44	14,94	17,32	15,21	14,67
A	11,95	9,30	15,18	14,78	16,34	16,28	14,49	13,45
B	13,30	11,41	15,11	13,37	15,76	16,37	14,72	13,71
C	12,50	8,35	14,93	14,85	15,66	15,86	14,36	13,02
x	13,00	10,08	15,42	14,61	15,68	16,46	14,70	13,72
Refined sugar (%)								
INTERA								
0	9,34	10,3	12,64	11,82	11,44	12,58	11,14	11,57
A	9,69	8,13	10,85	10,73	12,00	12,02	10,85	10,29
B	9,64	8,34	9,80	10,04	12,41	12,00	10,62	10,13
C	8,43	10,17	12,02	10,36	12,94	11,42	11,13	10,65
x	9,28	9,24	11,33	10,74	12,20	12,01	10,94	10,66
H I L M A								
0	11,65	8,22	13,93	12,86	12,41	14,91	12,66	12,00
A	9,47	6,01	12,54	12,12	13,24	14,04	11,75	10,72
B	10,62	8,46	12,69	10,78	12,85	13,28	12,05	10,84

C	9,81	4,52	12,28	12,20	12,66	12,70	11,58	9,81
x	10,39	6,80	12,86	11,99	12,79	13,73	12,01	10,84

(0) with following differences (a significant influence): to cattle FYM + 0.93 % rel. 8.52 %, to Ekofert + 0.93 % rel. 8.52 % and to Mikrobion application + 1.04 % rel. 9.63 %. The higher refined sugar yield was found out in case of the lower seed spacing 157 mm, too (+ 0.73 % relatively 6.8 %).

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THE INFLUENCE OF ZEOMIX N FERTILIZER ON THE WINTER RAPE YIELDS

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Summary

The experiments with winter rape were carried out on the Experimental place in Vysoká above river Uh during 1997 – 1999. The winter rape grown at the Luvisol. The ecological fertilizer ZEOMIX N was applied at 2nd additional fertilizing by nitrogen in dose 200 kg N .ha^{-1}. On this variant but was lower average thousand-kernel weight (4,9 g) than variant with calcium nitrate (5,0 g). The ecological fertilizer ZEOMIX N may be used as carrier of mineral nutrients for winter rape plants. Their application in soil decrease consumption of nutrients and costs on import of row materials are lower. Because less nutrients are leaching into groundwater the environment is protection, too.

Key words: crop rotation, physical and chemical soil properties, Eutric Fluvisol, Fluvi-Eutric Gleysol

Introduction

The winter rape is very interesting field crop in this time. Using of ecological fertilizer has serious role at its cultivation in field conditions.
The aim of this article is to determine effect of ecological fertilizer ZEOMIX N on the winter rape yields in the East-Slovakian Lowland conditions.

Material and methods

The field treatments were carried out on Albic Luvisol during 1996 – 1999. The experimental place is located in Vysoká above river Uh in central part of the East-Slovakian Lowland. Winter wheat was forecrop for winter rape.
Fertilization was realized by balance method and nutrients from manure were accepted, too. The placement of mineral fertilizers – superphosphate (21 % P) and potassium chloride (50 % K) – were realized before sowing. In spring the basic dose of 50 kg N.ha^{-1} as ammonium nitrate (27 % N) was applied. Further doses of nitrogen were applied during vegetation of winter rape (table 1). Chemical control of winter rape was made by suitable pesticides.
Each variant was three-times repeated and rape seeds were harvested from 10 m^2 experimental areas. The obtained data were tested by the analysis of variance.

Table 1: Nitrogen fertilizers and doses used in field treatment

Variant	Fertilizer	Dose of fertilizer (kg.ha^{-1})
1.	ZEOMIX N (ZEO, 10,4 % N)	100
2.	ZEOMIX N (ZEO, 10,4 % N)	200
3.	Ammonium nitrate (LAV, 27 %N)	100

4.	Ammonium nitrate (LAV, 27 %N)	200
5.	Control (K)	0

Results and discussion

ZEOMIX N is characterised as ecological fertilizer and help to decrease using of chemical preparations in plant production.
The application of ecological fertilizer ZEOMIX N in winter rape stand was not observed phytotoxicity in comparison to LAV variant (27 % N). Similarly influence of ZEOMIX N on growth phases of winter rape from flowering to harvesting was no-significant.
The year of growth was statistically significant at evaluation the effect of used fertilizers on winter rape yield. Higher rape seed yields were ascertained in 1997 and 1998 than in 1999 (table 2).

Table 2: The multiple LSD-test of yield comparison (95 % significance)

Year	Interactions yield x crop year			Difference
	Average yield (t.ha^{-1})	Homogenous groups		
1997	3,378		x	- 0,0768
1998	3,454		x	0,1540
1999	3,224	x		0,2308

Significantly higher winter rape yield were determined on variant with nitrogen fertilization than on variant without nitrogen. For fertilized variants were yields in average higher about 1,69 t.ha^{-1} (+ 46 %).
From results of variance analysis influenced no-significant increase of yield for variant ZEO 100 (3,340 t.ha^{-1}) in comparison with variant LAV 100 (3,291 t.ha^{-1}).
The highest rape winter yield – 4,208 t.ha^{-1} – were obtained from variant ZEO 200 and this yield was about 0,282 t.ha^{-1} higher in comparison with yield for variant LAV 200 (3,926 t.ha^{-1}). Results are situated in table 3**.**

Table 3: The multiple LSD-test of yield comparison (95 % significance)

Variant	Yield (t.ha^{-1})	Homogenous groups			
K	1,994	x			
ZEO 100	3,340		x		
LAV 100	3,291		x		
ZEO 200	3,926			x	
LAV 200	4,208				x

Obtained results are similarly as published TÓTH – RINÍK (1996), RINÍK (1997), KOVANDA – RŮŽEK (1996) and SOPKOVÁ et al. (1993).

Table 4: The multiple LSD-test of yield comparison (95 % significance)

Interaction: yield x variant	Differences ±	Limit
ZEO 100 - ZEO 200	-0,86800	0,00000*
ZEO 100 - LAV 100	0,04900	0,00000*
ZEO 100 - LAV 200	-0,58633	0,00000*
ZEO 100 - K	1,34567	0,00000*
ZEO 200 - LAV 100	0,91700	0,00000*
ZEO 200 - LAV 200	0,28167	0,00000*
ZEO 200 - K	2,21367	0,00000*
LAV 100 - LAV 200	-0,63533	0,00000*

Higher dose of ZEOMIX N (variant ZEO 200) increased the winter rape yield about 0,89 t.ha^{-1} in comparison with yield on variant ZEO 100. This conclusion corresponding with results by TORMA (1990, 1998) and CICIŠVILI – ANDRONKAŠVILI (1988). These authors determined increase of yield by application the ecological fertilizer on base of zeolite.
Increase of efficiency of nutrients in soil and nutrients in fertilizers is possible also of application of ZEOMIX N. This fertilizer has possibility to fix the nutrients in its structure and then these to loosen for field crops. In this way damages of mineral nutrition elements in root range of plant is decreased. Similar conclusions published also KOTVAS (1990), PETR – DLOUHÝ et al. (1992) and RINÍK (1995).

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THE CROP ROTATION AND FLUVISOL PROPERTIES ON THE EAST-SLOVAKIAN LOWLAND

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Summary

The field stacionary trials were carried out during 1994 – 1998. Two soil types Eutric Fluvisol and Fluvi-Eutric Gleysol were observed. Testing field crops were arranged to crop rotation as follows: sugar beet – spring barley – fodder plant 1st crop year – fodder plant 2nd crop year – fodder plant 3rd crop year. Physical and chemical soil parameters were compared with starting values from 1993. The manure in the dose of 40 $t.ha^{-1}$ and limy materials in the dose of 6 $t.ha^{-1}$ were applied to the first crop in the whole crop rotation. Other crops in crop rotation were fertilized with mineral fertilizers rationally by analytical determined contents of available nutrients in soil. Soil were taken from soil profile 0 – 0,3 m from variant with traditional tillage without irrigation after harvesting. The soil bulk density, total porosity, maximum capillary water from physical properties and content of phosphorus, potassium, magnesium and soil reaction were determined. The starting values of available nutrients were ascertained from soil sampling after harvesting of winter wheat. The highest bulk density and the lowest total porosity were when crop rotation ended. Higher bulk density values were observed for fodder plants. At rationally fertilization were not determined significant differences in content of macro-nutrients. Differences between followed soil types were statistically significant.

Key words: crop rotation, physical and chemical soil properties, Eutric Fluvisol, Fluvi-Eutric Gleysol

Introduction

The soil in relation to cultivated crops is environment which arrange the rooting of plants and sufficient supply of water and mineral substances to roots. The soil has physical, chemical and biological properties which are in mutual interaction and have significant influence on the soil fertility.
The physical properties are stable future and their changes are caused by modification of ecological conditions for field crops. The structure of crops rotation has important place in the cultivation on soil. Chosen crop rotation influence the changes of physical soil properties, the balance of organic matter in soil and total accessibility of nutrients (Ivanov, 1989; Riník, 1991).
The aim of this work was to determine the changes of physical and chemical properties for soil of the East-Slovakian Lowland by influence of crop rotation with higher presence of fodder plants.

Material and methods

This study includes data obtained from experimental places of Research Institute of Agroecology in Michalovce, Slovak Republic. Field experiments were carried out on Eutric Fluvisol (EF) and on Fluvi-Eutric Gleysol (FEG) in 1994 – 1998. Soil type EF is situated in Vysoká above river Uh and FEG in Milhostov. The values of physical and chemical soil parameters ascertained during field experiments were compared with starting year 1993.
The studied crops on both observed soil types were arranged into stabile crop rotation: sugar beet – spring barley – fodder plant the 1st crop year – fodder plant the 2nd crop year – fodder plant the 3rd crop year. The manure in the dose of 40 $t.ha^{-1}$ and limy materials in the dose of 6 $t.ha^{-1}$ were applied to the first crop in the whole crop rotation. Other crops in crop rotation were fertilized with mineral fertilizers rationally by analytical determined contents of available nutrients in soil.

The changes of physical and chemical properties of EF and FEG were searched during experiments. Soil samples for determination of physical properties were taken from the soil profile 0 – 0,3 m from variant with traditional tillage without irrigation after harvesting. The soil bulk density (ρ_d, kg.m^{-3}), total porosity (P, %), maximum capillary water capacity (Θ_{KMK}, %) were determined. Soil samples for determination of chemical parameters were taken from depth 0 – 0,3 m, too. The starting values were ascertained from soil sampling after harvesting of winter wheat. Content of phosphorus, potassium, magnesium and soil reaction were determined. The obtained data were tested by the regression analysis by Grofik et al. (1990).

Results and discussion

The values of bulk density are changed by influence of cultivated field crops that by crop rotation, too. The results in table 1 show gradual increase of bulk density during experimental season at comparison with starting values. This trend was observed on both soil types though between concrete values of bulk density for EF and FEG were ascertained differences for individual field crop. The positive reaction of bulk density on cultivated forecrop were determined on both soil types at spring barley which followed after sugar beet.

The total porosity corresponded with bulk density values at both soil types and all field crops arranged into crop rotation. From point of view of cultivated fodder plants influenced that if cultivate these plants during three crop years, irrespective of their species and sowing date, attend to significant increase of bulk density and decrease of total porosity. Is possible that effect of crop and soil tillage expressed in changes of soil physical properties of Fluvisol and Fluvi-Eutric Gleysol, too.

Hydro-physical soil properties are significantly influenced of content of clay particles in soil profile and their total surface. Fulajtár (1986) published that for Eutric Fluvisols are characteristic high values of maximum capillary water capacity. Similar results were obtained also in conditions of the East-Slovakian Lowland. Values of ΘKMK were higher on Fluvi-Eutric Gleysol than on Eutric Fluvisol.

The content of macro-nutrients in middle till good supply and neutral soil reaction are characteristics of agrochemical soil profile. Average contents of available nutrients and soil reaction in crop rotation are showed in table 2.

Table 1: The changes of physical soil properties during experimental season

Crop rotation	ρ_d (kg.m^{-3})		P (%)		Θ_{KMK} (%)	
Soil type	FM	FMG	FM	FMG	FM	FMG
Starting values	1 440	1 381	45,64	46,82	35,62	38,96
Sugar beet	1 469	1 430	45,10	45,84	35,23	37,08
Spring barley	1 456	1 425	45,68	46,28	37,17	39,50
Fodder plant 1st crop year	1 508	1 438	44,13	44,92	38,06	39,90
Fodder plant 2nd crop year	1 526	1 472	43,56	44,13	37,37	37,20
Fodder plant 3rd crop year	1 559	1 524	42,28	42,77	36,73	36,83

Table 2: Chemical soil parameters in crop rotation

Crop rotation	P (mg.kg^{-1})		K (mg.kg^{-1})		Mg (mg.kg^{-1})		pH/KCl	
Soil type	FM	FMG	FM	FMG	FM	FMG	FM	FMG
Starting values	51,8	47,0	140,7	155,3	107,0	267,1	6,91	6,57
Sugar beet	53,0	52,4	133,2	161,4	111,2	268,0	6,96	6,73
Spring barley	56,0	56,2	138,6	159,5	105,8	287,5	6,88	6,63
Fodder plant 1st crop year	52,9	51,6	140,3	176,2	110,3	282,1	6,90	6,60
Fodder plant 2nd crop year	49,3	53,6	148,9	163,3	107,8	270,3	6,81	6,65
Fodder plant 3rd crop year	47,8	49,8	138,5	165,9	113,8	266,8	6,83	6,56

The contents of macro-nutrients in followed crop rotation were in proportionally close large. In the crop rotation the differences between maximum and minimum value were as follows: Δ P = 7,35 mg.kg^{-1}, Δ K = 10,94 mg.kg^{-1}, Δ Mg = 9,62 mg.kg^{-1}. Interest differences were ascertained between soil types. For Fluvi-Eutric Gleysol the average content of available K was significantly higher than for Fluvisol (Δ K = 23,59 mg.kg^{-1}). Similarly average difference of magnesium between soil types (Δ Mg = 164,3 mg.kg^{-1}) was statistically significant. The highest values of soil reaction were determined after harvest of sugar beet. The manuring and liming under first field crop in crop rotation effected increasing soil reaction value at experiment ended.

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THE EFFECT OF SEEDING RATES ON GRAIN YIELD OF SPRING BARLEY IN SYSTEM WITHOUT TILLAGE

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Summary

The field treatments were carried out on two experimental places of Research Institute of Agroecology Michalovce. The influence of various seeding rates on the spring barley yield was observed in these small – plot field experiments during 1996 – 1997. On the average, the first seeding rate (4 mil. grains per hectare) gave the highest yield production in conditions of Fluvi-eutric Gleysol (5,16 $t.ha^{-1}$) and the second seeding rate (5 mil grains per hectare) gave the highest yield production in conditions of Eutric Fluvisol (5,19 $t.ha^{-1}$). Presented data showed that the highest seeding rate do not assure the highest grain yield production of spring barley.

Key words: spring barley, grain yield, seeding rates

Introduction

For normal growing and development must have each plant own vegetational space. The vegetational space is determined by spacing and by seeding rate. When the stand density is very high the intraspecific competition is very high too and nutritional space for every plants is very small. The weed infestation rate is very intensive in the thin stands and the density of productive culm (ears. m^{-2}) is not optimal. Optimal stand density is in interrelation with seeding rate and it is influenced by more factors: sort and variety of plant, soil and climatic conditions, forecrop, depth and time of sowing, quality of sowing and quality of seed. The aim of experiment was to evaluate the influence of seeding rates on spring barley yield production.

Material and methods

The field treatments were carried out on two experimental places of Research Institute of Agroecology Michalovce. The influence of various seeding rates on the spring barley yield was observed in these small – plot field experiments during 1996 - 1997. Spring barley variety Sladko was cultivated on the Eutric Fluvisol (Vysoká nad Uhom) and on the Fluvi – eutric Gleysol (Milhostov) in the climatic conditions of the East-Slovakia Lowland. Spring barley followed after sugar beet in the crop rotation and grown in natural conditions without irrigation. The experiment was conducted to study the effect of two seeding rates (4 million grains per hectare and 5 million grains per hectare) on production of spring barley grown in condition without tillage.

Results and discussion

The quantitative parameters of spring barley were dependent from different seeding rates. The grain yield of spring barley were moved in the range 5,37 – 4,91 $t.ha^{-1}$ (fig 1 and 2).
On the average, the first seeding rate (4 mil. grains per hectare) gave the highest yield production in conditions of Fluvi-eutric Gleysol (5,16 $t.ha^{-1}$) and the second seeding rate (5 mil grains per hectare) gave the highest yield production in conditions of Eutric Fluvisol (5,19 $t.ha^{-1}$). The importance of seeding rates has been reflected in experimental years, in our case, in favour of lower seeding rate by 0,07 $t.ha^{-1}$ on two years average in conditions of Fluvi-eutric Gleysol and in favour of higher seeding rate by 0,1 $t.ha^{-1}$ on two years average in conditions of Eutric Fluvisol.
The results indicated that the seeding rates had not statistically significant effect on grain yield. Higher seeding rate gave the similar grain yield comparing to the lower seeding rate on both of soil types (table 1). The results also indicated that there was not statistically significant difference between both of seeding rates which were compared in field experiment (table 2).
The aim of experiment was to evaluate the influence of seeding rates on spring barley yield production. There were two different seeding rates (4 and 5 mil. grain per hectare) and presented data showed that the highest seeding rate do not assure the highest grain yield production of spring barley. Similarly results published Dudáš (1991), Moustafa, Refay, (1998) and Míša (2001).

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Table 1: Evaluation of spring barley grain yield ($t.ha^{-1}$) by analysis of variance.

Studied factor	Degrees of freedom	Mean of squares	F-test	Probability	Significance
Years	1	0,0114761	2,958	0,2054	-
Soil	1	0,0013261	0,300	0,6273	-
Seeding rates	1	0,0172980	3,917	0,1422	-
Residual	3	0,0132498			
Total	31	1,4463329			

Table 2: Evaluation of spring barley grain yield ($t.ha^{-1}$) by LSD test.

Studied factors		Count	95 percent LSD Mean	Homogenous groups	
Years	1996	16	5,0963750	X	
	1997		5,1342500	X	
Soil	*Eutric Fluvisol*	16	5,1088750	X	
	Fluvi-Eutric Gleysol		5,1217500	X	
Seeding rates	4 mil. grains per hectare	16	5,0920625	X	
	5 mil. grains per hectare		5,1385625	X	

Fig 1: Spring barley grain yield grown in conditions of the Eutric Fluvisol (Vysoká nad Uhom), according to the seeding rate.

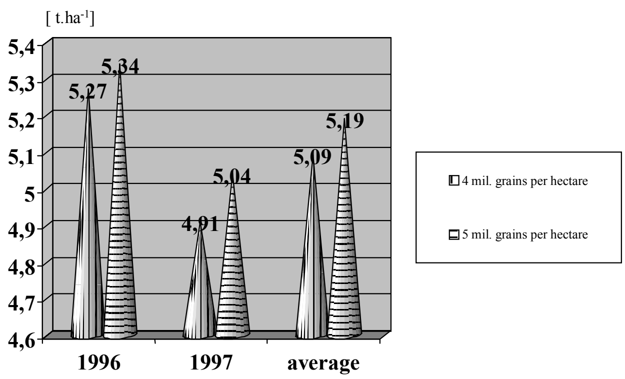
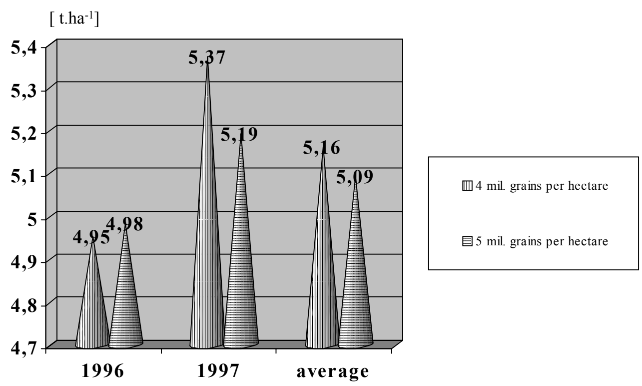


Fig 2: Spring barley grain yield grown in conditions of the Fluvi-Eutric Gleysol (Milhostov), according to the seeding rate.



INFLUENCE OF INCORPORATION BY-PRODUCT OF CULTIVATED CROPS ON SOIL MICROBIAL BIOMASS, OXIDIZABLE SOIL CARBON AND TOTAL SOIL NITROGEN

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Summary

Ploughing root and post-harvest residues, as well as all the whole by-product in soil resulted in a significant increase in total nitrogen (N_t) already after 2 experimental years, from 0.139-0.154 % to 0.195-0.207 %. In the following 2 years, values for nitrogen almost remained the same. Due to an increase in N_t and a slight decrease in oxidizable carbon (C_{ox}), a C : N ratio was reduced from 8 - 9 : 1 to 5 - 6 : 1. An amount of microbial biomass was influenced significantly by placement in soil of the by-product of cultivated crops. The highest values of this parameter were observed in 1996, when also a higher N content was noted. In spite of an adjustment of the C : N ratio, the substitution of manure for post-harvest and root residues or for by-product is not sufficient and after long use, it might cause changes in the cycles of nutrient fixation and release.

Key words: by-product, post-harvest residues, oxidizable carbon, total nitrogen, biomass of soil microorganisms

Introduction

In the last years of the 20th century, there was a substantial decrease in the quantity of farm animals, which causes a lower production of farm fertilizers, especially manure. In 1990, approximately 14 tons of farm fertilizers per hectare of agricultural land were produced, and in 1995 only 6.8 tons. Consequently, the negative balance of nutrients and soil organic matter has occured, resulting in depriving soil of the said substances. In view of the sustainable development of the condition of soils as well as the general conditions of agricultural production this phenomenon is evaluated as negative (Demo et al., 1999).
In microbiological practice, an assessment of biological soil activity as well as soil management systems meets with more serious problems in association with a choice and the use of suitable and available biological indicators to observe this activity. One of the most important indicators is determination of the amount of soil microorganism biomass which shares to a decisive degree in all the processes running in soil (Šantrůčková, 1993, Števlíková et Kopčanová, 1996).
The parameter of soil biological activity and selected chemical parameters were used to examine a possibility of replacing manure by post-harvest and root residues ploughed in soil along with the whole by-product of cultivated crops.

Materials and methods

A stationary experiment was conducted at the Experimental Station of the Faculty of Agronomy of the Slovak Agricultural University in Nitra, established in the locality of Dolná Malanta. As far as the soil type in the locality under investigation is concerned, it is Orthic Luvisol.
During the vegetation period 1994 -1997, samples were taken from a 0.0 – 0.2 m depth of the soil in which grain maize, barley, pea (*Pisum sativum)* and winter wheat (*Triticum Aestivum* L.) were grown using four-course rotation. Two treatments of fertilization were applied in the trial: treatment PH - rational fertilization to obtain an average yield level, treatment PZ – ploughing the whole by-product of crop in soil plus incorporation of nitrogen to support mineralization of wheat and barley straw plus supplementation with mineral fertilizers for balancing. The conventional cultivation of soil included ploughing up to a depth of 0.3 m for maize and up to 0.2 m for other crops, and soil surface treatment.
Collections of soil samples were made five or six times every experimental year in March to September. Samples were taken from 3 random sites and analysis were conducted from mixed samples. Soil samples were passed through a 2 mm sieve and analysed for soil moisture by the gravimetric method and for biomass carbon of soil microorganisms (C_{mic}) by the rehydratation method. They were then air dried and the samples collected as first, third and last were used for determination of oxidizable carbon content (C_{ox}) as described by Turin and for total nitrogen (N_t) using the Jodlbauer distillation method. All observation parameters were determined in 3 repetition.

Results and discussion

The orthic luvisol at the Experimental Station in Dolná Malanta contained a low to middle supply of organic matters ranging from 1.17 to 1.40 % under different fertilization treatments during the experimental years (Table 1). Ploughing the whole by-product in soil (treatment PZ) had no significant effect on the C_{ox} content (Table 2). A placement of crop residues in soil after harvesting is a natural way how to enrich arable land with organic carbon. These residues are valuated as the primary source of humus-forming material, which, in ecological agriculture, can be considered to be a local renewable source (Demo et al., 1999).

Total organic nitrogen (N_t) in the soil of the site was between 0.139 and 0.154 % in the first two experimental years (1994, 1995) (Table 1). In 1996 and 1997 we observed an increase to 0.183 - 0.209 % without differences between fertilization treatments. These facts have also been confirmed statistically. The stability of the natural and anthropogenic conditions of agroecosystem is the essential condition of total nitrogen of soil. Each change in the natural and anthropogenic conditions and in a method of soil utilization results in changes of the balance of nitrogen regimes in soil and produces a new level of total nitrogen stability in soil when acting for a longer time (Bielek, 1998). Also, a C : N ratio diminished from 8–9:1 to 5–6:1 due to an increase in total nitrogen content and a moderate fall in C_{ox}, which is a great change and cannot be evaluated as favourable. This state is characterized by a high degree of mineralization of post-harvest residues (bigger part of carbon is released by respiration as CO_2, and nitrogen remains built in the soil system). Several authors (Friedel et al., 1996, Števlíková et Kopčanová, 1996) point out that the application of one–way organic fertilization, which provides enough carbon and energetic sources for the soil microflora, causes the microbial immobilization of nutrients, especially nitrogen and its subsequent stabilization in humus substances. Consequently, after a longer time insufficient mobilization of nitrogen to plants could occur and be reflected in the yield reduction, which has not been detected in our trial so far.

Changes in soil organic matter mainly depend upon the promoters of these changes, namely soil microorganisms. In evaluating the complex microbiocenosis of soil, a big attention is paid to a weight of microbial biomass. Microbial biomass is defined as part of soil organic matter involving living microorganisms smaller than 5 to 10 μm^3. In general, it is given as the carbon content of microbial cells in $mg.kg^{-1}$ or $\mu g.g^{-1}$ soil (Šantrůčková, 1993).

Table 1 Chosen characteristics of soil experimental station (average values)

Year of determination	Crop	Variant of fertilization	C_{ox} [%]	N_t [%]	C_{mic} [$mg.kg^{-1}$]
1994	Maize	PH	1,20	0,142	243,28
		PZ	1,20	0,142	259,28
	Barley	PH	1,40	0,144	198,48
		PZ	1,26	0,144	230,24
	Pea	PH	1,25	0,144	210,00
		PZ	1,31	0,145	216,08
	Wheat	PH	1,29	0,140	212,08
		PZ	1,35	0,146	258,40
1995	Barley	PH	1,23	0,147	166,13
		PZ	1,17	0,139	184,60
	Pea	PH	1,17	0,151	172,00
		PZ	1,21	0,150	178,87
	Wheat	PH	1,17	0,134	187,13
		PZ	1,22	0,144	231,00
	Maize	PH	1,21	0,147	203,20
		PZ	1,22	0,154	246,98
1996	Pea	PH	1,17	0,201	286,80
		PZ	1,18	0,200	240,96
	Wheat	PH	1,24	0,200	261,92
		PZ	1,20	0,195	295,52
	Maize	PH	1,20	0,197	217,44
		PZ	1,25	0,196	274,32
	Barley	PH	1,27	0,201	293,60
		PZ	1,30	0,205	254,08
1997	Wheat	PH	1,20	0,184	264,27
		PZ	1,21	0,183	238,13
	Maize	PH	1,22	0,185	215,67
		PZ	1,21	0,192	247,07
	Barley	PH	1,20	0,203	170,53
		PZ	1,25	0,201	234,00
	Pea	PH	1,23	0,209	202,27
		PZ	1,27	0,207	241,07

Table 2 Analysis of variance according to ANOVA for C_{ox}, N_t and biomass of soil microorganisms

Source of variability Fertilization	C_{ox}	N_t	Biomass of soil microorganisms (C_{mic})
Significant Level	0,2185	0,8863	0,0272$^+$

The fertilization in which post-harvest and root residues along with the whole by-products of cultivated crops were ploughed in soil (treatment PZ) had a statistically significant effect (α = 0.05) on an amount of soil microorganism biomass (Table 2). The average C_{mic} value found in treatment PZ and treatment PH was 238.12 and 217.11 mg.kg^{-1} dry soil.
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EFFECT OF GROWING AREAS ON QUALITY OF SELECTED MALTING BARLEY VARIETIES

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Summary

Work concerns with evaluation of technological indicators of 5 selected malting barley varieties growing in the regions: suitable, mildly appropriate and inappropriate for malting barley. On the basis of obtained results from the crops in 1998 and 1999 we can say that between the experimental training stations (ETS) were marked differences in technological quality of observed varieties. The best chemical indicators of quality (starch content and content of crude protein) we observed in the inappropriate region for growing of malting barley in both years. The best mechanical indicators (grain size, thousand kernel weight) were in the mildly appropriate region in 1998 and in 1999 also in the inappropriate region.

Key words: barley, variety, quality, region

Introduction

The Slovak republic has a very different agroecological conditions which have very often decisive influence on malting barley growing in individual regions and producing areas. These conditions influence not only quality, but also quality of crop what is in much case decisive. Spring barley is growed in all producing areas, but the high malting value achieves only in specific soil and climatic conditions. Significant influence on the yield and grain malting quality has not only region but also year, forecrop and variety (Strnad, 1974; Očkay, 1978; Frančáková, Muchová, 1982). That is why the first step to success in the growing systems of malting barley is a choice of appropriate variety. A ratio of variety is estimated about 25 – 40% on achievement crops on dependence on growing conditions.

Material and methods

In the years 1998 – 1999 we determined a technological quality of 5 varieties of malting barley (Atribut, Jubilant, Kompakt, Progres, Sladko) that were growing in 3 different areas: Veľký Meder – mildly appropriate region, Veľké Ripňany – suitable region for the growing of malting barley, Jakubovany – inappropriate region.
After post – harvest maturation we observed: grain size, thousand kernel weight, starch content and content of crude protein. After malting process in the micromalter "Seeger" we determined these technological parameters, which were evaluated in terms of the malting quality index: malt extract, relative extract at 45 °C, Kolbach index, diastatic power, apparent final attenuation and friability.

Results and discussion

In the tables 1 – 3 are results of grain barley analysis from the crops 1998 and 1999. In 1999 we measured in all 3 growing regions better parameters of quality. Proportion of grains retained on a 2,5 mm sieve did not fall under 85% not even in one growing region, in the ETS Jakubovany was ranged in near all varieties over 90%. In 1998 the part of grain the first class was marked lower. The requirement of the norm 90% and more were not fulfilled. Paradoxically in the ETS Jakubovany the average content was the lowest (67,3%). Between the thousand grain weight (TGW) were not marked differences between 2 years. From the chemical indicators of quality we evaluated the starch content and the content of crude protein. The starch content was in the both years the highest in the ETS Jakubovany. Under 62% fell the content in the ETS Veľké Ripňany and Veľký Meder in 1998. The content of crude protein over 11% (average 11,9%) was established only in the ETS Veľký Meder in 1999.

For security of production of high malts quality a limit for barley 11,5% should not be overslept (Kosař, 2000). In 1998 the crude protein content was over 11% in the ETS Jakubovany, over 12% in the ETS Veľké Ripňany and almost 13% in the ETS Veľký Meder. The crude protein content is the sign which is the fastest influence of outside environment. Climatic conditions (most of all a long drought) can be a reason of increasing a crude protein content in barley caryopses also through a big growers endeavour. If crude protein content is a generally higher in consequence of years influence will be needed to mind choice part with higher grain size, thousand kernel weight and content of starch (Kosař, 2000).

On the basis of obtaining results it is possible to state that a course of weather has a marked influence on barley grain quality. Rainfall deficit we recorded in the ETS Veľké Ripňany and Veľký Meder in 1998. They were very low mainly in the decisive months – May and June in comparison with a normal average month rainfall. The year 1999 was not so critical. Mainly months May and June were rich on rainfall. Average temperatures were in the norm in both years.

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Results of barley analyses:

Tab. 1: Experimental training station - Veľké Ripňany

Variety	I. class (%)		TGW (g)		Starch (%)		Crude protein (%)	
	1998	1999	1998	1999	1998	1999	1998	1999
Atribut	74,4	86,6	46,6	44,1	54,8	62,3	12,96	11,00
Jubilant	83,0	91,9	42,0	41,2	60,2	61,6	12,95	10,04
Kompakt	78,7	82,3	44,6	42,1	60,1	65,6	11,86	10,43
Sladko	58,8	88,7	42,8	41,5	60,3	63,0	12,95	11,07
Progres	65,5	80,7	45,9	44,3	56,9	64,3	11,55	10,15
Average	72,1	86,0	44,4	42,6	58,4	63,4	12,45	10,54

Tab. 2: Experimental training station - Veľký Meder

Variety	I. class (%)		TGW (g)		Starch (%)		Crude protein (%)	
	1998	1999	1998	1999	1998	1999	1998	1999
Atribut	83,2	91,3	43,8	46,3	57,9	62,2	13,05	12,63
Jubilant	89,0	88,0	40,4	41,2	61,6	64,5	12,96	10,75
Kompakt	87,5	90,9	41,0	44,3	61,8	66,4	12,97	11,25
Sladko	60,0	84,1	39,6	43,6	58,4	63,0	12,99	12,60
Progres	90,4	85,4	45,9	45,3	62,9	64,6	12,95	12,31
Average	82,0	87,9	42,1	44,2	60,52	64,1	12,98	11,91

Tab. 3: Experimental training station – Jakubovany

Variety	I. class (%)		TGW(g)		Starch (%)		Crude protein (%)	
	1998	1999	1998	1999	1998	1999	1998	1999
Atribut	65,4	93,5	50,2	46,7	58,9	65,2	12,2	10,4
Jubilant	58,0	92,3	40,6	41,6	61,6	65,8	12,2	9,9
Kompakt	61,3	91,5	44,2	44,4	65,1	65,7	11,1	9,7
Sladko	87,9	92,4	50,2	42,7	63,1	63,6	10,0	10,5

Progres	64,1	92,9	48,5	47,3	63,6	67,0	12,7	10,3
Average	67,3	92,5	46,7	44,5	62,4	65,5	11,6	10,2

MICROBIAL BIOMASS AND ACTIVITY IN APPLE ORCHARD SOILS

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Summary

This study compared microbial biomass and activity in soils of the two different treated apple orchards. Microbial biomass carbon (C_{mic}), respiration activity and dehydrogenase activity (DHA) were measured at three depths of 0.0-0.1; 0.1-0.2; 0.2-0.3 m. The all parameters were especially influenced by the sampling depth and organic matter content in the soil layers. Values of C_{mic}, DHA and respiration activity were the highest in top layer (0.0-0.1 m) in both apple orchards. Value of the sum of CO_2 production during 14 days measurement dropped down with a depth. Differences among the variants were high significant ($\alpha = 0.01$). Relationship between dehydrogenase activity and organic matter was statistically confirmed by the high correlation coefficient ($r = 0.95$). High potential microbial activity was found in soil of the all variants after an addition of carbon substrate (glucose).

Key words: orchard, organic matter, microbial biomass, respiration activity, dehydrogenase activity

Introduction

Microorganisms in association with animals perform whole series of the processes which condition and directly influence the state of soil fertility. Therefore, quantitation, i.e. determination of the microbial biomass which is participating in these processes and, also informations about the rate of its turnover in soil have great importance. The microbial biomass is a potential source of nutrients for plants especially of their ability to bind temporally the nutritions to microbial cells. The microbial biomass and its activity are important indicators of changes in content and vertical distribution of the organic matter in a soil profile. The choice of suitable parameters of microbial activities which will by capable to respond sensitively to the changes of soil properties is discussed (Šantrůčková, 1993; Mäder et al., 1995; Vakula et al., 1997; Bujnovský et Juráni, 1999).

Material and methods

Soils from the two apple orchards from locality Ladzany (30-years old since 1993 untreated apple orchard and new, 4-years old apple orchard registered as a genetic resources of fruit-trees) were sampled in October 1999 to evaluate the biological activity. Soil samples were taken from a depth of 0.02-0.1; 0.1-0.2 and 0.2-0.3 m from three randomly chosen sites, i.e. in three replications. These replications for each layer were mixed, sieved through 2 mm screen and stored at 5 ºC ± 1 ºC for 5 weeks. Percentage of oxidizable carbon (%C_{ox}) was determined according to Tjurin (Arinuškinova, 1961). Percentage of total nitrogen (% N_t) was determined by Jodlbauer distillation method (Peterburskij, 1963). Actual $pH_{(H2O)}$ and exchange $pH_{(KCl)}$ were determined potentiometricaly.
The used variants: old apple orchard (OO): $I._O$ (0.02-0.1 m); $II._O$ (0.1-0.2 m); $III._O$ (0.2-0.3 m)
new apple orchard (NO): $I._N$ (0.02-0.1 m); $II._N$ (0.1-0.2 m); $III._N$ (0.2-0.3 m)
The following microbiological parameters were determined:

1. soil microbial biomass carbon (C_{mic}) by fumigate extraction method according to Vance et al., 1987.
   – in soil prior to establishment of the experiment and after finishing of basal mineralization activities
   – in soil with glucose addition after finishing of measurement of potential mineralization activities
2. soil respiration (CO_2 production) by titration method according to Bernat et Seifert (Kopčanová et al., 1990)
   – basal respiration
   – potential respiration (addition of glucose: 2,2 mg $C.g^{-1}$ dry soil mass)
3. dehydrogenase activity of microorganisms according to Casida et al., 1964
   – in soil prior to establishment of the experiment and after finishing of measurement of basal mineralization activities
   – in soil with an addition of glucose after finishing of measurement of potential mineralization activities

All observation parameters were determined in three replications.
CO_2 production was statistically evaluated by ANOVA; the relationship between DHA and organic matter was evaluated by regression analysis according to Stehlíková et Škulecová, (1999).

Results and discussion

Soil characteristics:Soil type of both orchards is cambisol characteristic by the highest soil organic carbon content (% C_{ox}) in top soil layer. % C_{ox} decreased with decreasing depth from maximum value 2.07 % ($I._O$) and 1.6 % ($I._N$) to minimum value 0.64 % ($III._O$) and 0.96 % ($III._N$). Also, the total nitrogen (%N_t) was decreased with the depth. In old apple orchard from 0.224 % to 0.085 %, in new apple orchard from 0.158 % to 0.096 %. Soil reaction (pH_{KCl}) in OO ranged from pH 6.25 at depth of 0.0-0.1 m to pH 5.18 at depth of 0.2-0.3 m; pH in NO ranged from pH 4.13 at depth of 0.0-0.1 m to pH 4.62 at depth of 0.2-0.3 m.
Microbiological characteristics: The highest C_{mic} values (with no carbon substrate addition) were found in top soil layer in OO ($I._O$ = 315.69 μg.g^{-1} dry soil mass) and in NO ($I._N$ = 151.05 μg.g^{-1} soil dry mass). Also, there was measured the highest organic carbon content. Correlation between the organic carbon content and the biomass amount was not statistically confirmed. Zeller et.al (2000) recorded increasing of the total organic carbon and of microscopic fungal biomass at a depth of 0.02-0.1 m in soil under untreated meadow in comparison with intensively managed meadow.
The highest CO_2 content in top layers and its decreasing with a depth reflected on intensity of mineralization activity in individual layers. Value of the sum of CO_2 production during 14 day-measurement in variant $I._O$ achieved 1022.13 mg.kg^{-1} soil dry mass, while in variant $I._N$ achieved only 68% of that value. Differences among the variants and days were significant (α = 0.01) (tab. 1). The results confirming increased activity at a depth of 0.02-0.1 m are in accordance with results of Lavahum et al. (1996), that found out the highest values of cumulative CO_2 production (2661 μg C.g^{-1} soil dry mass) just at the same depth in soil under grassland. CO_2- C dropped down with the depth. In our experiment, the potential respiration activity was high in the all variants in both apple orchards, especially in layers with the lowest basal respiration.
The highest DHA values were found in top layers of both orchards, as follows: $I._O$ = 28.15 and $I._N$ = 27.52 μg TPF.g^{-1} soil dry mass.h^{-1}. Potential microbial ability to decompose and to utilise easily decomposable substrates was especially attained by addition of glucose (tab. 2). However, the most intensive reactions on supplied glucose were observed in deeper layers (0.2 – 0.3 m) in soil of both orchards.

Table 1 Analysis of variance for basal respiration (P<0,01)

Source of variation Main effects	Sum of squares	d.f.	Mean square	F-ratio	Sig. Level
Variants	100957,82	5	20191,564	202,394	0,0000^{++}
Replication	17,66	2	8,831	0,089	0,9153
Days of measure	64957,29	13	4996,715	50,086	0,0000^{++}
Residual	22746,06	228	99,763423		
Total	187392,7	248			

Table 2 Dehydrogenase activity (DHA) μg TPF. g^{-1} soil dry mass . h^{-1}

Assessment period	**Variants**					
	$I._O$	**$II._O$**	**$III._O$**	**$I._N$**	**$II._N$**	**$III._N$**
Prior to experiment	28.15	5.42	3.12	27.52	6.87	3.73
After 14 - day incubation	16.38	5.72	3.89	13.46	4.51	3.11
After 14 – day incubation with glucose addition	29.57	6.28	3.60	24.94	9.43	6.48

TPF – trifenyl formazan

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THE INFLUENCE OF FERTILISATION AND IRRIGATION ON SENSORIAL AND CHEMICAL QUALITY OF APPLES

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Summary

Two varieties – Gala and Idared – and their 4 cultivated variants A, B, C, K were monitored a refrigeration room with modified storing conditions (storing temperature +1,5°C, relative atmospheric humidity 90%, gases 1% O_2, 3% CO_2 and 96% N_2) from September to March (Gala), and up to June (Idared). The total content of carbohydrates ranged between 300-930 $g.kg^{-1}$ dry matter (DM) for Gala apples and 780-910 $g.kg^{-1}$ DM for Idared apples. The total organic acid content was from 30 to 87 $g.kg^{-1}$ DM for Gala apples, whereas Idared apples had a higher content (80-180 $g.kg^{-1}$ DM). The total content of vitamin C ranged between 0-22,3 $mg.100g^{-1}$ fresh matter for Gala and for Idared from 3,25 to 15,56 $mg.100g^{-1}$ fresh matter. The content of calcium ranged between 3,21 and 5,69 $mg.100g^{-1}$ for Gala and Idared.

Keywords: sensorial analyse, chemical analyse, quality of apples, Gala, Idared

Introduction

The storage potential of different cultivars of apples is determined genetically but for any given cultivar storage life can be extended by the use of refrigeration and controlled atmosphere (CA) storage (Johnson, 1994). The conditions under which apples grown have a major influence on the duration of storage and the quality of fruit available to the consumer.
Fruit harvested before or during the climacteric period achieved better quality retention during long-term storage than those harvested at the post-climacteric storage (Lau, 1985).
The aim of this study was to find out, if there exists contrasts among samples - variants in organoleptic facilities, in total sensorial quality and determined their chemical composition.

Material and methods

Apples „Gala" and „Idared", and their cultivated 4 variants on grounds of VPS Most in homogeneous environment, were harvested in the autumn of 2000. Climatic conditions of the experiment has been monitored at meteorological station located approximately 1 km away from grounds. After harvest the apples were put in a storage with conditioned atmosphere. The quality of apples of individual variants has been defined after their gathering and storage in a model storage with conditioned atmosphere (storing temperature +1,5°C, relative atmospheric humidity 90%, gases 1% O_2, 3% CO_2 and 96% N_2).
The first evaluation was made immediately after harvest and next evaluations were made in month-intervals. Certain suitable methods and test have been chosen for a sensorial evaluation. A "triangle test" has been used in differential method to find out whether there exists a difference between varieties and variants. Results have been statistically verified by chi-squared method. A pointed test has been used in a scale system created by Kopec and Horčin. The quality of panelists and results has been monitored by the so called "number NVR" (number of a rating reliability), by the interval of reliability and some distribution-free tests (Kramer test, Friedman test for file, Friedman test for pairs, Page's method).
Difficult methods presented the profiled method, where a classic complete profile (smell, taste, texture) and polarity profile texture were applied, by which chosen intensities were compared to polar texture components. In terms of research chosen chemical indices (dry matter, fibre, organic acids, sugar, vitamin C, calcium) were examined and firmness was measured by penetrometrical measurement and statistic dependency was studied by means of regressive responsibly correlation counts.

Results and discussion

From the beginning of September (1999) till the end of June (2000) there was done 5 valuations of Gala apples and 7 valuations of Idared apples (everything multiplied by 4 variants). Data presented in Table 1 summarize mean chemical composition of Gala and Idared apples distributed by type of variant.
Average dry matter (DM) concentrations in Gala apples was in range from 13,01% to 13,95% and from 12,84% to 13,66% in Idared apples. Dry matter concentration in apples grown in the Slovak republic varies according to the growing conditions in any particular year. The same results reported study by Johnson (2000).
The mean content of organic acids was average from 61 to 77 $g.kg^{-1}$ in Gala apples and from 97 to 129 $g.kg^{-1}$ in Idared apples. Suni et al (2000) have reported contents of organic acids from 30 to 103 $g.kg^{-1}$ in apples.
Average content of vitamin C in Gala was range from 20,14 to 22,30 $mg.100g^{-1}$ and from 13,20 to 15,56 $mg.100g^{-1}$ in Idared apples. The decreased of vitamin C was more evident at Gala apples, whereas vitamin C content at Idared apples was decrease equally. As time of storage progressed vitamin C content decreased. To similar results inferred Drake et al. (1991).

The mean content of Ca was in range from 3,79 to 5,69 $mg.100g^{-1}$ at Gala and from 3,87 to 4,61 $mg.100g^{-1}$ at Idared. Johnson (2000) reported higher content of calcium 7,4 $mg.100g^{-1}$ in Gala apples. Low Ca in apples is associated primarily with premature senescence and the development of various types of physiological disorders during storage (Sharples and Johnson, 1987).
The sensorial valuation always begun by discharging of valued samples (selection file) 24 hour before the measurement. Members of rating commission were submitted to wards the test of momentary fitnesslability during analyses. The results of sensorial test are shown in Table 1.
A triangle test has been chosen from several tests of differential methods. This test has not mostly shown contrasts statistically documented in an application for whole files, but in individual pairs a repining process contrast has appeared. Per cent given points in scale method shows the ripping quality of Gala variety, in comparison with Idared variety whereas its quality upgrades during the storage. The total quality in profiled method has not indicated in frames variant statistically

Table 1 Results of chemical and sensorial analysis

Variety	VaRiAnt	Para-meter	CHEMICAL ANALYSIS						SENSORIAL ANALYSIS				
			Dry matter (%)	Total fibre (%)	Org. acids g/kg	Sugar g/kg DM	Vit. C mg/100 g	Ca mg/100g	Point test		Polarity test (points)		
									Mean points	Mean rank	smell	taste	texture
GALA	A	x	13,79	4,63	61	784	10,2	3,63	92,42	1,97	2,79	2,93	4,77
		x_{min}	11,73	3,78	35	470	0	3,44	70,6	1,67	2,39	2,12	3,5
		x_{max}	18,17	5,67	87	930	21,88	3,79	104	2,3	3,16	3,52	5,28
	B	x	13,01	4,65	64	728	9,15	3,87	86,65	2,95	2,51	2,31	3,75
		x_{min}	11,26	3,84	30	300	0	3,37	55,6	2,13	2,06	1,11	2,0
		x_{max}	15,4	6,01	87	900	20,14	4,38	104,25	4,0	3,25	3,38	5,01
	C	x	13,94	4,54	74	826	9,87	3,85	91,54	2,73	2,69	2,71	22,34
		x_{min}	12,98	3,77	44	520	0	3,32	72,7	2,3	2,28	2,01	3,4
		x_{max}	17,32	6,14	87	890	21,92	4,29	102	3,25	3,62	3,03	5,63
	K	x	13,95	4,51	66	807	10,27	4,36	92,41	2,35	2,88	2,87	4,11
		x_{min}	12,71	3,22	48	700	0	3,21	73,6	1,8	2,2	1,95	3
		x_{max}	16,31	5,91	76	840	22,3	5,69	103,23	2,88	4,18	3,83	5,12
IDARED	A	x	12,84	5,13	97	793	9,12	3,93	93,24	2,25	2,34	2,16	3,31
		x_{min}	12,65	4,42	80	780	3,25	3,38	91,5	1,75	1,8	1,73	2,9
		x_{max}	13,09	5,93	117	820	15,12	4,61	95,5	3,1	3,03	2,64	3,8
	B	x	13,06	4,99	129	815	8,57	3,71	86,33	3,08	1,76	1,85	3,16
		x_{min}	12,89	4,06	103	780	3,7	3,55	75,75	1,83	1,38	1,51	2,0
		x_{max}	13,28	5,84	180	840	13,48	3,87	98,25	4,0	2,35	2,48	4,96
	C	x	13,66	5,01	97	865	10,12	3,95	91,76	2,23	1,98	2,13	3,339
		x_{min}	13,4	4,02	82	790	4,82	3,55	85,75	1,7	1,52	1,7	2,5
		x_{max}	14,22	6,12	104	910	15,56	4,61	96,8	3,0	2,65	2,42	3,96
	K	x	13,27	5,4	99	888	9,47	3,97	92,47	2,42	1,92	2,18	3,02
		x_{min}	12,59	4,6	84	840	6,05	3,61	85,83	1,25	0,94	1,24	2,5
		x_{max}	13,73	6,13	110	900	13,2	4,19	94,8	3,83	2,46	2,65	4,0

A - liquid fertilisation with fertilising irrigation, amount of fertiliser 80 kg . ha^{-1} N, 80 kg . ha^{-1} P_2O_5 and 25 kg . ha^{-1} K_2, B - as A, only the amount of nitrogen has been increased to 120 kg . ha^{-1}, C - stiff fertiliser in amount as in A + irrigation, D- stiff fertiliser in amount as in A without irrigation (only natural rainfalls).

documented results in primary measurement, the quality of Idared variety has improved in later measurement. Gala variety in 5th measurement (March) already accounted of indicia survey, mainly in variant B. Variant B already appeared worse in these

last valuations that means it can be only applied up to the end of January for roughly assumed storage. However it is not possible for longer storage. To similar result inferred Drake and Elfving (1999), Drake (1991) and Cliff et al. (1998), who demonstrated that Gala apples are not well adapted long term storage because they rapidly lose firmness and aromatic constituents of flavour during storage. Therefore Meheriuk (1993) suggested a storage life of 5-6 months in 1-5% CO_2 + 1-2,5% O_2 at 0-2 °C. Second variety (Idared) maintained excellent quality up to the the 7th measurement.
The polarity test of profiled methods proves justness to its texture applications mainly because of that texture plays a determining role in a total quality of apples. High texture values in a scale method and in both profile tests can prove it.. Soft, floury or hyaline meshes are immediately noticed and cared of low valuation. In this respect the worst variant is B from variants, even though it did not appear during the first valuations and that the results were oscillated.
Relationships among some already achieved results of sensorial, chemical and physical analyse have been examined in terms of research quality of monitored apples. Obtained results were determined to parametric t-test. If the calculated t-values were higher than table ones correlation coefficient r_{xy} was noticeable. And there existed dependence on a chosen level of significance between variable quantities x and y. Tightness of monitoring relations was closer, the more the value of a correlation relation approached to 1. In Gala variety statistically demonstrated dependencies have been proved (α = 0,05) between smell and taste, taste and texture (physically measure) and fibre and hardness, whereas fibre was stated chemically. Dependence has not been found between chemical sweet and sensorial taste. There has been shown a relation between smell and taste, hardness and fibre, texture and fibre in Idared variety. The reliance has not been unconfirmed between taste and texture, hardness and texture and between taste and content sugar. Contrasts are caused by another characteristic variety, which is slow ripping during storage. Results indicate that texture evaluated by sensorial analyse is not identical with hardness measured by instrumental engineering.

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THE INFLUENCE OF VARIETY AND NITROGEN FERTILIZATION ON YIELD AND QUALITY OF MALTING BARLEY

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Summary

Work evaluates an influence of variety (Kompakt, Garant, Atribut and Expres) and nitrogen fertilization during vegetation season (based on mineral nitrogen content in soil) on yield and crude protein content in barley grain. Variability of yields was most affected by varieties. Garant had significantly higher average yield (7,60 t . ha^{-1}) than varieties Kompakt (6,92 t . ha^{-1}) and Atribut (7,27 t . ha^{-1}). Crude protein content in grain of variety Garant (10,39 %) was significantly lower compared to varieties Expres (10,79 %) and Atribut (11,15 %). Nitrogen fertilization significantly influenced number of ears per 1 m^2, thousand grains weight and yield of spring barley. The highest yield (7,59 t . ha^{-1}) was found out after rate 20 kg of nitrogen per hectare (fertilizer DAM-390) at the end of tillering. Crude protein content in spring barley grain was not significantly influenced by any way of nitrogen fertilization during vegetation.

Key words: spring barley, variety, nitrogen fertilization, yield, quality

Introduction

The achievement of good barley yield and its high malting quality requires growing technology on high level and also favourable weather conditions during vegetation season. Appropriate growing technologies enable us to minimize the unfavourable effects of weather conditions on barley yields and quality. According to Kulík (1995) production of any crop, especially economically important, is not possible without respecting of intensification factors, which ensure adequate yield and its qualitative parameters. There is contemporaneously necessary to take into account adequacy of intensification factors in relation to economy and environment. The most important intensification measures in growing technology of spring barley are use of fertilizers and pesticides, also varieties and forecrops.
Our work was focused on evaluation of two important agrotechnical factors – variety and nitrogen fertilizaton in interaction with conditions of year on barley yields and its malting quality. Close relationships between variety, nitrogen fertilization and malting quality of barley are well known from works of many authors (Conry 1995, Fecenko, Bízik, Ložek 1989 etc.).

Material and methods

The small–plot experiments were performed under conditions of beet growing region in 1997 – 1999. Experiments were established by block method with randomly arranged plots in three repetitions. Varieties Kompakt, Garant, Atribut and Expres were used. The seed rate was 4,5 millions of germinable grains per hectare, forecrop of barley was sugar beet.
Variants of fertilization: **A** - unfertilized control, **B1** – 20 kg of nitrogen per hectare (ammonium nitrate) applied at the beginning of tillering, **B2** - rate of nitrogen calculated for 5 tons yield per hectare applied at the beginning of tillering (ammonium nitrate), **C1** – 20 kg of nitrogen per hectare (DAM - 390) at the end of tillering, **C2** - rate of nitrogen calculated for 5 tons yield per hectare applied at the end of tillering (DAM - 390), **D1** – 20 kg of nitrogen per hectare (Fostim) at the end of tillering, **D2** - rate of nitrogen calculated for five tons yield per hectare applied at the end of tillering (Fostim)
The nitrogen rate on variants B2, C2 and D2 was based on agrochemical analysis of soil on mineral nitrogen content. The need of nitrogen for production 5 tons of grains and appropriate amount of straw was calculated for 125 kg of nitrogen per hectare.

Table 1 Mineral nitrogen content in soil at beginning of tillering and really used rates of nitrogen on variants B2, C2 and D2

Year	Depth of sampling	Mineral nitrogen content in soil				Rate of nitrogen ($kg . ha^{-1}$)
		$N – NH_4^+$	$N – NO_3^-$	N_{min} ($mg . kg^{-1}$)	N_{min} ($kg . ha^{-1}$)	
1997	0,00 – 0,30	1,73	8,79	10,53	88,56	36,46
	0,30 – 0,60	1,00	7,64	9,15		
1998	0,00 – 0,30	2,42	11,58	14,00	116,15	8,86
	0,30 – 0,60	2,49	9,32	11,81		
1999	0,00 – 0,30	2,40	9,30	11,80	84,60	40,40
	0,30 – 0,60	1,20	5,80	7,00		

$N – NH_4^+$ - ammonium nitrogen; $N – NO_3^-$ - nitrate nitrogen; N_{min} - mineral nitrogen

The yield was harvested by smallplot combine-harvester. Crude protein content in grain was determined according to Kjeldahl. The influence of experimental factors on observed characteristics was evaluated by multifactor analysis of variance. Statistical significance of differences between averages was examined by Tukey test on 95 % significance level.

Results

The highest values of thousand grains weight was found out in 1997 (49,36 g). Also the highest average yield (7,48 t . ha^{-1}) and the most favourable crude protein content in grain (9,76 %) was in 1997. The lowest yields (7,16 t . ha^{-1}) and the highest crude protein content was achieved in 1999.
Variety Garant had significantly higher ears density per m^2 before harvest than other varieties. Garant had the highest average grain yield (7,60 t . ha^{-1}), significantly higher than varieties Kompakt and Atribut. Crude protein content in grain of variety Garant was significantly lower compared to varieties Atribut and Expres, average values of crude protein at variety Garant was the lowest in all three experimental years. Variety Atribut was characteristic by the greatest thousand grains weight in all three years and also the highest crude protein content was found out at this variety in all experimental years. Variety Kompakt achieved the lowest thousand grain weight (46,62 g). This variety had the smallest yield potential within all evaluated varieties, it produced the lowest yield in all years. Average yield of variety Kompakt for three years period (6,92 t . ha^{-1}) was significantly lower compared to other varieties. Variety Expres had the lowest density of ears per m^2 (749,97 ears).
Nitrogen fertilization significantly influenced number of ears per 1 m^2, thousand grains weight and yield of spring barley. Thousand grains weight decreased on all fertilized variants compare to variant A, the most on variants B2 and C2 – significantly. Decrease was minor on variants B1, C1, where nitrogen was applicated in rate only 20 kg per hectare and on

variants D1, D2, where Fostim was used (Fostim contains not only nitrogen, but also phosphorus). The lowest average yield was achieved on control variant (7,15 t . ha^{-1}), the greatest yield was on variant C1 (7,59 t . ha^{-1}), where nitrogen was used in rate 20 kg per hectare (fertilizer DAM-390) at the end of tillering. The difference was statistically significant. Yield on other variants was non-significantly higher compare to variant A. Crude protein content in spring barley grain was not statistically significantly influenced by fertilization.

Discussion

Year conditions and varieties highly significantly influenced all evaluated characteristics. The year had the greatest proportion on total variability of yield forming components and crude protein content. Variability of yields was most affected by varieties.
Results confirmed earlier findings of Frančáková (1985), the more nitrogen is used for yield formation, the less nitrogen deteriorates protein content in grain and malting quality of barley. There is interesting finding, that variety Garant achieved the most favourable crude protein content in grain compared to other varieties. Garant belongs on the base of malting quality into group „B“ (standard varieties) and another varieties into group „A“ (malting varieties). Decrease of thousand grains weight as a consequence of higher nitrogen rates was observed also by Frančáková (1985). Results showed, that when nitrogen rate for spring barley is determined on the base of soil analysis (on mineral nitrogen content in soil), risks of harmful effects of foliar nitrogen aplication on malting quality of barley can be eliminated.

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Table 2 Average values of yield forming components, yields and crude protein content of spring barley

Factor	Levels of factor	n	Number of ears per m^2		Thousand grains weight		Yield		Crude protein content	
Year	1997	84	725,00	a	49,36	c	7,48	b	9,76	a
	1998	84	831,62	b	46,28	a	7,34	ab	11,12	b
	1999	84	859,05	b	46,87	b	7,16	a	11,26	b
Variety	Kompakt	63	803,05	b	46,62	a	6,92	a	10,52	ab
	Garant	63	878,10	c	46,86	a	7,60	c	10,39	a
	Atribut	63	789,78	ab	48,63	c	7,27	b	11,15	c
	Expres	63	749,97	a	47,90	b	7,52	bc	10,79	b
Fertilization	A	36	787,33	ab	47,82	c	7,15	a	10,59	a
	B1	36	812,11	ab	47,55	bc	7,36	ab	10,85	a
	B2	36	815,00	ab	47,16	ab	7,26	ab	10,77	a
	C1	36	770,00	a	47,68	c	7,59	b	10,70	a
	C2	36	847,33	b	47,02	a	7,35	ab	10,82	a
	D1	36	819,89	ab	47,70	c	7,29	ab	10,79	a
	D2	36	784,89	ab	47,60	bc	7,28	ab	10,47	a

Averages with different letters are statistically significant at $P \leq 0,05$

SOME INDICATORS OF SOIL QUALITY IN SEVERAL CROP PRODUCTION SYSTEMS

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Summary

In 1999-2000 the microbial soil activity (presented by CO_2 release, ammonification and nitrification activities) has been evaluated in four crop production systems (ecological and conventional I, integrated and conventional II). The ammonification and nitrification activities have been observed between the ecological and integrated production systems only. In the integrated system, there were detected the statistically significantly highest microbial activity. The differences among the other crop production systems were not statistically significant. The activity of soil microorganisms in the integrated production system was promoted by the ploughless soil tillage that increased the content of the organic matter in the topsoil.

Key words: production systems, CO_2 release, ammonification, nitrification

Introduction

The environment is very changed by agricultural activities. The conventional intensive agriculture decreases soil quality, causes water pollution and reduses biodiversity of the countryside. Therefore, it is necessary to find the way to the productive farming system without environmental damage.
The aim of the paper is to compare the ecological and integrated (ploughless) crop production systems with conventional ones from the viewpoint of the soil microbial activity evaluation. The soil organic matter, soil respiration, ammonification and nitrification activities are the microbiological characteristics that indicate possible negative ecological consequences of the anthropogenical activity (Cannell, Hawes, 1994; Filip, Berthelin, 1999).

Material and methods

In the years 1999-2000 some soil chemical characteristics and mineralization processes like CO_2 release, ammonification and nitrification have been determined in several crop production systems in Borovce near Piešťany (the maize growing region on chernozem soils). The characterization of the crop production systems is presented in Table 1.
The soil samples have been taken from the constant sampling plots four times (April, May, June/July, October/November) in 1999 and 2000. The depth of sampling was 2-20 cm in all plots. Immediately after sampling, the fresh soil samples were passed through 2-mm sieve and several microbiological analyses were performed. The chemical characteristics (pH_{KCl}, C_{ox}, C_{tot}, N_{tot}, N_{in}) were determined from air-dried soil samples.
Microbiological analyses:

- basal soil respiration - CO_2 release (titration method of Bernát and Seifert)
- ammonification activity - the increase in content of ammonium nitrogen ($N\text{-}NH_4^+$) after 14 days aerobic incubation
- nitrification activity - the increase in content of inorganic nitrogen ($N\text{-}NH_4^+ + N\text{-}NO_3^-$) after 14 days aerobic incubation

The content of ammonium nitrogen was detected by colorimetric method with Nessler' agent and content of nitrate nitrogen by isotachophoresis method with EA 100 analyser (of LEBACO firm).
The results were statistically evaluated by variance analysis.

Results and discussion

The soil chemical characteristics are shown in Table 2. The soils are moderately acid (pH_{KCl} 6,0-6,9 according to Šály, 1996), with medium resource of good quality humus (2-3% humus content, C/N about 10 according to Hraško, Bedrna, 1988). During two years period of 1999-2000 the highest contents of soil carbon (C_{ox}, C_{tot}) and nitrogen (N_{tot}, N_{in}) have been observed in the integrated system without ploughing. The statistically significant differences among the compared crop production systems were detected only in C_{tot} contents. The differences in other chemical characteristics were not significant. These results support the fact that the ploughless tillage increases the content of the organic matter in the topsoil. The organic matter accumulation in the upper soil layer has been identified by several research projects about the ploughless soil tillage (Cannell, Hawes, 1994; Rasmussen, 1999; Tebrügge, Düring, 1999). The litter left on the surface of non-ploughed soils can be considered as a key factor for promoting the microbial activity, improving the aggregate stability and protecting against erosive water forces (Tebrügge, Düring, 1999).
The substrate quantity and quality have significant influence to the microbial activity. The soil respiration is an important characteristics of the carbon dynamics in soil (Kubát et al., 1999). It represents the rate of the soil organic matter decomposition. The basal soil respiration activity was statistically significantly the highest in the integrated production system (Table 3), where the most quantity of soil organic matter was accumulated.

Table 1: Agrotechnical characterization of crop production systems

Systems	Soil tillage	Crop rotation	Manure	Plant protection	Weed control

ecological	ploughing	6 crops rotation	stable manure stubble remains	biological	mechanical
Conventional I	ploughing	6 crops rotation	stable manure stubble remains NPK fertilizers	chemical	chemical (weedkillers)
integrated	ploughless	4 crops rotation	compost stubble remains NPK fertilizers	chemical (integrated)	chemical (integrated)
conventional II	ploughing	4 crops rotation	compost NPK fertilizers	chemical	chemical (weedkillers)

Six crops rotation: pea (1999), winter wheat (2000), potatoes (stable manure application), spring barley and additional sowing of meadow clover, meadow clover, winter wheat
Four crops rotation: pea (1999), winter wheat (2000), maize (compost application), spring barley

Table 2: Soil chemical characteristics

		System				
		ecological	conventional I	integrated	conventional II	average
PH $_{KCl}$	1999	5,8	5,9	6,1	6,5	6,1
	2000	6,0	6,0	5,9	6,1	6,0
	average	5,9 a	6,0 a	6,0 a	6,3 a	6,1
$\%C_{ox}$	1999	1,16	1,23	1,44	1,29	1,28
	2000	1,26	1,17	1,40	1,18	1,25
	average	1,21 a	1,20 a	1,42 a	1,24 a	1,27
$\%C_{tot}$	1999	1,30	1,35	1,53	1,37	1,39
	2000	1,37	1,33	1,60	1,29	1,40
	average	1,34 a	1,34 a	1,57 b	1,33 a	1,40
$\%N_{tot}$	1999	0,12	0,13	0,14	0,13	0,13
	2000	0,13	0,13	0,16	0,13	0,13
	average	0,13 a	0,13 a	0,15 a	0,13 a	0,13
N_{in} (mg/kg)	1999	14,1	17,5	22,1	18,6	18,1
	2000	11,8	9,0	23,3	11,9	14,0
	average	13,0 a	13,3 a	22,7 a	15,3 a	16,1

Values followed by the same letter within lines are not significantly different (ANOVA, α=0,05).

The ammonification and nitrification activities of the soil microorganisms have been determined between the ecological and integrated systems. In the integrated system the ammonification and nitrification microorganisms were more active than in ecological production system (Table 4).

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Table 3: Basal soil respiration activity

System	CO_2 release (mg / 100 g / 24 h)		
	1999	2000	average
Ecological	4,6	4,8	4,7 a
Conventional I	4,6	4,7	4,7 a
Integrated	7,7	8,4	8,1 b
Conventional II	5,3	5,1	5,2 a

Average	5,6	5,8	5,7

Values followed by the same letter within column are not significantly different (ANOVA, α=0,05).

Table 4: Ammonification and nitrification activity

		System		
		Ecological	integrated	average
ammonification (mg/kg)	1999	7,6	10,4	9,0
	2000	12,4	19,8	16,1
	average	10,0 a	15,1 b	12,6
nitrification (mg/kg)	1999	7,4	10,1	8,8
	2000	12,7	20,8	16,7
	average	10,1 a	15,5 b	12,8

Values followed by the same letter within lines are not significantly different (ANOVA, α=0,05).

OCCURRENCE AND DEGRADATION OF NITRATE IN SOME SOIL PROFILES IN HUNGARY

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Summary

We studied the profiles of three Fertilization Experimental Farms of Debrecen Agricultural University in Hungary. The soil samples were usually taken by drilling by 20 cm layers from 0 to 200 cm, by 25 cm from 200 to 300 and by 50 cm from 300 to 600 cm. The soil types of profiles differed basically in moisture, clay and silt and organic carbon content. The pH values in the upper layers of all soil types were slightly acidic then increased and became alkalic because of the appearance of $CaCO_3$. In the control chernozem profile the nitrate content decreased from the top to the bottom of profile. There was an accumulation detected in the control meadow soil.
The effect of fertilization can be shown clearly, because the nitrate accumulated in lower layers. As an effect of fertilization, the nitrate content increased remarkably in layers 160-350 cm and 450-600 cm of calcareous chernozem. The nitrate content was two and three times higher from 40 cm to 200 cm in the treated meadow soil, than in the control, because of the fertilization. In the upper layer of the blownsand the nitrate content was remarkable high then it decreased to 100 cm and increased again down to the bottom of the profile. Nitrate degradation - in which bacteria plaid an important role - was the most expressed in the layers of 0-40 cm in all the three soil types. It decreased with depth, but increased again in the lower layers.

Keywords: nitrate accumulation, nitrate degradation, soil profiles, effect of fertilization on nitrate content of soil.

Introduction

Presently, at a time of intensive use of chemicals in agriculture, the leaching and accumulation of fertilizers containing nitrogen represents a global hazard. Since 1990, the amount of applied fertilizers in Hungary has dramatically decreased. In spite of this fact, it is very important to focus on their ecological and environmental effects.
Increasingly more data may be found in the special literature in Hungary concerning the investigation of the spread of nitrate ion into soil profiles (HELMECZI, 1983; NÉMETH, et al. 1989; RUZSÁNYI, 1991; PEPÓ et al. 1997, PEPÓ, 2001). However, long term fertilizer experiments also provide a very good possibility for the study of leaching and accumulation of nitrate ion in different soil types (NÉMETH, 1993, 1994).
Debrecen Agricultural University joined an EC project, which partly concerned itself with the nitrate problem. The two participating departments were the Central Laboratory of the Faculty of Agronomy and the Departmant of Soil Science and Microbiology.
Our aims were
- to investigate the physical and chemical characteristics of profiles of different soil types ,
- to compare the nitrate content of fertilized and non fertilized soil profiles,
- to estimate nitrate disappearance (denitrification activity) during the degradation experiment.

In this paper, we present a portion of these results.

Material and methods

Soil samples were collected from the profiles of three experimental farms of Debrecen Agricultural: University:Debrecen-Látókép Experimental Farm (calcareous chernozem), Hajdúböszörmény Experimental Farm (meadow soil), Debrecen-Pallag Experimental Farm (blownsand / sand mantle). The soil samples were usually taken in 20 cm layers from 0 to 200 cm, by 25 cm from 200 to 300 and by 50 cm from 300 to 600 cm.

On the Debrecen-Látókép and Hajdúböszörmény Experimental Farms maize is produced intensively. Fertilization and irrigation have been applied for more than 15 and 40 years. On the Debrecen-Pallag Farm the horticultural production was carried out.
Water content of the soil was measured by weight loss after drying at 105 °C and was expressed in the proportion of dry soil. **Clay and silt**, the particles with diameter less than 0,02 mm were determined by elutriation. The **pH value** of the samples was measured using distilled water and M KCl solution. Lime content (depending on pH values) was also determined (BALLENEGGER - di GLÉRIA, 1962). **Organic carbon** was measured using SZÉKELY's method (1960). **The nitrate content** of the whole profile and the investigation on degradation were determined with sodium salicylate (FELFÖLDY, 1987).
Nitrate degradation experiment was set up, as follows. Two series of 10-10 g soil samples were measured into sterile-labelled bottles. 30 ppm nitrate solution was added to the first series, while distilled water was added to the second series. The bottles were completely filled to produce anaerobic condition. The samples were incubated at 25 °C for 28 days and nitrate was measured in the solution. Finally we calculated the nitrate disappearance.

Results

We measured some physical (moisture-, clay and silt content) and chemical (pH, $CaCO_3$, organic- and nitrate content) characteristics of layers of profiles. According to our data, the soil types of profiles and layers differed basically in moisture, clay and silt and organic carbon content. The pH values in the upper layers of all soil types were slightly acidic then increased and became alkalic because of the appearance of $CaCO_3$.
In the control **chernozem profile** the nitrate content decreased from the top to 140 cm. In the lower layers we could detect only 1-2 ppm. In the upper layers of fertilized plot the nitrate content was lower than in the control and decreased to 120 cm. In this profile the nitrate maximum was at 300 cm and from 450 cm more nitrate was present than in the control.
The productive layer of **meadow soil** had also larger nitrate content. The maximum value was detected at 120 cm in the control and it decreased gradually down to the bottom of the profile. In the fertilized profile the nitrate maximum was at 100 cm. The nitrate content was two and three times larger from 40 to 200 cm than in the control's (Table 1).
In the upper layer of the **blownsand** the nitrate content was remarkable high then it decreased to 100 cm and increased again down to the bottom of the profile.
In the chernozem control soil the nitrate dissipation decreased from the top layer, with a minimum value was at 140 cm then increased again. In the fertilized profile the tendency was similar to the control one but this value was lower. The nitrate degradation has not changed considerably in the layers of 275-600 cm.
In the control and fertilized plots of profile in the case of **meadow soil** the nitrate disappearance (Table 2) decreased from the surface. In the control it increased from 300 cm, while in the fertilized profile from 180 cm. The nitrate degradation in the majority of layers in was higher the treated meadow soil. The nitrate degradation was higher in 0-40 cm of both fertilized soil types.
In the blownsand the nitrate degradation was remarkable high in the top layers (0-40 cm). We could not detect considerable changing in the blownsand profile down to the bottom.
The nitrate degradation was the most expressed in the layers of 0-40 cm in all the three soil types. It decreased with the depth, but increased again in the lower layers.
The effect of fertilization increased the nitrate degradation first of all in the meadow soil.

Table 1Nitrate content of different soil type profiles (NO_3 mg/kg)

Layer (cm)	Calcareous chernozem (control)	Calcareous Chernozem (treated)	Meadow (control)	Meadow (treated)	Layer (cm)	Blownsand
0-20	14,9	9,8	16,8	10,7	0-30	13,2
20-40	14,9	9,6	12,8	11,7	30-50	1,0
40-60	11,2	7,0	8,3	21,6	50-70	1,8
60-80	13,3	5,0	12,1	19,8	70-100	1,1
80-100	7,1	2,2	25,2	71,9	100-130	1,6
100-120	4,7	2,4	33,5	90,7	130-160	6,2
120-140	2,5	9,9	23,8	53,9	160-190	2,9
140-160	1,7	4,3	12,4	27,7	190-215	2,5
160-180	1,1	7,0	5,9	15,7	215-240	4,7
180-200	0,9	13,1	6,1	11,2	240-290	5,7
200-225	2,4	17,6	4,9	4,4	290-350	4,5
225-250	1,6	17,3	5,4	2,7	350-400	6,0
250-275	1,4	20,0	3,4	0,2	400-450	11,5
275-300	1,5	22,9	1,5	1,3	450-500	21,4
300-350	2,2	12,2	2,9	2,6	500-550	8,9
350-400	1,0	1,9	0,3	1,3	550-600	13,0

400-450	0,2	0,6	0,2	0,2		
450-500	0,2	4,1	0,2	0,2		
500-550	0,8	5,0				
550-600	0,7	5,9				

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Table 2 Nitrate degradation in the different soil type profiles during incubation experiment (NO_3^- mg/dm^3/28 days)

Layer (cm)	Calcareous chernozem (control)	Calcareous chernozem (treated)	Meadow (control)	Meadow (treated)	Layer (cm)	Blownsand
0-20	23,27	29,01	28,29	31,21	0-30	25,91
20-40	14,97	23,98	20,09	26,47	30-50	20,47
40-60	12,40	12,47	21,75	12,50	50-70	2,02
60-80	4,37	2,04	2,16	11,83	70-100	1,85
80-100	3,25	7,40	6,73	6,39	100-130	4,24
100-120	5,71	2,04	3,97	5,27	130-160	0,86
120-140	4,71	4,44	3,24	9,58	160-190	0,43
140-160	3,59	7,65	5,35	2,08	190-215	0,65
160-180	6,96	2,04	6,65	1,86	215-240	0,13
180-200	4,76	7,15	2,29	2,63	240-290	2,16
200-225	6,83	5,31	2,21	9,93	290-350	0,43
225-250	10,50	7,22	2,21	7,60	350-400	0,26
250-275	8,51	6,78	1,66	13,90	400-450	0,26
275-300	8,12	10,67	1,17	5,78	450-500	0,56
300-350	5,79	5,49	7,34	4,06	500-550	1,47
350-400	8,10	2,09	6,64	5,78	550-600	2,07
400-450	8,90	2,17	8,46	9,24		
450-500	7,30	1,94	9,24	22,36		
500-550	6,74	2,47				
550-600	5,84	3,42				

IMPORTANCE OF *OROBANCHE* SPECIES IN AGRICULTURAL CROPS IN SLOVAKIA

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Summary

In 2000-2001, regular surveys of agricultural plants, supposed as potential hosts of *Orobanche* spp., were done in Slovakia. *Orobanche cumana* Wallr. was not found at 26 sunflower fields checked for its occurrence. Together 8 tobacco fields and 6 tomato fields were checked for *Orobanche ramosa* L.. From those, four tobacco fields (at localities Bešeňov - 48°03´N 18°16´E, Dolný Ohaj - 48°04´N 18°15´E, Veľké Lovce - 48°02´N 18°21´E and Demandice - 48°08´N 18°47´E) and one tomato field (at locality Branovo - 48°02´N 18°18´E) were attacked by *O. ramosa*. The survey shows that *O. cumana* it not real agronomic problem in Slovakia and *O. ramosa* is very important parasitic weed.

Key words: *Orobanche cumana*, *Orobanche ramosa*, distribution, Slovakia

Introduction

Jehlík et al. (1998) mentioned three *Orobanche* species as invasive in Czech and Slovak Republic. They were *Orobanche cumana* Wallr., *Orobanche minor* Smith in Smith and *Orobanche ramosa* L.. Few localities were mentioned in the case of *O. cumana* and *O. minor* in Slovakia. On the other hand high number of *O. ramosa* localities were mentioned in the book. Chemical control was recommended for the control of *O. ramosa* in Slovakia (Danko, 1991, 1993).
The aim of this paper was to identify how important are parasitic weeds in the agriculture of Slovakia. The information will be used in the study of potential biocontrol agents.

Material and methods

In 2000, regular surveys of agricultural plants, supposed as potential hosts of *Orobanche* spp., were done in Slovakia. Together 26 sunflower fields (the districts are mentioned in results and discussion), 8 tobacco fields and 6 tomato fields were checked for *Orobanche ramosa* (for identification of localities please see table 1).
Tobacco & tomato plantations were regularly checked every week for *O. ramosa* occurrence from the beginning of June until the middle of October. Sunflower fields were checked three times – in the middle of July, middle of August and in the middle of September.

Table 1 Localities checked for the occurrence of *Orobanche ramosa*. in Slovakia during 2000.

Locality	Coordinates	Crop
Bešeňov	48°03´N 18°16´E	Tobacco +
Dolný Ohaj	48°04´N 18°15´E	Tobacco +
Veľké Lovce	48°02´N 18°21´E	Tobacco +
Demandice	48°08´N 18°47´E	Tobacco +
Malé Vozokany	48°18´N 18°26´E	Tobacco -
Kamenica nad Hronom	47°49´N 18°44´E	Tobacco -
Gbelce	47°50´N 18°31´E	Tobacco -
Bíňa	47°54´N 18°38´E	Tobacco -
Branovo	48°02´N 18°18´E	Tomato +
Štúrovo	47°48 N 18°43´E	Tomato -
Dvory nad Žitavou	48°00 N 18°16´E	Tomato -
Imeľ	47°54´N 18°09´E	Tomato -
Svätý Peter	47°49´N 18°16´E	Tomato -
Vráble	48°12´N 18°19´E	Tomato -

+ *Orobanche ramosa* was found; - *Orobanche ramosa* was not found

Results and discussion

Orobanche cumana was not found at 26 sunflower fields checked for its occurrence. Sunflower field were checked in the districts of Komárno, Nové Zámky, Nitra, Topoľčany, Levice, Veľký Krtíš, Lučenec, Rimavská Sobota, Košice and Trebišov. Special attention was paid at the localities, where this species was already mentioned before (Jehlík et al., 1998). They were localities Búč and Iža (saline Bokroš) in western Slovakia, and localities Čierna nad Tisou, Veľké Trakany, Malé Trakany and Somotor in eastern Slovakia. It seems that *O. cumana* does not exist at this time in Slovakia. And more, climatic conditions seem to be more important for the distribution of the weed than host plant variety. According to Jehlík et al. (1998), *O. cumana* was found only in a very warm areas of Slovakia (average yearly temperature of 10°C). But, sunflower is grown at relatively cold localities with average yearly temperature less than 9°C.
From 8 tobacco plantations, 4 were attacked by *Orobanche ramosa* L. They were locality Bešeňov, Dolný Ohaj, Veľké Lovce and Demandice (Table 1). *Orobanche* plants were found from June 15 at all four localities. Very high number of *O. ramosa* was found especially at the localities Demandice and Veľké Lovce. At these localities the number of *O. ramosa* plants achieved 2.4 per one attacked tobacco plant in average. From six tomato plantations were checked for *O. ramosa*, one was attacked by *O. ramosa* (Branovo). The first *O. ramosa* plants were found on June 22. The number of *O. ramosa* plants achieved only 0.2 per one tomato plants at the area of *O. ramosa* distribution.
During the study, only tobacco and tomato were the host plants of *O. ramosa* in Slovakia. Similarly, the spread of *O. ramosa* was studied in numerous horticultural crops and tobacco in Italy (Zonno et al. 2000). In France, *O. ramosa* was found as an

important weed in rape (Collin, 1999). In Slovakia, rape is a very important and widespread crop and, in spite of this, there is no information about the interaction of rape – *O. ramosa*. It is difficult to say if the reason is different *O. ramosa* strains, or resistant varieties of rape. Ranking tomato cultivars for *Orobanche* resistance indicated the existence of different resistance mechanisms in these cultivars (Qasem, Kasrawi 1995).

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SPREAD OF DODDER (*CUSCUTA* SPP.) IN THE AGROECOSYSTEMS OF SLOVAKIA: IS IT AN EMERGING PROBLEM?

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Summary

During 2000, field surveys of dodder (*Cuscuta* spp.) occurred at cropland were done in Slovakia. From among 150 localities surveyed, 96 have been found infested by dodder. The existence of four dodder species was revealed: *Cuscuta campestris* Yuncker, infested vegetable crops (potato, sugar beet, alfalfa and tobacco) and variety of weeds (together 18 species, especially *Polygonum* spp.), *C. epithymum* (L.) Murr., parasited exclusively on alfalfa and accidentally on weeds growing in this crop, *C. europaea* L. and *C. lupuliformis* Krocker occurred only at field margins, along rivers and roads, where *Urtica dioica* L. and *Rubus* spp. served as hosts. Dodders were distributed throughout south of Slovakia, with maximum occurrence in the western part of state. *C. campestris* was not found in cold climatic regions with altitude higher than 240 m, while *C. epithymum* was recorded up to 398 m and *C. europaea* up to 720 m a. s. l.

Key words: *Cuscuta campestris*, *Cuscuta epithymum*, *Cuscutaceae,* dodder, host plants, distribution

Introduction

Dodders (*Cuscuta* spp.; Cuscutaceae) are annual stem parasites with leafless, thread-like, orange or yellow stems that twine over other plants. They can be problematic in agricultural crops, especially alfalfa, tomatoes, potato and sugar beet. In addition, dodder seed is difficult to exclude from commercial alfalfa, clover, or flax seed (Parker & Riches 1993).
Cuscuta spp. are distributed worldwide (Holm et al. 1979) and have very low host specificity attacking many different host plants simultaneously. Although dicots are preferred, attack on monocots has been observed also. (Erdös 1971, Nikitin 1983).
There is five species from Cuscutaceae known in Slovakia. *Cuscuta epithymum* L., *C. epilinum* Weihe, *C. europaea* L. and *C. lupuliformis* Krocker are native (Dostál & Červenka 1992). Only invaded species is *C. campestris* Yuncker, which was introduced from North America to Europe in 1883 (Jehlík 1998).
Biological control is a particularly attractive means of suppressing dodders in crop because, owing to their intimate relationship with the host plant, it is difficult to apply chemical herbicides in such a way the crop is not adversely affected (CAB, 1987). Hence, it is surprising that little effort has been made to achieve biological control of these weeds worldwide. This study is the first step to biological control of dodders in Slovakia. The aim of this work was to determine the infestation and its extension, the dodder species composition as well as their host range.

Material and methods

During the growing season 2000 the occurrence of *Cuscuta* spp. was observed in the agroecosystems of Slovakia following the natural phenology of dodders. 150 localities were chosen in different geographic and climatic regions. Collections were made depending on the amount of variation in the geography and land use. Collecting sites were grassy or weedy roadsides, fallow fields and *Cuscuta spp.* – infested cropland planted with various crops. At each locality plants were identified. Identification was based on the flower structure.

Results

Altogether 4 species of dodders were found on 96 different localities in agroecosystems of Slovakia. The complete list of localities visited their associated dodder species and plant species infested is given in Table 1.

Table 1 Host plants and distribution of dodders (*Cuscuta* spp.) recorded in agroecosystens of Slovakia during growing season 2000.

Locality	Coordinates	Altitude (m)	Host plant
Cuscuta campestris **Yuncker**			
Balog nad Ipľom	48°05'N 19°08'E	145	*Polygonum* spp.
Cabaj Čápor	48°15'N 18°02'E	165	*Polygonum* spp.
Čermany	48°28'N 18°02'E	190	*Polygonum* spp.
Demandice	48°08'N 18°47'E	143	*Nicotiana tabacum* L.
Egreš	48°37'N 21°37'E	153	*Convolvulus arvensis* L., *Sonchus* spp., *Elytrigia repens* (L.) Dev., *Daucus* spp.
Gemerský Jablonec	48°12'N 19°59'E	240	*Polygonum* spp.
Chanava	48°20'N 20°18'E	176	*Polygonum* spp.
Choča	48°22'N 18°20'E	180	*Polygonum* spp.
Iža	47°45'N 18°14'E	109	*Polygonum* spp., *Atriplex tatarica* L.
Jablonica	48°36'N 17°25'E	211	*Polygonum* spp.
Jahodná	48°03'N 17°42'E	110	*Polygonum* spp., *Datura stramonium* L.
Kálna nad Hronom	48°12'N 18°32'E	162	*Polygonum* spp.
Kamenín	47°53'N 18°39'E	127	*Medicago sativa* L., *Artemisia vulgaris* L., *Ambrosia artemisiifolia* L., *Capsela bursa-pastoris* (L.) Med., *Polygonum* spp., *Atriplex* spp.
Komárno - Lándor	47°48'N 18°08'E	109	*Polygonum* spp.
Krakovany	48°37'N 17°46'E	165	*Sonchus* spp., *C. arvensis*, *Polygonum* spp., *Tripleurospermum* spp.
Malé Ludince	47°59'N 18°42'E	136	*Urtica dioica* L., *Sonchus* spp., *C. arvensis*, *Pastinaca sativa* L.
Malé Kosihy	47°55'N 18°45'E	115	*Polygonum* spp., *Atriplex* spp.
Malé Kozmálovce	48°17'N 18°31'E	175	*Sonchus* spp., *Polygonum* spp., *M. sativa*
Maňa	48°09'N 18°17'E	131	*Polygonum* spp.
Michalovce	48°45'N 21°56'E	115	*Polygonum* spp.
Mužľa	47°48'N 18°36'E	121	*M. sativa, Polygonum* spp.
Neded	48°01'N 17°59'E	112	*Polygonum* spp.
Nevidzany	48°17'N 18°23'E	181	*Tripleurospermum* spp., *Polygonum* spp.
Poľný Kesov	48°10'N 18°04'E	172	*Polygonum* spp., *Sonchus* sp.
Olichov	48°21'N 18°29'E	209	*Polygonum* spp.
Selice	48°05'N 17°59'E	113	*D. stramonium*, *Polygonum* spp.
Sikenica	48°07'N 18°46'E	150	*M. sativa, Polygonum* spp.
Sládkovičovo	48°12'N 17°39'E	120	*Polygonum* spp.
Strážske	48°52'N 21°50'E	135	*Polygonum* spp., *Sonchus* spp.
Šamorín	48°02'N 17°19'E	130	*Polygonum* spp., *A. artemisiifolia*
Štefanovičová	48°11'N 18°06'E	160	*Polygonum* spp., *Chenopodium* spp., *Atriplex* spp.
Tehla	48°11'N 18°23'E	180	*Polygonum* spp.
Tesárske Mlyňany	48°20'N 18°22'E	165	*Polygonum* spp.
Trhová Hradská	47°59'N 17°45'E	112	*C. arvensis*, *Polygonum* spp.
Trstice	48°01'N 17°49'E	114	*M. sativa*, *Polygonum* spp., *Tripleurospermum* spp.
Turňa nad Bodvou	48°36'N 20°53'E	190	*Polygonum* spp., *Atriplex* spp.
Urmince	48°32'N 18°06'E	199	*Polygonum* spp.
Veľké Trakany	48°23'N 22°06'E	103	*Daucus* spp., *Polygonum* spp., A. vulgaris

Veľký Ďur	48°12'N 18°27'E	185	*Polygonum* spp., *A. vulgaris*
Veľký Kamenec	48°22'N 21°49'E	124	*Polygonum* spp., *Chenopodium* spp.
Vlkas	48°07'N 18°17'E	130	*Polygonum* spp.
Volkovce	48°20'N 18°28'E	210	*Polygonum* spp.
Zbehy	48°22'N 18°02'E	144	*Polygonum* spp.
Zeleneč	48°20'N 17°36'E	146	*Malva* spp., *Atriplex* spp., *Tripleurospermum* spp., *Polygonum* spp.
Zlaté Moravce	48°23'N 18°24'E	196	*Polygonum* spp.
Želiezovce	48°03'N 18°40'E	137	*Solanum tuberosum* L., *S. nigrum* L., *Amaranthus* spp., *Chenopodium* spp., *Polygonum* spp.
Žitavce	48°12'N 18°18'E	141	*Tripleurospermum* spp., *Polygonum* spp., *Beta vulgaris* L., *C. arvensis*
***Cuscuta epithymum* L.**			
Čajkov	48°17'N 18°36'E	188	*Medicago sativa* L.
Čečejovce	48°36'N 21°04'E	205	*M. sativa*
Červený Hrádok	48°18'N 18°23'E	170	*M. sativa*
Dedina Mládeže	47°56'N 18°00'E	109	*M. sativa*
Dolná Strehová	48°15'N 19°30'E	182	*M. sativa*
Gemerský Jablonec	48°12'N 19°59'E	240	*M. sativa*, *Plantago lanceolata* L.
Hoste	48°16'N 17°38'E	126	*M. sativa*
Imeľ	47°54'N 18°09'E	111	*M. sativa*
Ipeľský Sokolec	48°01'N 18°49'E	116	*M. sativa*, *Chenopodium* spp.
Ivánka pri Nitre	48°14'N 18°07'E	146	*M. sativa*
Jatov	48°10'N 18°06'E	116	*M. sativa* L., *Cirsium arvensis* L.
Jur nad Hronom	48°08'N 18°39'E	146	*M. sativa*, *Plantago* spp.
Kostolné	48°44'N 17°42'E	219	*Medicago sativa* L.
Kubáňovo	48°04'N 18°49'E	127	*M. sativa*, Poaceae
Medzibrod	48°48'N 19°21'E	398	*M. sativa*
Melek	48°12'N 18°20'E	170	*M. sativa*, *Persicaria* spp.
Mochovce	48°16'N 18°27'E	270	*M. sativa*
Myjava	48°45'N 17°34'E	325	*M. sativa*
Nemčiňany	48°18'N 18°28'E	212	*M. sativa*, *Echinochloa crus galli* L.
Nová Ves n/Žit.	48°17'N 18°20'E	164	*M. sativa*
Pastovce	47°58'N 18°46'E	124	*M. sativa*, *Lamium purpureum* L.
Rankovce	48°48'N 21°28'E	364	*M sativa*
Sikenica	48°07'N 18°46'E	150	*M. sativa*, *Daucus carota*
Slepčany	48°19'N 18°20'E	160	*M. sativa*
Šaľa	48°09'N 17°53'E	118	*M. sativa*
Tekovské Nemce	48°22'N 18°32'E	244	*M. sativa, Trifolium pratense*
Veľké Bielice	48°38'N 18°21'E	200	*M. sativa*
Višňové	48°43'N 17°45'E	220	*M. sativa*
***Cuscuta europaea* L.**			
Bíňovce	48°30'N 17°29'E	198	*Urtica dioica* L.
Čamovce	48°15'N 19°53'E	213	*U. dioica*
Drieňov	48°52'N 21°16'E	226	*U. dioica*, *Calystegia sepium* (L.) R. Br.
Dubovec	48°17'N 20°10'E	182	*Rubus* spp., *U. dioica*, *Robinia pseudoacacia* L.
Egreš	48°37'N 21°37'E	153	*U. dioica*
Horná Baba	48°14'N 19°45'E	210	*U. dioica*
Horné Lefantovce	48°25'N 18°09'E	160	*Rubus* spp., *U. dioica*
Horné Vestenice	48°43'N 18°26'E	260	*U. dioica*, *Rubus* spp.
Hostie	48°27'N 18°27'E	290	*U. dioica*, *Rubus* spp.
Koplotovce	48°28'N 17°49'E	165	*Clematis* spp., *Rubus* spp.
Machulince	48°25'N 18°26'E	250	*Rubus* spp.
Malá Lehota	48°30'N 18°34'E	600	*Rubus* spp.
Maňa	48°09'N 18°17'E	131	*U. dioica*
Nevidzany	48°17'N 18°23'E	181	*U. dioica*
Nová Ves n/Žit.	48°17'N 18°20'E	164	*Rubus* spp., *U. dioica*
Obyce	48°26'N 18°27'E	250	*Rubus* spp., *U. dioica*
Pohorelá	48°40'N 20°01'E	720	*Rubus* spp.
Slaská	48°40'N 18°50'E	430	*U. dioica*, *Rubus* spp., *C. sepium*

Spišské Podhradie	49°01'N 20°45'E	450	*U. dioica*
Veľké Pole	48°33'N 18°34'E	580	*Rubus* spp.
Veľké Chyndice	48°17'N 18°18'E	190	*U. dioica*
Závada	48°18'N 19°29'E	230	*Rubus* spp.
Zlatno	48°28'N 18°20'E	340	*U. dioica*, *Rubus* spp.,
***Cuscuta lupuliformis* Krocker**			
Čoltovo	48°30'N 20°23'E	227	*Rubus* spp.

Discussion

While five dodder species, *C. campestris, C. epilinum, C. epithymum, C. europaea* and *C. lupuliformis* are known in Slovakia (Dostál & Červenka, 1992), four of them were recorded during the surveys at agroecosystems in the growing season 2000. The missing species was *C. epilinum*, whose host plant is flax (*Linum usitatissimum* L.). The main reason of its absence is probably decrease of flax growing and the new technology used.

Of the four dodder species recorded at Slovakian cropland only *C. campestris* and *C. epithymum* were found regularly throughout south of Slovakia. *C. campestris* never exceeded 240 m a. s. l. and was found exclusively at the warmest localities of Slovakia, with maximum occurrence in the western part of state. Although distribution of *C. epithymum* was mentioned up to 980 m a. s. l. in Slovakia (Bertová et al. 1988), the maximum altitude recorded during this study was 398 m a. s. l.

From the literature it is known that 85 various crop plants and weeds serve as hosts for *C. campestris* (Erdös 1971). Our findings show crops parasitized by this species included potato (*Solanum tuberosum* L.), sugar beet (*Beta vulgaris* L.), alfalfa (*Medicago sativa* L.) and tobacco (*Nicotiana tabacum* L.). In addition, next 18 plants were found as hosts for *C. campestris*. Within these hosts, *Polygonum* spp. was the most common one occurring on 44 out of 47 localities observed. Similarly Jehlík et al. (1998) cited *Polygonum arenastrum*, *Artemisia vulgaris* and *Atriplex tatarica* like dominant hosts of *C. campestris* in Slovakia. Though in Hungary, *C. epithymum* was registered to grow on 91 host plants from different families (Erdös 1971), it was parasited explicitly on alfalfa and accidentally on weeds (such *as Plantago* spp., *Chenopodium* spp. and *C. arvense*) growing in this crop at Slovakian agroecosystems.

C. europaea L. and *C. lupuliformis* Krocker occurred only at field margins, along rivers and roads, where *Urtica dioica* L. and *Rubus* spp. served as hosts. *C. europaea* was also mentioned to parasite on *Salix* and *Alnus* (Dostál & Červenka 1992). We did not find the infestation of shrubs and trees by the species in Slovakia, with the exception of *Robinia pseudoacacia* infested at locality Dubovec. *C. lupuliformis* was found only at one locality (Čoltovo). This confirms, as stated equally Bertová et al. (1988), the species turn to be more rare in Slovakia because of luck of suitable localities.

Only problematic species are *C. campestris* and *C. epithymum* in the agroecosystems of Slovakia. While, *C. epithymum* is already infesting huge amount of alfalfa fields throughout the state, hitherto *C. campestris* is damaging crops at the warmest localities exclusively. On the other hand, there is a big potential of *C. campestris* to spread into agricultural crops. The reasons for such spread are different. Above all: 1) the great distribution of the main host plant (*Polygonum* spp.) throughout Slovakia and very low host specificity, 2) limited natural enemies of *C. campestris* expected (because it is invasive plants) in order to suppress population density and 3) expected warming, which can make the species more aggressive.

There are many options available to help decrease the crop infestations by dodders such as hand cultivation, spot or field burning, close mowing, later planting time, and crop rotation to cereals or corn (Dawson et al. 1994). Nevertheless, especially *C. epithymum* in alfalfa fields is still remaining a big problem in the south of Slovakia. Here, biological control is a particularly attractive means of suppressing dodders. In this way a search for biological control agents therefore seems to be warranted.

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PHOTOSYNTHETIC RESPONSES OF BARLEY TO HARMFUL ENVIRONMENT AND EFFICIENCY OF LIGHT CONVERSION

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Summary

In this study we demonstrate how photoadaptation affects the photosynthesis. The strong light during the mid-day depression of photosynthesis caused photoinhibition, measured as a decrease in the ratio of variable to maximum fluorescence. The loss of photosystem II (PSII) electron transfer activity correlated with the decrease in the fluorescence ratio. The constant rate of photoinhibition was directly proportional to photon flux density in all studied light intensities. We discuss the mechanisms of maintenance of high photosynthetic performance.

Key words: photosynthesis, photoinhibition, photochemical PSII efficiency, barley

Introduction

Under natural conditions, photosynthesis is regulated biochemically to maintain a balance between the rates of its component processes and the concentration of metabolites while environment changes (Singsaas et al. 2000). Plants respond to sudden and sustained fluctuations in light quality and quantity, temperature, water and nutrient supply, partly via their chloroplast molecular redox signalling transduction mechanisms that initiate and network to induce marked modulations of chloroplast components, ultimately leading to acclimation of the photosynthetic apparatus allowing plants to coordinate the allocation of resources not only to achieve and maintain optimal rates of photosynthesis, but also and as importantly to function effectively under limiting and excessive light (Anderson et al. 1997; Basu et al 1998). Regulatory mechanisms can respond either to environmental stimuli (exogenous factors) or to biochemical limitations of the mesophyll cells (endogenous factors). Plants must maintain an effective balance between energy supply and energy consumption. Solar energy is trapped by photosystem II (PSII) and photosystem I (PSI) and transformed to chemical energy through photosynthetic electron transport and carbon assimilation which make ATP and carbon skeletons for all other major metabolic processes. Coordinated interactions between light-harvesting, energy conversion, electron transport, proton translocation and carbon fixation are inextricably linked in photosynthesis. Thus, chloroplasts not only are energy transducers for life, but also are primary redox sensors of environmental change that act together with other signal transduction pathways to elicit appropriate physiological and molecular responses (Asada et al. 1998; Matoo et al. 1999).
The objectives of this study is a better understanding the plant tolerance and protective mechanisms in natural environmental conditions via studying the photosynthesis and growth responses of spring barley with different acclimation to light conditions.

Material and methods

The barley plants (cv. Kompakt, Slovakia) were cultivated naturally in 18 kg plastic pots with soil substrate (40 plants per one pot), watered regularly and manured according to growth demands. As soon as the first leaf had emerged the plants were placed under the shields and cultivated for the rest of vegetation period to be acclimated for different light regimes, as follows:
A - control - diurnal incident photosynthetically active radiation (PAR, maximal PPFD level of 1500 $\mu mol.m^{-2}.s^{-1}$)
B - shaded plants - 25 % PAR of the control (PPFD 300-350 $\mu mol.m^{-2}.s^{-1}$)
The diurnal fluctuations of climatic factors were monitored by automatic micro-meteorological station Datalogger LI-1400 (LiCor, Lincoln, Nebraska, USA) with compatible sensors for photosynthetically active radiation (PAR, LI-190SA), global radiation (GR, LI-200SA), air temperature and relative humidity (1400-104) and soil temperature (1400-103) measurements. The leaf and soil water status were measured by HR-33T microvoltmeter and sample chambers C-52 (Wescor, Logan, Utah, USA). During the measuring shaded plants were exposed to diurnal incident radiation and the following photosynthetic characteristics were measured, such as: net CO_2 assimilation rate (A_{CO2}, LI-6200, LiCor, Lincoln, Nebraska, USA) and chlorophyll fluorescence parameters (MINI-PAM, 2030-B leaf clip holder; Waltz, Germany).

Results and discussion

Analysis of primary production processes is of paramount importance to plant cultivation. Primary production ultimately depends on the process of photosynthesis which is a light dependent process. When plants are transferred from a low light intensity to a high light intensity or when radiation is fluctuating, the chloroplasts acclimate to the new light regime (Osmond et al. 1995; Anderson et al. 1997). The different light regimes used in our experiments induced the integral changes of whole plants including leaf and chloroplasts architecture. The leaf photosynthetic activity (A_{CO2}) of shaded variants was significantly lower in comparison to control plants (17,2 and 4,2 μmol.m^{-2}.s^{-1}, respectively). Exposure to excessive light lead to the photoinhibition of photosynthesis. This phenomenon may resulted from decreased electron transport rate and carbon assimilation (photoinhibitory damage) and/or increases in fluorescence and thermal excitation (photoprotection).

A negative relationship was found between PPFD and Fv/Fm. Extrapolation of the Fv/Fm ratio to 0,8, a value typical for uninhibited plants, indicated empiricaly that plants started to lose PSII function (Oquist et al. 1992; Yin et al. 2000). The 60-min exposure to different light treatment led to decrease in the activity of PSII reaction centre and of maximal photochemical PSII efficiency (Fig. 1). Non-acclimated plants to high light achieved a saturation rate of relative electron transport (ETR) under lower light intensities in relation to sun plants. The determination of Fv/Fm during 1-, 5-, 15- and 30-minute PSII relaxation (Fig. 2) in the dark was associated with mechanisms of dynamic and chronic photoinhibition. The 1-minute dark relaxation of non-acclimated plants after exposure to diurnal incident light leads to fast but not sufficient restoration of RC PSII. The Fv/Fm reached the value of 0,6 which represents 33 % decline in comparison to optimal Fv/Fm. On the other hand, the Fv/Fm decrease in acclimated plants does not practically exceed 10 %.

Photosynthetic apparatus of spring barley is sensitive to diurnal fluctuations of environmental factors, mainly of light which induce moderate stresses in the plants. Their short-term effects expressed in terms of relative air humidity, air and soil temperature was not significant in relation to the parameters of chlorophyll fluorescence under such conditions. Moreover, we demonstrate the activity changes of PSII and consider it as a good indicator of a high light signal. Plant photoprotection and maintenance of high photosynthetic performance are the functions of plant acclimation capacity.

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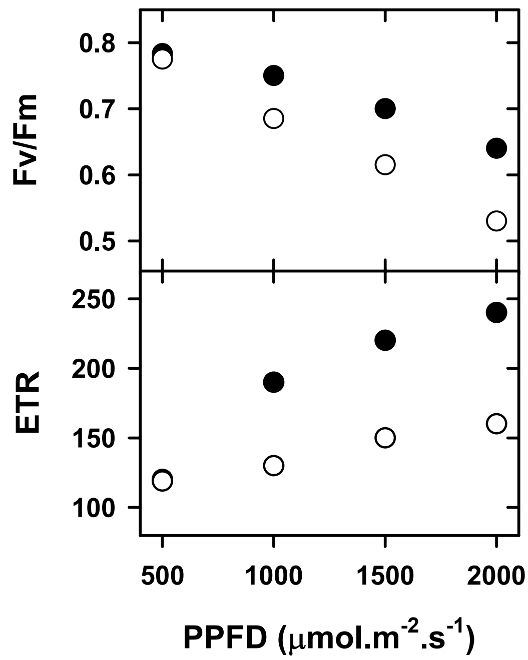

Figure 1: Maximal photochemical PSII efficiency (Fv/Fm) and relative electron transport rate as a function of irradiation. Full symbols – sun plants, empty symbols – shade plants.

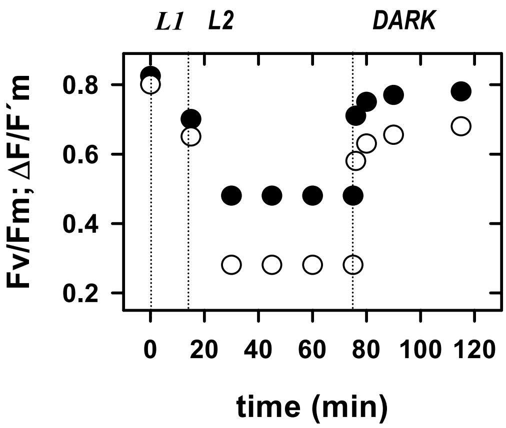

Figure 2: Course of actual photochemical PSII efficiency (ΔF/F´m) during the photoadaptation (50 μmol.m^{-2}.s^{-1}; L1) and photoinhibitory treatment (1000 μmol.m^{-2}.s^{-1}; L2), maximal photochemical PSII efficiency (Fv/Fm) during the dark period.
Full symbols – sun plants, empty symbols – shade plants.

VARIABILITY OF CHLOROPHYLL CONTENT UNDER FLUCTUATING ENVIRONMENT

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Summary

A leaf chlorophyll concentration is strongly affected by numerous external factors. Therefore, their quantitative determination, in different investigation objects, is specially recommended. In present work we demonstrated effect of different light intensity regimes and water supply on the chlorophyll content development. This work did not confirm fully the available informations about the chlorophyll content dynamics and chlorophyll *a/b* ratio decrease in shaded plants. In field of water stress, our results, except to chlorophyll *a/b* ratio, are consistant with many authors.

***Keywords*:** chlorophyll content, chlorophyll *a/b* ratio, light regimes, drought, barley

Introduction

Chlorophylls of different form play an important role as a part of photosynthetic apparatus of all phototrophic organisms. Higher plants contain chlorophyll a (the major, yellow-green pigment), chlorophyll b (blue-green), accessory pigments and several additional forms of chlorophyll. Both chlorophyll a and b pigments are associated with light harvesting processes at the antenna. Moreover, chlorophyll a takes a part in the electric charge separation (Procházka *et al.,* 1998). Numerous authors demonstrate a rapid chlorophyll content response to internal as well as external factors. Here are several examples of the ambient ones.
It is known for a longer time that shaded plants exhibit a higher chlorophyll pigments content per dry mass weight unit but a lower chlorophyll a/b ratio (about 2,5 - 2,9), whereas sun plants ca 3,2 - 4 (Lichtenthaler, 1987). On the other hand, excessive light intensity has a destructive effect on photosynthetic pigments leading to inhibition of photosynthesis. Haspelová (1981) discusses importance of sufficient water supply of maturing leaves to form and develop new leaves and allocate the chlorophylls. Furthermore, it was concluded that the chlorophyll content changes correlate with water stress intensity. Recent works with subtropic trees demonstrate the chlorophyll content dynamics within dry and wet seasons (Montagu, Woo, 1999). During dry period, decreases in phyllode chlorophyll (at the end of dry season it was about 73%) were accompanied by a decrease in stomatal conductance. Four weeks after the water stress was acting, photosynthetic rate recovered to 70 - 95% what corresponded also with chlorophyll content restoration. Ramalho, Lauriano, Nunes (2000) add information on lower values of chlorophyll a/b ratio at the end of summer (2,6) than obtained in the spring (3,6). Relationship between plant nutrition and chlorophyll content values is very complicated and strongly modified by other internal and external conditions. The N- and chlorophyll concentration dynamics are studied very detail. Dhir *et al.* (1999) show the impact of air pollutants from a thermal power station on chlorophyll content. Also soybean *(Glycine max* Merrill*.)* and maize *(Zea mays* L*.)* plants exposed to herbicide diquat led to chlorophyll destruction (Milivojevic, Nikolic, 1998). Nowadays, the quantitative determination of chlorophyll in different experimental plant material and investigation objects is specially recommended as a valuable characteristic of light harvesting capacity under stress. In the present work we verify the effect of different light intensity regimes and water supply on chlorophyll content development in juvenile to mature barley *(Hordeum vulgare* L*.)* plants.

Materials and methods

Plants of spring barley *(Hordeum vulgare* L*.)* cv. Kompakt (Slovakia) were grown under external conditions in 10-litre pots with soil substrate. Elementary fertilization and water supply were applied. Since the first leaf emergency, the plants were treated by different growth light intensity regimes - sunny regime and shading regime (25% of natural PAR values). First two measurable leaves were cut and the chlorophyll concentration (Lichtenthaler, 1987) was determined. The examination of sunny plants continued to the end of vegetation (once a week). The irrigation was interrupted in the DC 45 - 49 stage of development.

The chlorophyll content determination

Firstly, we cut ten leaf tissue segments and ground with a mortar and pestle in a presence of a little sea sand, 0,2 - 0,5 g $MgSO_4$ and ca 0,5 ml 100% acetone (Šesták, Čatský 1966). We added 2 -5 ml of 80% acetone to the fine powder and decanted the homogenate into centrifugation tube through 2 x 5 ml 80% acetone (Cholvadová, Erdelský, Masarovičová, 1999). Centrifugation at 2500 rpm for 2 min separated solid compound elements. Measured absorption values was used for chlorophyll content calculation according to Lichtenthaler (1987):

chl. *a* (mg.l^{-1}) = $(12{,}25 \cdot A_{663} - 2{,}79 \cdot A_{647}) \cdot D$
chl. *b* (mg.l^{-1}) = $(21{,}5 \cdot A_{647} - 5{,}1 \cdot A_{663}) \cdot D$
chl. *a+b* (mg.l^{-1}) = $(7{,}15 \cdot A_{663} + 18{,}71 \cdot A_{647}) \cdot D$,
where: A is absorption at given wavelengths, D - thickness of the used cuvette (cm).

Expression of results in leaf area units:

PC (mg.m^{-2}) = (V/1000*1/A)*PC (mg.l^{-1}),

where: PC is the pigment concentration, V - 80% acetone volume used, A - leaf tissue segments area (m^2).
To get a higher accuracy, adjustment of sample absorbancy values (-A_{750}) is needed (Cholvadová, Erdelský, Masarovičová, 1999).

In comparison with widely used expression method (Šesták, Čatský 1966, Arnon, 1949) we did not achieve any significant differences, but the used procedure is less pretentious and more exact results are obtained due to more exact equations (Figure 1).

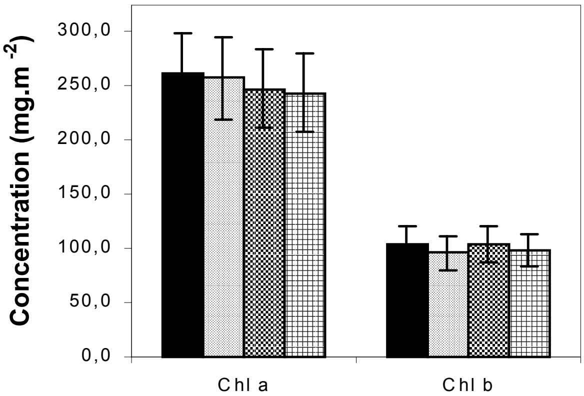

Figure 1: Comparison of chlorophyll content by two methods in maize example (Arnon, Arnon – adjusted, Lichtenthaler, Lichtenthaler – adjusted)

Results and discussion

Shaded leaves exhibit a lower chlorophyll content. As we suppose, this disproportion with many authors (Lichtenthaler, 1987, Larcher, 1988, Gilmore, 1997) could arise in relationship to pigment content expression units (mg.g^{-1} dry matter / mg.m^{-2} leaf area). As very interesting seems to be the chlorophyll a/b ratio in second shaded leaf which might be caused by different in physiological age of both sun and shade leaves. Generally, pigment ratio in sun leaves indicates no real sun effect (Lichtenthaler, 1987).

Table 1

Variant	Chlorophyll a content (mg.m^{-2})	Chlorophyll b content (mg.m^{-2})	Chlorophyll a/b ratio
Shade, 1st leaf	223,64	108,73	2,06
Shade, 2nd leaf	234,97	108,11	2,17
Sun, 1st leaf	396,55	192,64	2,06
Sun, 2nd leaf	343,49	180,2	1,91

1st leaf – onthogenetically older

Differences between individual leaves position in sun plants are in favour of the first leaf that may indicate an unfinished development of the second leaf, whereas in shade plants both leaves seem to be alreeady developed.

Leaf pigment content dynamics was strongly affected by stress (Figure 2). This result is consistant with Fernandéz-Conde (1998). Similar conclusions demonstrate Montagu, Woo (1999). Nilsen, Orcutt (1996) confirm the degradation effect of water stress on pigment content. Lower values of chlorophyll b content in the 6th leaf during first stages of their function were probably caused by cloudy and cold weather. Stress conditions had no effect on chlorophyll a/b ratio, what is in oposition to Ramalho, Lauriano, Nunes (2000).
We may conclude that fluctuating environment influenced chlorophyll content more than chlorophyll a/b ratio.

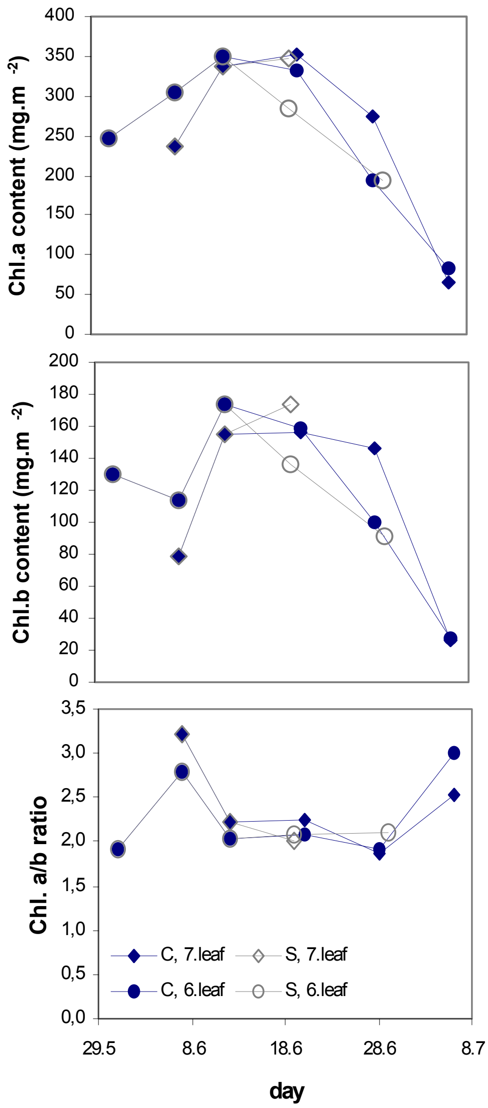

Figure 2: Development of leaf chlorophyll content and chlorophyll a/b ratio in stressed (S) and control (C) plants, 7th leaf – penultimate leaf.

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CHLOROPHYLL *A* FLUORESCENCE AS A BIOINDICATOR OF THE PLANT ENVIRONMENTAL STRESS

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Summary

In the work with barley plants acclimated to different light regimes we demonstrate that although light is an essential source of energy for photosynthesis but can also be harmful to plants. The presented data show potential of chlorophyll fluorescence measurements for analysis of photosynthetic performance and plant environmental stress under natural conditions.

Key words: barley, photosynthesis, chlorophyll *a* fluorescence, quenching analysis

Introduction

Plants are in natural environment exposed to various kinds of natural and anthropogenic stress factors (Lichtenthaler 1996). The quantification of plant stress status is a long-term study problem that affects many physiological processes. Exposure of green plants to strong light and frequently to other environmental stresses potentially results in photoinhibition of photosynthesis (Osmond 1994; Critchley 1998).

Measurement of chlorophyll *a* fluorescence has become a very useful technique for obtaining a rapid quantitative and qualitative information about photosynthesis, mainly in case when gas-exchange measurements reach their limits (compensation CO_2 point). Progress in understanding and practical use of chlorophyll fluorescence in area of plant eco-physiology was made by development of proper instruments (Schreiber *et al*. 1986) establishment of methodology and terminology . Chlorophyll fluorescence has been widely used for quantify a photochemical efficiency of PSII and electron transfer of many crops, woody shrubs and trees ant to assess physiological impairment of vegetables and fruits during storage (Earl and Tollenaar 1999; DeEll *et al*. 1999).

The objective of presented work is to give a look into the modification of light photosynthetic responses in natural conditions. We show a protocol of evaluation of photochemical and non-photochemical fluorescence quenching induced by stress factors, mainly strong irradiation.

Material and methods

Plant material

Barley plants (*Hordeum vulgare* L., cv. Kompakt) were cultivated naturally in artificially regulated micro-ecosystems in 20 kg pots with soil substrate and watered regularly. As soon as the first leaf had emerged the plants were placed under the shields and cultivated for the rest of vegetation period to be acclimated for two different light regimes, as follows: (i) sun adaptation regime - diurnal incident photon flux density (maximal PPFD level of 1500 µmol.m^{-2}.s^{-1}) and (ii) shade adaptation regime - 25% PPFD of the sun adaptation (maximal PPFD level of 300 µmol.m^{-2}.s^{-1}).

Chlorophyll a fluorescence measurement

Daily modulation of photochemical PSII efficiency were measured by *MiniPam* fluorometer (Walz, Effeltrich, Germany). An intact leaf was inserted into the leaf-clip holder (2030-HB; Walz, Effeltrich, Germany) and connected to fluorometer. Minimal fluorescence yield (Fo) was measured by modulated red light beam with low light intenzity (0,15µmol.m^{-2}.s^{-1}). Maximal fluorescence yield (Fm) was determinate by application of 800 ms saturation white light pulse of 7000µmol.m^{-2}.s^{-1} intensity. Both determined parameters were measured pre-dawnly (4.00am). Plants were then illuminated by natural daily light. The steady state value of chlorophyll *a* fluorescence (Fs) was thereafter recorded and the next saturating pulses were applied each hour to determine the maximal fluorescence yield (F´m) in the light adapted leaves (for detail see figure 1). The following calculations were made, such as: (i) maximal photochemical PSII

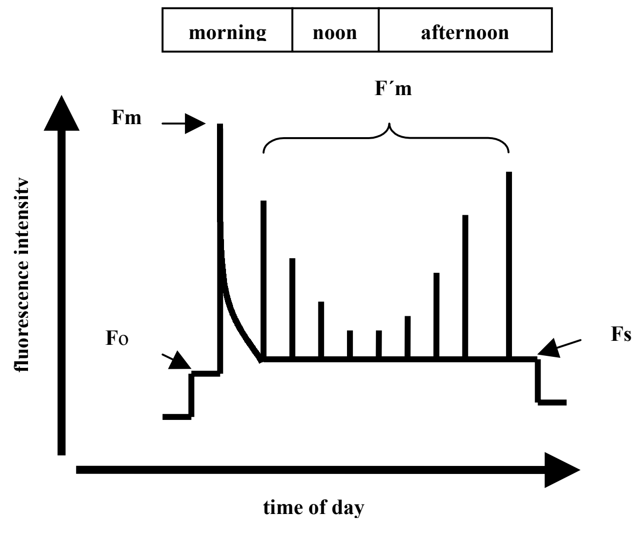

Figure 1: Sequence of the determination of various chlorophyll *a* fluorescence parameters in barley leaves in the course of the natural day using the MiniPam.

efficiency, Fv/Fm, after a 30-minute dark adaptation, where Fv=Fm-Fo; (ii) actual photochemical PSII efficiency, ΔF/F´m according to Genty *et al.* (1989); (iii) electron transport rate, ETR=ΔF/F´m*I_{ABS}*0,5, where I_{ABS}=PPFD*0,84 is the intensity of absorbed light energy by a leaf, 0,5 reflected that two photons must by absorbed by PSII and PSI *per* one transported electron and 0,84 represents an absorption coefficient of a leaves; (iv) photochemical, qP=(F´m-Fs)/(F´m-Fo) and (v) non-photochemical fluorescence quenching, NPQ=(Fm-F´m)/F´m.

The response of photosynthetic apparatus to increasing PPFD was measured using a light curve with 3-min interval of individual light intensities of PPFD (50-, 100-, 200-, 400-, 550-, 750-, 1000-, 1500- and 2000 µmol.$m^{-2}.s^{-1}$) which were generated by external halogen lamp (Walz, Effeltrich, Germany) connected to leaf-clip holder. All light curve measurements were made in laboratory conditions after previous dark leaf adaptation (30 min.).

Results and discussion

Plants are generally acclimated to different growing environments on morphological, physiological and molecular levels (Pearcy 1998). Photosynthetically active light quanta are absorbed by the light-harvesting complexes of both PSII and PSI photosystems. The interpretation of chlorophyll fluorescence changes used in account of plant environmental stress is greatly facilitate by the fact, that at room temperature fluorescence originates almost exclusively from PSII.

Light responses of barley leaves to increasing PPFD (known as a light curve) are used to quantify the limits of photosynthetic machinery, as well as quenching analysis which determines the efficiency of individual protective mechanisms realized in stress conditions (figure 2). Photochemical quenching (qP) refers to photosynthetic activity of electron transport from PSII and non-photochemical quenching (NPQ) refers to thermal dissipation of excitation energy from PSII (Krause and Weis 1991). Generally, NPQ is considered as a mechanism protecting photosynthetic machinery against the excessive light (Critchley 1999).

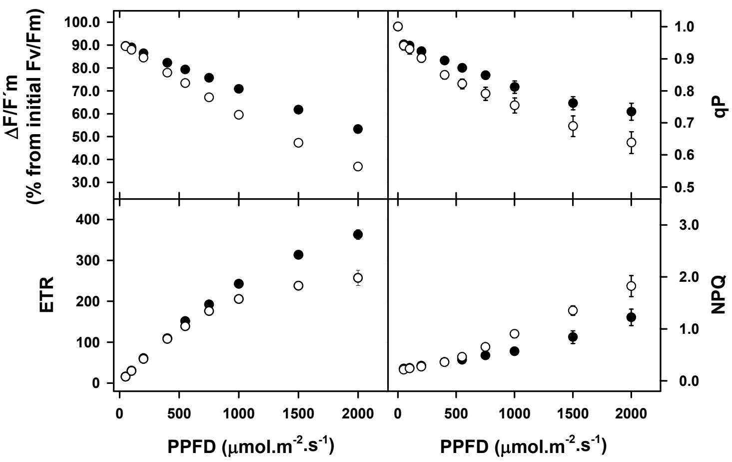

Figure 2: Response of actual photochemical PSII efficiency (ΔF/F´m), electron transport rate (ETR), photochemical (qP) and non-photochemical (NPQ) quenchings on increasing PPFD. Full symbols – sun plants, empty symbols – shade plants.

In conclusions, the presented results of chlorophyll *a* fluorescence yield detected by a fluorescence technique is very facile and grateful tool for measurement of plant stress state affected by harmful environmental circumstances. We recommend this technique for determination of plant environmental stress in the area of eco-physiology, ecology and breeding.

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ROLE OF METABOLIC EVENTS INDUCED BY WATER STRESS IN BARLEY (HORDEUM VULGARE L.)YIELD CONSERVATION

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Summary

This paper evaluates sensitiveness of selected physiological characteristics in screening barley genotypes for their tolerance to drought. the plants were cultivated in pots in natural climatic conditions up to the growth stage of anthesis and then exposed to slow dehydration to evoke metabolic changes resulting in leaf turgor and growth maintenance and finally in yield conservation. During slow plant dehydration the osmotic potential of mature leaves and free proline accumulation were measured and final yield components were analysed. The results give information related to the role of tissue osmotic adjustment in water conservation during period of drought that might be essential for higher yielding in tolerant compared to sensitive genotypes. The detailed analysis of ear structure is also presented and relationship between the physiological and production criteria is discussed which could be useful in screening biological material tolerant to drought.

Key words: drought tolerance, osmotic adjustment, free proline content, barley, productivity

Introduction

Grain yield of small-kernel cereals is a complex trait which is influenced by a range of physiological mechanisms and is characterized by low heritability especially in conditions of water stress. Efficiency of selection for this trait my be increased by indirect selection for morphophysiological traits related to yield which are highly heritable, positively associated with yield, and quickly and easily measured (Blum, Zhang, Nguyen 1999).
According to Gunasekera et al. (1994) wild genotypes of barley which had a greater response to water stress also had a greater osmotic adjustment capacity under water stress and came from areas with low water availability. The major yield benefits derived from tissue osmotic adjustment in different crop species under drought predominantly lie in the maintenance of proper water supply from sub-soil during reproductive phase of growth, cooler canopy and growth processes (Gonzales, Martin, Ayerbe 1999) those generally producing higher dry matter and seed yield.

As stated by Morgan (1992), carbon seems to be a significant component of effective osmotic adjustment which means that OA may be considered as a competitive sink for assimilates comparing to other sinks. Therefore, carbon allocation for osmotic adjustment is to a large extent a function of whole plant response to drought stress and the balance between carbon assimilation, allocation to and utilization by various sinks. On the other hand, OA which depends on accumulation of ions or specific metabolites (glycinbetaine, proline, etc.) might be relatively independent of whole plant growth interactions, thus a correlation of this characteristic with a higher yield could be found (Cantero-Martinez et al. 1995, Olšovská et al. 2000).
The objective of this work was to study adaptive responses of plants to drought by means of metabolic changes in cells leading to changes in ear structure and final plant productivity.

Material and methods

The three ecologically distant genotypes of barley (Hordeum vulgare L.), such as Kompakt (Slovakia), Dobla and Albacette (Spain) were cultivated in natural climatic conditions in 25 l plastic pots with loam soil substrate supplemented by mineral nutrients up to the level of 1:0,88:2,01 (N:P:K). The pots (40 plants per one pot) were placed to simulate a compact canopy. Additional pots eliminated the marginal effect of canopy. The plants were watered regularly to maintain the 70 % of total available water. At the end of anthesis the pots were hydrated to maximal level 100% and from this moment the plants were subjected to 9-day dehydration by withholding water.
During a long-term dehydration we measured water (Ψ_w) and osmotic (Ψ_S) potentials in MPa by psychrometer Wescor (Wescor, Logan, Utah, USA) and relative water content RWC (from fresh, saturated and dry mass weights) of the same leaves. After harvesting the main yield components as well as detailed characteristics of ears were analysed.

Results and discussion

Adaptation to drought appears to be a result of numerous anatomical, morphological, physiological, and biochemical characteristics, constituent or inducible, which interact in order to make possible the keeping of growing and development processes.
While plants loss their water gradually, a positive turgor is important to maintain mechanical properties of tissues, leaf growth and cell metabolic activity. When plant tissue water potential decreases, a change in osmotic potential may be essential to maintain turgor pressure at a water potential that would otherwise result in turgor loss. This situation occurs frequently during the vegetation season (mainly during slow changes of water availability), but also over a diurnal period (Brestič, Olšovská, unpublished). According to our results cv. Dobla of Spanish provenience kept its leaf water potential and turgor higher for the first 5 days of water stress while osmotic potential was decreased to the largest extent comparing to cvs. Kompakt and

Albacette. Figure 1 shows that this decrease in Ψs was caused mainly by free proline accumulation for all the period of water stress which acted as an osmoprotectant adjusting water relations in cells and balancing concentration state of cytoplasm and vacuol (Nanjo, Kobayashi 1999). Tissue metabolic adjustment was related to final yield and was found to have a positive effect on average grain weight per 1 ear in stressed comparing to control plants. Cv. Dobla attained the highest stress index (SI) calculated as a ratio of average grain weight in stressed to control plants, however the final grain yield of Dobla did not exceed the yield of productive cv. Kompakt (tab. 1). Also the ear structure was determinated differently in studied cultivars indicating a higher production potential of Kompakt which compensated for a negative effect of water stress via stem reserves mobilisation and accumulation into the central ear modul and on the other hand, indicating a higher stress index in cv. Dobla representing yield stability.

According to Arraudeau (1989) yield potential and yield stability of barley are largely independent of each other, so this traits can be manipulated independently in a breeding program. As seen from our results, cultivars with high yield potential under optimal water supply can be converted into a drought tolerant one by selective incorporation of drought resistant factors such as better osmotic adjustment, accumulation of different compounds, earliness, etc. But the opposite is also possible, and a drought tolerant line can be improved for its yield potential by selective incorporation of yield factors.

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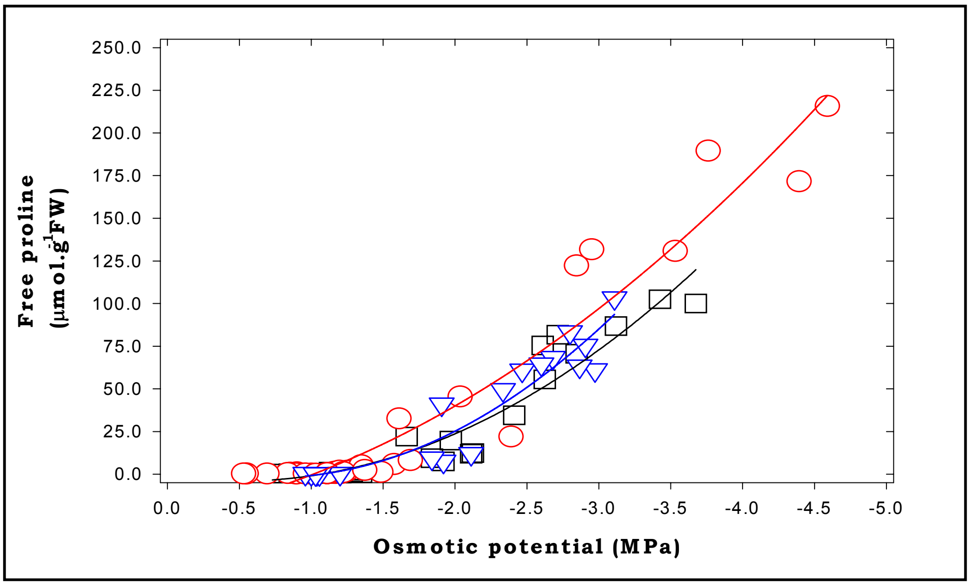

Figure 1: Nonlinear relationship between decreasing leaf osmotic potential and free proline accumulation during period of slow plant dehydration (circle – Dobla, square – Kompakt, rhombus – Albacette)

Tab. 1: Yield parameters from final yield analysis after applied water stress (K – watered plants, S – stressed plants, HS – main stem, ODN – tillers, SI – stress index)

Cultivar	Var.	Part of a plant	Grain number in aver. ear		% reduced grain number	Grain weight in an aver. ear in (mg)	SI %)
			forming	reduced			
Kompakt	K	HS	20,12	4,18	17,19	802,2	-
		ODN	17,06	7,94	31,76	644,8	-
	S	HS	17,64	3,33	15,87	600,2	0,748
		ODN	13,47	6,9	33,87	329	0,51
Dobla	K	HS	18,48	12,92	41,14	239,8	-
		ODN	27,83	29,75	51,66	188,1	-
	S	HS	14,77	15,08	50,51	196,9	0,821
		ODN	11,75	17,46	59,77	123,2	0,625
Albacette	K	HS	11,66	4,23	26,62	159,9	-
		ODN	10,32	7,36	41,62	77	-
	S	HS	3,8	29,8	88,69	37,4	0.232
		ODN	-	-	-	-	-

THE INFLUENCE OF THE WEED INFESTATION AND COMPETITION UPON THE WINTER WHEAT YIELD IN RELATION TO DIFFERENT FERTILIZER LEVEL

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Summary

Weed infestation is one of the negative factors, which influences a success of crop production in our agriculture. As regards to diversity and flexibility factors, a determination of weed harmfulness is very difficult.
The weed infestation and competition was observed in winter wheat field trials at 5 different fertilizer levels at the Research Station in Vysoka nad Uhom, the Eastern Slovakia, in 1995-1997. The alluvial soil type and arid condition are typical for crop production in this area in the East-Slovakian Lowland. There were used the winter wheat variety HANA and its seedrate 5 million germinating grains per hectare were used. The weed infestation was observed before the stand harvest and the 9 points EWRS Scale was used.
As far as the decrease of fertilizer level is concerned, an average of weed infestation and weed range were going up. The weed density caused the unfavourable decrease of competition and its grain yield. The middle and strong negative correlation, respectively (r = -0,60), is typical between the winter wheat yield and weed density on this crop stand. The variability of weed infestation influenced in average more than 40 % of crop variability in average. These dependences were statistically significant at the level from 1,2 - 1,3 %.

Introduction

The decrease of the yields at middle or strong weediness can achieve more than 30 %. The yields losses can achieve 90 % at the weediness (TYR, 1995).
The plant nutrition is the base of competition ability. It was conclude that the trend towards lower level of nitrogen fertilizer application concerning the environment will the favourable for most of the weed species and the composition of the weed populations (WILSON 1986, DAVIES 1987, KUDSK 1989, DYCK et al. 1995).
By BENADA and VANOVA (1985) it is necessery to be real, that relationships between harmful occurrence of weed and crops yields are considerably variable and depend on many factors. Therefore the expression of harmfulness can not be constant, but it must be a range of values, which is responsible for the changeability of actual factor.
The aim of this work is to document the intensity of late summer weed infestation on winter wheat stands in the dependence on intensity of nutrition after using of herbicide in the cropping. The quantification of the influence of weediness with interaction with the different nutrition levels on the yields of winter wheat is the next element.

Materials and methods

We solved the problems of the winter weediness in the stationary system of crop rotation. The field trial was established in the experiment working place of OVUA Michalovce in Vysoka nad Uhom on the alluvial soil in the conditions without irrigation, 107 m above sea-level. The locality is situated in the central part of East-Slovakian Slowland. A continental climate is characteristic for this region.

The soil composition is sandyloam - loam, according to the performed analysis in 1997 the average humus content was 2,1 %, pH/KCl 6,7, the changeable sorption capacity 24,9 mmol.100 g^{-1}. In climatic point of wiev the locality is situated in warm, middledry-dry area with the average annual temperature 9 °C and the average temperature in vegetation period 15,2 °C. The long-term average of annual rainfall average is 557 mm and in the vegetation period 397 mm. The information about atmospheric conditions during experiment was obtained from the local meteorological observation station and is included in the enclosure.
The intensity of secondary weediness was studied with 10 models of 5 part crop rotation with 5 repetitions, which was devided spatially and timely.
RINIK et al. (1997) presented the concrete description of this locality, agrotechnics, including the herbicide protection.
The winter wheat variety HANA was used in the experiments. The seeding amount was 5 million of germinating grains per hectare. The distance between the lines was 125 mm. The weed infestation and competition was observed in winter wheat small-plot field trials under 5 different levels of fertilization. The liming and protection was everywhere the same.
Characteristic of preparations:
BIOSIL: the organic-mineral mixture made on the basic dairy by-products. It is ecologically pure. It increases natural soil fertility and promotes development of vegetative and generative plant organs.
ZEOMIX: mixture of NPK and further trace elements: B, Mo, Ti, Fe. Mg, Ca and activ zeolit mineral - klinoptilolit. The content of the mentioned zeolit in the preparation was 36-42 %.

Nutrition at the variants: (in kg p.n.NPK.ha^{-1} , Zeomix, Biosil in kg.ha^{-1}, rate of manure (MH) and of lime $CaCO_3$) in t.ha^{-1})

Variant	N	P	K	Zeomix	Biosil	$CaCO_3$	MH*
I.	105	55	100	-	-	6	40
II.	(13,5)*	(9)**	(9)**	150	-	6	40
III.	-	-	-	-	-	6	40
IV.	-	-	-	-	150	6	40
V.	-	-	-	-	-	6	-

* - manuring and liming once a 5 years at the beginning of the crop rotations
** - elements in Zeomix

The weed infestation was evaluated according 9 points of EWRS scale a week before the stand harvest. The following weed species were recorded: agropyron repens, echinochloa galli, avena fatua, apera spica-venti, chenopodium album, cirsium arvense, convolvulus arvensis, anthemis arvensis and polygonum persicaria. The total weedines was especially registered.
The obtained authentic data were mathematically prepared and statistically evaluated with the regression alysis.

Results and discussion

The average weediness of the winter wheat stands was in the evaluated 3 years period at relatively low level 3,42 p. WILSON and WRIGHT (1990) indicated a good competition ability of the winter wheat. They ascertained that on the stand with the dense wheat the majority of vegetative weeds were suppressed. CERNUSKO (1991) saw the reason for good competition in complete, quick growth, mighty and alelopaty.
The absolute weediness and occurrence of weed species was very variable in the individual years. The highest weed infestation was observed in 1997 and the lowest in 1996. RINIK and HNAT (1990) ascertained a very important role of beginning of sprouting in regard to the wheat weediness. In the case that it begins in the spring the wheat ability of competition is significantly decreased. The most variable weed was avena fatua. One of the important factors, which is determinate by deferences on absolute weedines and occurrence of avena fatua are (KOHOUT and ZAHRADNIKOVA, 1995) the differences in the weather when spring coming. The higher weediness is excepted in the year with early spring when the period with the low temperature as a rule coming. The stands are completed slowly and weeds have beter chance to compete.
The most frequent weeds were agropyron repens, convolvulus arvensis, avena fatua and anthemis arvensis. Agropyron repens occured during 3 years of investigation in 25 % cases. Second most frequent weed was convolvulus arvensis in 19,7 % cases. Avena fatua in 16 % cases and anthemis arvensis in 16 % cases was the further very frequent weeds. The occurrence was relatively low of cirsium arvense 5,7 % polygonum persicaria 2 %, equisetum arvense 1,7 % and chenopodium album 1 %. The winter wed apera spica-venti and summer weed echinochloa galli were not recorded in the winter wheat. As far as the group of other weeds with the occurrence of 14 % is concerned the most frequently occurring and economically low important species were anagallis arvensis and some kinds of veronica.
Agropyron repens bolong to cosmopolitan weeds (HRON, KOHOUT 1986, WHITEHEAD, WRIGHT 1989). COUDNEY et al. (1991) wrote, that the relative low avena fatua infestation wheat had a significant influence on the light penetration and wheat yields.
It was evident a different weedines of variants. In 3 year average we obvious higher weed infestation on the first variant than on the second one. RICHARDS (1993) ascertained the highest weed infestation in N-highest plots in the wheat variety trial. It was concluded that a trend towards the lower application of nitrogen fertilizer concerning the environment will be favorable. It is concerning also for the most of the weed species, and composition of weed populations (WILSON 1986, DAVIES 1987,

KUDSK 1989, DYCK et al. 1995). The weedines of first, fourth and fifth variants increased with the decrease of nutrition. The third variant belongs between the first and the second one regarding the weediness.
Our data about min., max., aver. Weed infestation on variants implicitly indicated the different wheat competition in different nutritional conditions according to RICHARDS (1989) intention, that higher crop covering caused lower weed coverage. The decrease of weed covering in dependence on wheat covering increase was observed by WRIGHT (1993) in conditions of different nutrition and seedrate too.
The attained wheat yields were in 3 years salvation in the wide interval from middle to strong correlation with weedines, on every variants. These relationships were variable by years and nutrition variants and are in space from weak to very strong correlation. The hyphen of corr. coefficient was right as regards to economical interpretation and the type of regression and the weed infestation.
We find the strongest relationship between weed coverage and achieved wheat yields on fifth, nonmanured variant. The variability of weedines caused 41,92 % changes in the variability of the wheat at this variant. We observed the lowest dependence at the variant with the application of Biosil as far as the evaluated variants are concerned. The changes in weedines variability caused 13,06 %, variability of the wheat yields. It is clear from Tab.3, that the weed harmfulness at the first, the fourth and the fifth variant increased with the decrease of nutrition. The relationships between yields and weedines at the first and second variant are aproximately the same. The statistical parameters were variable on every variant according to year. As regards to the mentioned facts we observed the significant influence of weedines on the decrease of the yield of winter wheat. The decrees of the nutrition intensity cause a scale of weedines with the parallel increasing of economical weed harmfulnes. It is responsible with CAUSSANEL et al. (1996) confirmation, that weed competition significantly influenced winter wheat yealds in despite of parallel wheat yeald increasing in conditions of nutrition range intensity. We observed the weedines decreasing in comparation by the first and the second variant, what was confirmed by corresponding literature (JORNSGARD et al., 1996).
We represented the functions of achieved wheat yealds on stand weedines on the Fig.1. The x-axis is determined by real values.
Our conclusions are corresponding with confirms in literature (SALONEN 1992, WRIGHT 1993, LINTELL-SMITH et al. 1992). FUCHS and SCHMIDT (1993) by who weed and crop competition is significantly influenced by fertilization By JORNSGARD et al. (1996) nutrition is the base of crop competition ability. Our results that weed competition significantly influenced winter wheat yields, despite of parallel yields increasing at conditions of the increase of nitrogen. confirmed also CASSANEL et al. (1996). We are agree also with ZANIN et al. (1993), that without information about nitrition it is impossible to calculate an economic threshold for some of the treatments which could not be economically justified.

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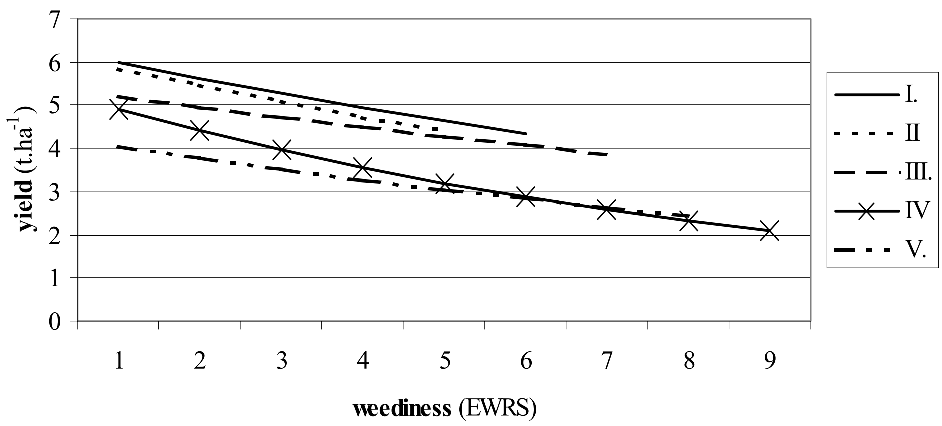
Fig.1: The winter wheat yield dependence on weediness intensity according followed nutrition variants



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DESIGNING MULTIFUNCTIONAL CROP ROTATION AND YIELDS OF WINTER WHEAT IN ECOLOGICAL AND INTEGRATED FARMING SYSTEMS

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Summary

Integrated and ecological arable farming systems were established on brown clay-loamy soil in the south Slovakia in 1990. The chemical inputs in the integrated system were replaced in the ecological one by designed multifunctional crop rotation, ecological plant nutrition with mechanical and physical weed control. According to results of the analysis of variance, the integrated system gave significantly higher yields of winter wheat (6.2 $t.ha^{-1}$) than did the ecological one (5.6 $t.ha^{-1}$). Similarly the yields were higher under conventional cultivation than under minimum tillage (0.3 $t.ha^{-1}$). Differences of winter wheat yields between the systems were greater under minimum cultivation than under conventional tillage.

Key words: crop rotation, ecological farming, integrated farming, winter wheat

Introduction

Integrated and ecological farming systems represent in Slovak Republic non traditional ways of agro-ecosystem management. They are regarded as production methods, which enhanced the quality of production and they are compatible with increasing demands for environmental protection and landscape management. One of the most important cash crop is winter wheat. The objectives of this study were to evaluated the interactive effects of farming systems and soil tillage on yields of winter wheat, grown after maize for silage.
Multifunctional crop rotation (MCR) is a basic and comprehensive method to preserve soil fertility in biological, physical and chemical terms and to sustain quality production with a minimum of inputs.

Material and methods

Long term field experiments of *integrated* and *ecological* arable farming systems were established in the fall of 1990 at the Slovak Agricultural University Research Station near Nitra on brown clay-loamy soil. In both systems natural regulation processes are supported by crop rotations with inter-crops (green soil cover), integrated crop nutrition and fertilisation and non-chemical plant protection and conservation soil management. In both systems two different basic soil cultivation are used: *conventional* with ploughing to the depth of 0.24 m and *minimum* with shallow cultivation to the depth of 0.12-0.15 m. Farm yard manure is incorporated with middle depth ploughing two-times during the rotations in the amount of 40 $t.ha^{-1}$. Crop rotations with their evaluation according to Vereijken (1995) are shown in Tables 1 and 2.
The statistical design was a split plot within a complete block with four replications. Farming system with crop sequence served as the main plot, with factorial combination of tillage representing split plots. Data were evaluated statistically by analysis of variance, and minimum significant differences were calculated by Tukey test. Significance is indicated at $P \leq 0.05$.

Results and discussion

The interactive effects of farming systems and soil management on yields of winter wheat grown after maize for silage are shown in Table 3. In the first year of experiments there were already significantly higher yields of winter wheat in integrated system (6.31 $t.ha^{-1}$) than in ecological one (5.7 $t.ha^{-1}$). In the next two years neither the growing system nor the cultivation methods had significant effect on yields. In 1994, in minimum cultivation and later regardless of cultivation, winter wheat gave significantly higher yield in integrated system compared to the ecological. The minimum cultivation in ecological system resulted in significantly lower yields (4.7 $t.ha^{-1}$) than it was in the case of conventional cultivation (5.9 $t.ha^{-1}$). These yields were even lower compared with minimum cultivation effect in integrated system (6.1 $t.ha^{-1}$).
Minimum cultivation caused the main differences between the systems. Influence of growing systems and cultivation demonstrated variable effect over the eight years period. However, the influence showed up at the final evaluation of the experiment. Due to statistically insignificant effects of the interaction between growing systems and cultivation, the integrated system gives higher winter wheat yields irrespective of the cultivation methods. The conventional cultivation in both systems results in higher yields.
Generally lower yields under minimum cultivation were caused mainly by higher soil compaction in the top layer (no deeper loosening of soil within 8 years) and in ecological system also by higher weed infestation with domination of perennial weeds (*Cirsium arvense*) and *Amaranthus retroflexus*.
Growing systems and cultivation methods demonstrated variable effect on winter wheat yields over the eight years period. The integrated growing system gave significantly higher yields of winter wheat (6.2 $t.ha^{-1}$) than did the ecological one (5.6 $t.ha^{-1}$) at the final evaluation of the experiments. Differences of winter wheat yields between the systems were greater under minimum cultivation than were under the conventional one. Chemical inputs in integrated system conciliated the influence of minimum tillage to the greater extend than it was in ecological system. The conventional cultivation in both system resulted in higher yields.

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Table 1: Design and ratings of integrated crop rotation

Block no.	Biological		Physical (ratings)		Chemical (N ratings)		
	Species	Group[1]	Cover[2]	Structure[3+4]	Offtake[5]	Transfer[6]	Need[7]
1.	Alfalfa	legume	0	2	0	2	-1
2.	Maize	root crop	-2	0	3	1	1
3.	Maize for silage	root crop	-2	0	4	1	3
4.	Winter wheat	cereal	0	2	4	1	3
5.	Sugar beet	root crop	-2	-3	2	1	1
6.	Spring barley	cereal	-4	2	3	1	2
7.	Common pea	legume	-4	1	0	1	-1
8.	Winter wheat	cereal	0	2	4	1	3
	average of crop rotation		-1.75	0.75	2.5	1.12	1.38
Evalu-ation	Share of species = 0.25	Share of group = 0.375	-1		1.38		

Table 2: Design and ratings of ecological crop rotation

Block no.	*Biological*		Physical (ratings)		Chemical (N ratings)		
	Species	Group[1]	Cover[2]	Structure[3+4]	Offtake[5]	Transfer[6]	Need[7]
1.	Field bean + alfalfa	legume	0	2	0	1	-1
2.	Alfalfa	legume	0	2	0	2	-1
3.	Winter wheat	cereal	0	2	4	1	2
4.	Maize for silage	root crop	-2	0	3	1	2
5.	Sunflower	oil crop	-4	1	2	1	1
6.	Common pea	legume	-4	1	0	1	-1
7.	Maize	root crop	-2	0	3	2	2
8.	Winter wheat	cereal	0	2	4	1	2
	average of crop rotation		-1.5	1.25	2.0	1.25	0.75
Evalu-ation	Share of species = 0.25	Share of group = 0.25	-0.25		0.75		

Legend for Tables 1 and 2:

1. Genetically and phytopathologically **related groups**, such as cereals, legumes, crucifers, composites, umbellifers. All subsequent blocks of perennial crops are counted as 1 block;
2. No cover in autumn and winter =-4, no cover in autumn or winter=-2, all others =0 (green manure crops included);
3. Cereals, grasses and alfalfa=3, root, bulb and tuber crops=1, all others=2 (green manure crops included);
4. Compaction by mowing in summer=-1 and autumn=-2, lifting in summer=-2 and in autumn=-4;
5. N offtake by harvested crop product from soil reserves: legumes=0, all other crops: 25-50 kg. ha^{-1}=1, 50-100 kg. ha^{-1}=2, 100-150 kg. ha^{-1}=3, 150-200 kg. ha^{-1}=4;
6. N transfers is the expected net contribution of N to subsequent crop, based on N residues in the soil after harvest, N mineralisation from crop residues and N losses by leaching and denitrification. In this rating, the effect of green manure crops should be included. N transfer <50 kg. ha^{-1}=1, 50-100 kg. ha^{-1} =2, 100-150 kg. ha^{-1}=3;
7. N need = N offtake minus N transfer. N need is net N input to be provided by manure or N fertiliser.
8. **Limiting crop frequencies** to ≤ 25% in integrated system and ≤ 16.7% in ecological system.
9. **Limiting crop group frequencies** to ≤ 50% in integrated system and ≤ 33% in ecological system.
10. **Physical soil fertility** (physical ratings): ≤ -1 in integrated system and ≤ 0 in ecological system.
11. **Chemical soil fertility** (Chemical - N ratings): ≤ 2 in integrated system and ≤ 1 in ecological system.

Table 3: Yields of winter wheat [$t.ha^{-1}$]

Year	Soil cultivation	Ecological system	Integrated system	Mean
1991	Minimum	5.7	6.3	6.0
	Conventional	5.7	6.4	6.0
	Mean	5.7	6.3 a	6.0
1992	Minimum	6.1	6.3	6.2
	Conventional	6.2	6.3	6.3
	Mean	6.2	6.3	6.2
1993	Minimum	3.3	3.1	3.2
	Conventional	3.1	3.5	3.3
	Mean	3.2	3.3	3.3
1994	Minimum	6.6	7.0 a	6.8
	Conventional	6.8	6.9	6.8
	Mean	6.7	7.0 a	6.8
1995	Minimum	5.2	5.9 a	5.5
	Conventional	6.6 B	6.2 A	6.4 B
	Mean	5.9	6.0	6.0
1996	Minimum	6.1	6.6	6.4
	Conventional	6.1	6.8	6.5
	Mean	6.1	6.7	6.4
1997	Minimum	4.7	6.1 b	5.4
	Conventional	5.9 A	6.8	6.4 A
	Mean	5.3	6.5 b	5.9
1998	Minimum	5.2	7.3 a	6.3
	Conventional	6.3	7.0	6.6
	Mean	5.7	7.1 a	6.4
Mean	Minimum	5.4	6.1 b	5.7
	Conventional	5.8	6.2 a	6.0 B
	Mean	5.6	6.2 b	5.9

Legend:
Significance levels for comparison of systems: a is $P \leq 0.05$; b is $P \leq 0.01$;
Significance levels for comparison of soil cultivation: A is $P \leq 0.05$; B is $P \leq 0.01$.

INFLUENCE OF SOIL CULTIVATION AND FERTILIZATION ON QUALITATIVE CHARACTERISTICS OF SUGAR BEET BULBS

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Summary

Contents of sugar, alfa-amino nitrogen, sodium, potassium in bulbs of sugar beet and their influence on the calculated technological parameters (refined sugar yielding, refined sugar production, losses of sugar in molasses, coefficient of alkalinity) were investigated in four-year field experiment (1995 to 1998) under the minimal and conventional soil cultivation with fertilized (manure + inorganic fertilizers) and unfertilized treatments within each soil cultivation system. Achieved results confirmed strong relation between sugar beet quality and the course of meteorological conditions. System of soil cultivation significantly influenced content of sodium in sugar beet bulbs. Fertilization with manure + inorganic fertilizers negatively affected refined sugar yielding and losses of sugar in molasses.

***Key words*: sugar beet, technological quality, soil cultivation, fertilization**

Introduction

Quality of sugar beet bulbs is influenced by a number of factors and their´s mutual interactions. The result of these interactions represents certain level of technological quality of bulbs which is a decisive criterion for economically effective processing of this raw material. Recently, new technological procedures have been introducing within sugar beet production focused to improving its technological parameters.

Katagi (1986) investigated effect of minimal soil cultivation on yields and sugar content in bulbs. He found out that minimal cultivation reduces yields and increses content of sugar, decreasing content of molasses-forming elements at the same time. Similar results were published by Muchová et al. (1998), Frančáková et al. (1996) and Pačuta (1996).
Nutrition of sugar beet in relation with course of weather influences strongly technological quality of bulbs. Cationic component of mineral substances and portion of monovalent and bivalent cations play important role in the process. Especially content of monovalent cations is important because in relation to alfa-amino nitrogen decisively influences coefficient of alkalinity (Nomura 1986, Chochola 1988, Bízik 1993).
Studying alternative systems of sugar beet production, a great attention was devoted to the utilization of manure. Kennedy (1993) concluded that high rates of manure decrease sugar content of bulbs in alternative cropping systems as well.
To test the effect of two different systems of soil cultivation and fertilization on sugar beet bulbs quality within integrated farming system was the aim of the work.

Material and methods

Within the integrated farming system four-year field experiment with sugar beet was established on brown clay loamy soil (tab. 1) on the experimental basis of Slovak Agricultural University in Nitra (48°19´N; 18°09´E). There were investigated two soil cultivation systems (minimal shallow cultivation into the depth of 0,15 m and conventional cultivation into the depth of 0,25 m) there. Within each cultivation system, two treatments of fertilization were applied: 1.) fertilization with the dose of 40 t.ha^{-1} of manure+NPK inorganic fertilizers calculated on the basis of balance and diagnostic method 2.) unfertilized treatment.

Table 1 Agrochemical charakteristics of soil (into the depth of 0.4 m)

Year	Site N°	Soil reaction pH/ KCl	Oxidizable carbon (C_{ox})	Humus content (%)	Inorg. N Nin (mg.kg^{-1})	Available nutrients (mg.kg^{-1})		
						P	K	Mg
1995	4	5,81	1,15	1,98	8,13	67	200	150
1996	7	5,75	1,17	2,02	16,1	98	435	190
1997	1	5,80	1,26	2,17	10,9	88	300	175
1998	8	5,93	1,20	2,06	31,9	86	410	232

Inorganic and easy hydrolyzable nitrogen was analysed in soil. Because of the relatively high supply of nutrients in soil (tab. 1) low rates of essential inorganic nutrients were applied within the sugar beet pattern of fertilization. In crop rotation, sugar beet (variety Intera) followed winter wheat. Each experimental plot (combination of experimental factors) was four times replicated. Sugar beet was harvested in the stage of technological maturity at the beginning of October. Within the chemical analyses the following characteristics were determined: content of sugar (° S)-polarimetrically, content of Na, K and alfa-amino nitrogen (mmol.100g^{-1})-spectrophotometrically. On the basis of these analytical values, the other technological parameters were calculated according to Reinefeld et al. (1974) including refined sugar yielding (%), losses of sugar in molasses (%), coefficient of alkalinity and refined sugar production (t.ha^{-1}). This trial was integral part of the research project VEGA GP 1/2081/95 in which the field experiments of integrated and ecological farming system were realized and researched (Lacko-Bartošová, Antala 1996).

Results and discussion

Strong effect of weather conditions on the qualitative parameters of sugar beet bulbs results from the analysis of variance (tab. 2). All investigated characteristics were influenced by this factor highly significantly. This finding is in accordance with the results achieved by Muchová et al. (1998).

Table 2 Analysis of variance of experimental factors on the variability of investigated characteristics

Characteristic		Sugar (°S)	K	Na	α N	Yielding of sugar (%)	Losses of sugar (%)	Coef. of alkalinity	Prod. of sug.(t.ha^{-1})	Yields of bulbs t.ha^{-1}
			mmol.100g^{-1}							
Source of var.	df	Calculated F-values								
Cultivation	1	0,57	0,19	4,9*	0,48	0,67	0,10	1,41	25,8**	35,7**
Fertilization	1	3,52	3,4	1,0	2,46	5,88*	4,21*	0,29	0,012	1,56
Years	3	14**	74**	15**	**	4,44**	97,6**	102**	14,7**	12,3**
Cult. x Fertil.	1	0,4	0,0	0,32	0,55	0,47	0,33	2,47	18,5**	19,5**

df – degree of freedom * significant effect ** highly significant effect

Soil cultivation showed statistically significant effect on sodium content in bulbs (tab. 2, 3). Lower Na content was analysed in bulbs under minimal cultivation (0,52 mmol.100g^{-1}) comparing with conventional system (0,59 mmol.100g^{-1}). Frančáková et al. (1996) states decrease of this element content in bulbs by 15,1 % as a consequence of minimal soil tillage. Similar tendency was also observed with alfa-amino N, but without statistical significance. As to the potassium, minimal soil cultivation increased potassium content in bulbs (not significantly).
Fertilization as the second investigated factor showed no significant effect on the contents of these elements in sugar beet. However, there was a tendency to reduce their content in bulbs under the unfertilized treatment (Katagi 1986).
Content of sugar was higher under minimal soil cultivation (17,16 °S), but not statistically significant comparing with conventional soil tillage (17,04 °S). Fertilization was not significant, but there was tendency to increase sugar content under unfertilized treatment (17,24°S) versus fertilized one (16,96 °S). Similar results were achieved by Kováčová (1999) and Pačuta (1996).
Soil cultivation statistically influenced neither refined sugar yielding nor both losses of sugar in molasses and coefficient of alkalinity. Effect of fertilization was negative and decrease the values of sugar yielding and contrarily increase the losses in molasses (not significantly).

Table 3 Significance of mean characteristic differences between levels of investigated experimental factors (LSD-test)

Characteristic	Level of	Sugar	K	Na	αN	YS	LS	CA	PS	YB
Source of var.	factor	Mean								
Soil cultivation	MIN	17,16a	5,97a	0,52a	5,25a	14,15a	2,41a	1,35a	6,33a	44,70a
	CON	17,04a	5,92a	0,59b	5,34a	14,02a	2,42a	1,31a	7,38b	52,55b
Limit diff. (0,05)		0,302	0,225	0,064	0,256	0,317	0,098	0,065	0,415	2,635
Limit diff. (0,01)		-	-	-	-	-	-	-	0,553	3,509
Fertilization	manure+N PK	16,96a	6,05a	0,57a	5,39a	13,89a	2,47a	1,32a	6,87a	49,45a
	unfertilized	17,24	5,84a	0,54a	5,19a	14,28b	2,37b	1,34a	6,84a	47,81a
Limit diff. (0,05)		0,302	0,225	0,064	0,256	0,317	0,098	0,065	0,415	2,635

YS-refined sugar yielding LS-losses of sugar in molasses CA-coefficient of alkalinity
PS-refined sugar production YB-yields of sugar beet bulbs

Conventional soil cultivation showed strong statistically significant effect on refined sugar production (7,38 t.ha^{-1}) in comparison to minimal cultivation (6,33 t.ha^{-1}). Fertilization was not significant in this parameter. There was also found out highly significant interactions between soil cultivation and fertilization (tab. 2). In this connection, important role was played by the yields of sugar beet bulbs which levels were strongly effected by conventional cultivation and slightly by fertilization (tab. 3).

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EFEECT OF FERTILIZATION ON HEAVY METALS ACCUMULATION IN SOIL AND ALFALFA (MEDICAGO SATIVA L.)

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Summary

In the field trial situated at Dolná Malanta an influence of inorganic and organic fertilization on the Pb, Cd and Hg accumulation in soil and dry matter of alfalfa was investigated. Application of inorganic fertilizers did not cause significant increase of the contents of heavy metals in soil. In the first two experimental years there was tendency of their content increase in soil after the 1st cut in the depth of 0.3 m (tab. 1). On the course of the trial, the contents of lead and cadmium were being reduced in soil under both fertilizing treatments. In contrary, content of Hg in soil was increasing in all cuts. Contents of all investigated heavy metals in alfalfa dry matter were decreasing with order of the cut, reaching the maximum in the first one under inorganic fertilization. Under organic fertilization it was not so uniform. The highest uptake of investigated heavy metals by the yield of alfalfa was calculated with Pb (3469 mg.ha^{-1}) followed by Cd (803 mg.ha^{-1}) and Hg (180 mg.ha^{-1}) on the average of three years. Input of Pb into soil through the fertilization was approximatelly 1.5-2 times higher than its uptake by plants within a year. On the contrary, inputs of Cd and Hg into soil were lower comparing with amounts of these elements taken up by alfalfa above-ground biomass. Alfalfa has shown quite a good disposition for high accumulation of cadmium contained in phosphoric fertilizers. Limit standardized values of Pb, Cd and Hg contents both in soil and dry matter of alfalfa were not exceeded during experiment duration.

Key words: heavy metals, soil, alfalfa, fertilization

Introduction

Contamination of agricultural crops by undesirable substances, including heavy metals, and posibilities of their control aiming to the minimalization of their entry into the food chain are being delt with by several authors (Cibulka et al. 1991, Ducsay 1995, Kováčik et al. 2000). Contamination of soil with Cd over hygienic limit within agricultural land of Slovak Republic occurs approximately on 15 % of total acreage, with Pb and Hg it represents 6 % and 5 %, respectively (Linkeš et al. 1997). The highest permissible limit contents of Cd, Pb and Hg in soil (mg.kg^{-1}) are as follows: 0.8, 35 and 0.3, respectively (Rozhodnutie MP SR 1994). In DM of plants the limit standardized contents (mg.kg^{-1}) for Cd, Pb and Hg represent 1.136, 11.36 and 0.1136, respectively (Vestník MP SR 1998). Taking into account the fact that alfalfa belongs among the most important forage crops of arable land producing the most of proteins per unit of area and having extraordinary positive effects on soil fertility, there is an understanding interest for research of heavy metals accumulation by this crop.

Material and methods

Three-year field trial with alfalfa was established at locality of Dolná Malanta (48° 19´N; 18° 09´E) on the loamy brown soil with slightly acid soil reaction and high supply of available nurients. The contents of Pb, Cd and Hg in soil as well as in dry matter of above-ground biomass of alfalfa were investigated within two treatments: 1.) fertilization with inorganic fertilizers based on the balance methods considering planned yield including 108 kg of triple superphosphate per hectare + 20 t.ha^{-1} of manure applied under bean as a cover crop for alfalfa 2.) organic fertilization represented by the rate of 20 t.ha^{-1} of manure. Research within this experiment was performed with alfalfa grown in the second harvest year. The 1st cut was realized at the stage of full buds, the 2nd at full flowering and the 3rd one at the beginning of flowering. Above-ground biomass of alfalfa in respective cuts was analysed for heavy metals contents in dry matter. The contents of the heavy metals were also determined in soil in the depth of 0.0-0.30 m and 0.31-0.60 m, respectively as well as in all materials incorporated into soil within alfalfa cropping (triple superphosphate, manure, seed of alfalfa). Lead and cadmium in soil after their extraction by 2 M HNO_3 and in plant material after their mineralization by dry method and dissolving of ash in 1 M HCl were determined by differential pulsating anodic solving voltametry on hanging mercury drop electrode. Mercury was determined by atomic absorption spectrophotometry method on the analyzer TMA 254. The fertilizers were analyzed according to the standard ON 654 860.

Results and discussion

Application of inorganic fertilizers did not cause significant increase of investigated heavy metals in soil. In the first two experimental years there was tendency of their content increase in soil after the 1st cut in the depth of 0.3 m (tab. 1). On the course of the trial, the contents of lead and cadmium were being reduced in soil under both fertilizing treatment. In contrary, content of Hg in soil was increasing in all cuts. Measured values (tab. 1) are in accordance with those stated by Linkeš et al. (1993) in the framework of monitoring of Slovak Republic soils.
Within both treatments there was tendency of Pb and Cd contents decrease in soil after respective cuts. For example, Pb content in soil after the 3rd cut represented approximately 58 % of its content after the 1st cut on the treatment 1 and 55 %

on the treatment 2 in the depth of 0,3 m. The differences of Pb, Cd and Hg contents between the exemined treatments were not statistically significant (tab. 5).

On the basis of data stated in the tables 1, 2 and 3, a relationship among content of heavy metals in soil and dry matter of alfalfa can be considered. Owing to a great number of soil factors which inhibits mobility of Pb in soil, the plants are able to take up only little part of soil lead (Mocik et al. 1987). Our 3-year results confirm it. From the total amount of Pb in soil alfalfa accumulated in above-ground dry matter approximately 5 % of Pb on treatment 1 and 6.4 % on teratment 2 on the average of years and cuts. Substantially lower uptake of Pb by plants comparing to its soil content is connected with the formation of insoluble Pb salts or little mobile Pb complexes (Mengel and Kirkby 1987). Continuously there is more lead accumulated in the roots of alfalfa than in above-ground biomass (Azpiazu et al. 1986). Stated results show the decrease of Pb content in alfalfa aboveground DM after respective cuts (tab. 3). Higher content of Pb was found out in the treatment 2 (0.4682 $mg.kg^{-1}$) in comparison with treatment 1 (0.3855 $mg.kg^{-1}$). The difference was not statistically significant (tab. 5). Alfalfa accumulates in aboveground DM substantially more Pb than winter wheat and spring barley (Hanáčková 1998).

Table 1 Changes of Pb, Cd and Hg contents in soil after individual cuts of alfalfa in the 2nd harvest year

Treat.	Cut	Depth (m)	1991			1992			1993		
			Pb	Cd	Hg	Pb	Cd	Hg	Pb	Cd	Hg
			$mg.kg^{-1}$ of soil								
1	I.	0-0.30	13.3	0,080	0,055	10.4	0.068	0.044	11.4	0.018	0.054
		0.31-0.60	9.5	0.043	0.029	7.4	0.039	0.031	9.1	0.017	0.039
	II.	0-0.30	12.8	0.061	0.051	3.3	0.026	0.048	6.9	0.013	0.058
		0.31-0.60	6.8	0.070	0.044	4.9	0.035	0.039	5.6	0.005	0.043
	III.	0-0.30	7.7	0,051	0,056	3.1	0.010	0.047	5.0	0.013	0.050
		0.31-0.60	5.5	0.041	0.040	8.0	0.048	0.029	3.9	0.010	0.033
2	I.	0-0.30	12.8	0.069	0.050	12.1	0.049	0.045	12.4	0.031	0.072
		0.31-0.60	5.2	0.050	0.033	8.3	0.033	0.033	8.9	0.019	0.049
	II.	0-0.30	13.0	0.056	0.038	4.1	0.017	0.063	7.2	0.030	0.067
		0.31-0.60	6.6	0.050	0.042	4.9	0.035	0.043	6.4	0.013	0.054
	III.	0-0.30	7.1	0.040	0.045	3.6	0.025	0.052	4.7	0.010	0.067
		0.31-0.60	4.8	0.043	0.037	5.8	0.035	0.044	4.0	0.010	0.053

Table 2 Content of Pb, Cd and Hg in dry matter of alfalfa in the 2nd harvest year

Treat.	Cut	1991			1992			1993		
		Pb	Cd	Hg	Pb	Cd	Hg	Pb	Cd	Hg
		$mg.kg^{-1}$								
1	I.	0.547	0.041	0.035	0.501	0.040	0.017	0.285	0.222	0.021
	II.	0.280	0.038	0.010	0.273	0.096	0.027	0.461	0.135	0.017
	III.	0.340	0.059	0.015	0.376	0.042	0.016	0.294	0.099	0.014
2	I.	0.470	0.023	0.034	0.559	0.014	0.031	0.483	0.049	0.016
	II.	0.266	0.022	0.012	0.487	0.079	0.024	0.670	0.076	0.016
	III.	0.353	0.049	0.016	0.401	0.042	0.016	0.376	0.031	0.016

Cd within the investigated heavy metals seems to be the most mobile and for plants most available. It is proved by its 2.5 and 2.4 times higher content in aboveground alfalfa DM in comparison with its content in soil on the treatments 1 and 2, respectively. On the treatment fertilized with commercial inorganic fertilizers its content in alfalfa DM represented 0.0892 $mg.kg^{-1}$, that is 2.2 times higher comparing to treatment 2. The difference was statistically significant (tab. 3, 5).

There were minimal differences (statistically not significant) in alfalfa DM Hg content between examined treatments (tab. 3).

Within the framework of treatment 1 content of all 3 investigated heavy metals was decreasing with cuts, within the treatment 2 it was not so uniform (tab. 3).

Uptake of Cd by alfalfa yield was 2.24 times higher in treatment 1 comparing to treatment 2. This was the consequence of inorganic fertilizers application and within them especially phosphoric ones. Uptake of Pb and Hg by yield was higher on the treatment 2 (tab. 3). There was higher input of Pb into soil than its uptake by yield per year, with Cd and Hg it was oppositely on both treatments of fertilization (tab. 3, 4).

Table 3 Heavy metals in alfalfa (total/weighted average of 3 years)

Treat.	Cut	Yield of DM (t.ha^{-1})	Contents of heavy metals inDM kg. kg^{-1}			Uptake of heavy metals by yield mg.ha^{-1}		
			Pb	Cd	Hg	Pb	Cd	Hg
1	I.	4.05	0.444	0.101	0.024	1798	409	97
	II.	2.70	0.338	0.090	0.018	913	243	49
	III.	2.25	0.337	0.067	0.015	758	151	34
	Total/avrg.	9.00	0.3855	0.0892	0.020	3469	803	180
2	I.	4.00	0.517	0.029	0.027	2068	116	108
	II.	2.50	0.474	0.059	0.017	1185	148	43
	III.	2.30	0.377	0.041	0.016	867	94	37
	Total/avrg.	8.80	0.4682	0.0407	0.0214	4120	358	188

Table 4 Content of heavy metals in fertilizers/seed and their input into soil by these materials

Material	Rate	Content of Pb	Content of Cd	Content of Hg	Input into soil per year Pb	Input into soil per year Cd	Input into soil per year Hg
		mg.kg^{-1}			mg.ha^{-1}		
Triple superphosphate	108 kg.ha^{-1}	0.594	4.15	0.111	64	448	12
Farmyard manure	20 t.ha^{-1}	1.707	0.043	0.006	6828	172	24
Seed of alfalfa	15 kg.ha^{-1}	0.171	0.022	0.058	3	1	1
	T o t a l		Treatment 1		6895	621	37
			Treatment 2		6831	173	25

Table 5 One-way analysis of variance of fertilization effect on the contents of heavy metals in soil and dry matter of alfalfa

Fertilization	In soil (mg.kg^{-1})			In dry matter of alfalfa (mg.kg^{-1})		
	Pb	Cd	Hg	Pb	Cd	Hg
Treatment 1	7.48 a	0.036 a	0.044 a	0.3855 a	0.0892 a	0.020 a
Treatment 2	7.33 a	0.034 a	0.049 a	0.4682 a	0.0407 b	0.021 a
LSD	2.14	0.013	0.007	0.112	0.0465	0.007

LSD – least significant difference ($\alpha = 0.05$)

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