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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.

References

Vereijken, P. 1995. 2. Designing and testing prototypes (Progress report of research network on integrated and ecological arable farming systems for EU and associated countries – concerned action AIR 3-CT 920 755). Wageningen (NL): Research Institute for Agrobiology and Soil Fertility (AB-DLO), 1995, 90 p.

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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.