Acta fytotechnica et zootechnica, Vol. 4, 2001, Special Number
Proceedings of the International Scientific Conference on the Occasion of the 55th Anniversary of the Slovak Agricultural University in Nitra

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.

The results presented in this work were taken out from the grant projects 1/1067/94 (A 29 G) and 1/6124/99 (A 10 G).

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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