EFFECTS OF DIFFERENT GROUNDCOVER APPLICATIONS ON AVAILABLE EASILY SOULBLE NITROGEN FORMS OF SOIL IN AN INTEGRATED APPLE ORCHARD IN EAST HUNGARY

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Abstract
Groundcover experiment was set up to investigate the mulching technique on easily mobilize nitrogen forms in an integrated, six-year-old 'Idared' (Malus domestica Borkh.) orchard (MM 106) soil. Applied treatments can be divided into two groups: different livestock manures and other mulches. Soil strips of 150 cm width were covered either with straw, different livestock manure, black plastic foil, pine bark mulch or were without cover i.e. clean cultivation as a check. Soil samples were collected for chemical analysis. The effect of different groundcover applications on the content of easily-soluble (0,01 M $CaCl_2$) nitrogen fractions of soil was studied. It was established that all applied treatments increased the content of different nitrogen fractions of soil. Difference among treatments was showed regarding to the degree of effects and the depth of soil.

Keywords: groundcover, available N forms, apple

INTRODUCTION

Nowadays conservation of soil moisture is the most goals of fruit growers in the semi-arid fruit growing zone (Neilsen et al., 2004). Unfortunately problems of water supply are turn into the focus in Eastern Europe as well. Increased use of organic materials as soil amendments or surface mulches have been advocated (Merwin et al. 1995) as compatible with integrated fruit production (IFP) since fertilizer and herbicide inputs can be reduced.
Moreover mulching has used generally in organic fruit farming all over the world due to benefits of it (Skroch and Shribbs 1986). Mulches applying for groundover are not only highly effective in checking evaporation and in preventing weed growth, but also have influence on several processes in the soil. The benefits are variously attributed to the suppression of weed growth, to the conservation of moisture by reducing evaporation and run off, to protection from erosion, to increased infiltration of water, to the increase or decrease of soil temperature fluctuations, to the enhancement of mineral nutrient availability, to the enhancement of nitrification, to additional nutrients and organic matter derived from a decomposing mulch, or to the preservation or improvement of soil structure (Merwin et al. 1994). Moreover, mulching has a positive effect on nutritional and biological factors as well.

On the one hand mulching produces an increase in the nutrient content of the soil by leaching of nutrients from the mulch, but at the same time the entire condition of nutrient availability may be modified for better or worse by changes induced by the mulch in the moisture and temperature regimes of the soil. On the other hand applying mulches increases root length density and brought the roots closer to the surface (Merwin and Stiles 1994).

Despite of above mentioned trend only little information is available concerning the effects of mulches on soil N processes in typical apple orchards in Hungary.

The aim of present paper is to study the effect of different groundcover methods on contents of easily soluble nitrogen forms of soil in integrated apple orchard.

MATERIAL AND METHODS

The experiment was carried out at the orchard of TEDEJ Rt. at Hajdúnánás-Tedej, in Eastern Hungary. The orchard was set up on lowland chernozem soil in the Nyírség region. It was established in the autumn of 1999, using grafted on MM106 rootstocks at a spacing of 3.8 x 1.1 m Idared cultivar, which was planted in plots. Each plot consisted of 10 trees. The orchard has been treated according to the Integrated Fruit Production guidelines. Orchard has irrigation system and applying if the weather conditions require but in 2005 the sampling site was not irrigated due to the sufficient rainfall. Soil samples were taken from three layers (0-20 cm; 20-40 cm and 40-60 cm) of each plot, at the middle of the section by using manual soil sampling equipment. Sampling was performed at the beginning of the vegetation period on April, in 2005, before applying groundcover matters. For the characterisation of the soil the most important soil parameters and nutrient status were determined. The applied treatments of examined orchard part shows in Table 1. Applied treatments were divided into two groups according to origin and effect. On the one hand different livestock manures, on the other hand different mulch-matters were used. The used different manures and mulches were applied to the surface to test the effectiveness of these materials. Layout of groundcover matter was the same all treatments. From the line of trees 0.75 m both deals all each plot. The covered area was 16.5 m^2.

Table1.

Applied treatments

Treatments	Applied dose (m^3/plot)
Control	-
Straw	2.475
Pine bark mulch	0.5
Cow manure	1.65
Horse manure	1.65
Pig manure	1.65
Black foil	0.5 mm thickness of a layer

Laboratory examination of soil samples

The soil samples were dried outdoors, in an airy place under air temperature in a 1-1.5 cm layer. Before grinding, samples were cleaned from plant remains and other possible dirt, and the soil was passed a 2 mm screen, homogenized and stored in plastic boxes in dry place until the examination. Besides the main characteristics of soil, the contents of macronutrients were measured by using two kinds of methods. For establishing the content of easily soluble nutrient forms of N, P and K 0.01 M $CaCl_2$ extractant was used according to the method described by Houba et al. 1986. For studying the available P and K content of soil the conventional extracting solution NH_4-lactate+acetic acid (so called AL extractant) was used according to the Hungarian standards. The humus content of soil calculated from organic carbon content of soil, which determined by dry combustion method (Nagy 2000).

RESULTS AND DISCUSSION

Results of soil sampling before treatments were set up

Results of soil sampling before treatments were set up were showed in Table 2.

Table2.

Results of soil sampling before treatments were set up

Parameters	Depth (cm) 0-20	20-40	40-60	0-60
pH (CaCl2)	7.43	7.36	7.54	7.44
Hu%	2.95	2.83	2.58	2.79
KA				45
CaCO3%	8.30	8.50	12.50	9.77
	mg/kg			
AL-P2O5	164.11	89.12	42.7	98.64
AL-K2O	263.93	160.69	88.65	171.09
CaCl2-NO3-N	13.05	8.29	5.25	8.86
CaCl2-NH4-N	1.05	0.76	0.19	0.67
CaCl2-Norg	3.29	4.32	2.64	3.42

The pH of soil was near the neutral value, slightly alkaline. The physical category of soil was clay loam with major carbonate content. According to results of AL solution the P- and K-supply of examined soil was in the "medium", but their amounts were significantly decreased by depth. Soil N was sufficient based on humus content.

The values of measured 0.01 M $CaCl_2$ soluble N forms correspond to the type of examined soil. Presence of mineral nitrogen was mainly as nitrate-nitrogen form due to soil pH. The nitrate and ammonium content of soil was low and decreased according to depth while the soluble organic nitrogen content of soil was slightly different among examined layers. Notable that the amount of soluble organic nitrogen content of soil is commensurable with mineral N forms of soil.

Results of soil sampling after treatments

The results of 0.01 M $CaCl_2$ soluble NO_3^--N of soil after treatments (autumn 2006) were showed in the Table 5. All used treatments increased 0.01 M $CaCl_2$ soluble NO_3^--N content of examined soil layers.The effect of manure treatments was the highest. Significant increasig was observed using by horse and pig manure especially. The effect of mulching and foil covering was the smallest.

Table3.

Effect of treatments on 0.01M $CaCl_2$ soluble NO_3^--N content of soil (2006)

NO_3^--N (mg/kg) **Treatments**	Depth (cm) 0-20	20-40	40-60
Control	2.01	0.72	0.40
Straw	7.23	8.16	10.16
Pine bark mulch	3.82	5.78	4.78
Cow manure	7.34	6.26	10.65
Horse manure	14.60	8.59	7.51
Pig manure	17.51	10.18	11.90
Black foil	2.98	2.66	3.21
Average	***7.93***	***6.05***	***6.94***
$LSD_{5\%}$	***4.13***	***2.33***	***2.97***

The results of 0.01 M $CaCl_2$ soluble NH_4^+ -N of soil after treatments (autumn 2006) were showed in the Table 4.

Table 4.

Effect of treatments on 0.01M $CaCl_2$ soluble NH_4^+-N content of soil (2006)

NH_4^+-N (mg/kg) **Treatments**	Depth (cm)		
	0-20	20-40	40-60
Control	2.53	0.91	0.70
Straw	3.90	5.07	3.16
Pine bark mulch	4.67	6.61	1.57
Cow manure	2.46	3.85	4.44
Horse manure	4.98	5.37	4.24
Pig manure	8.34	3.41	3.51
Black foil	1.94	2.03	1.22
Average	***4.12***	***3.89***	***2.69***
$LSD_{5\%}$	***1.52***	***1.37***	***1.05***

Beside horse and pig manure using of pine bark much increased significantly the easily soluble ammonium nitrogen of examined soil layers.

Applied treatments increased the amount of 0.01 M $CaCl_2$ soluble ammonium in slighter degree than measured nitrate. It was especially true for the upper layer of soil.

Moreover the amount of 0.01 M $CaCl_2$ soluble ammonium was increased more expressive in all treatments than in the control in the upper layers of soil (Table 5).

The results of 0.01 M $CaCl_2$ soluble organic N of soil after treatments (autumn 2006) were showed in the Table 5.

Table5.

Effect of treatments on 0.01M $CaCl_2$ soluble organic N content of soil (2006)

Organic N (mg/kg) **Treatments**	Depth (cm)		
	0-20	20-40	40-60
Control	2.51	3.52	2.86
Straw	3.17	4.95	3.79
Pine bark mulch	2.44	4.95	4.80
Cow manure	3.83	4.25	3.84
Horse manure	3.40	3.66	3.91
Pig manure	9.19	8.10	7.92
Black foil	3.31	3.97	3.85
Average	3.55	4.77	4.42
$LSD_{5\%}$	1.88	1.09	1.14

Significantly higher organic N was measured in the upper layer of soil when pig manure was used. But most treatments increased the easily soluble organic N of soil in deeper layers. Slightly effect was caused applied no manure treatments also compared to the control. Easily soluble organic N fraction is distributed smoother in the examined layers than inorganic forms. Its amount increased by depth. Amount of easily soluble organic nitrogen form was essential and significant as compared to inorganic nitrogen forms.

CONCLUSIONS

- Our results pointed out that used ground covering matters divided into more categories regarding their effects.
- Available N, P and K content of soil was mostly incresed by applying manures.
- Effectiveness of straw, mulch and mostly black foil was more lower than using diffent manures.
- Differences were found between nutrient supplying treatments and those treatments which did not supply nutrients.

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REFERENCES

1. Houba V.J.G., Novozamsky I., Huybregts A.W.M., J.J. van der Lee (1986): Comparison of soil extraction by 0.01M CaCl2 by EUF and by some conventional extraction procedures. Plant and Soil 96:433- 437.
2. Merwin, I.A., W.C. Stiles, and H.M. van Es. (1994): Orchard groundcover management impacts on soil physical properties. J. Amer. Soc. Hort. Sci. 119:209-215.
3. Merwin, I.A., and W.C. Stiles (1994): Orchard groundcover management impacts on apple tree growth and productivity, and soil nutrient availability and uptake J. Amer. Soc. Hort. Sci. 119:216-222.
4. Merwin, I. A., Rosernberger, D.A., Engle, C.A., Rist, D.L., Fargione, M. (1995): Comparing mulches, herbicides and cultivation as orchard ground cover management systems. Hort Technology 5:151-158.
5. Nagy P.T. (2000): Égetéses elven működő elemanalizátor alkalmazhatósága talaj- és növényvizsgálatokban. Agrokémia és Talajtan 49. 3-4. 521-534.
6. Neilsen, G.H., Hogue, E.J., Neilsen, D., Forge, T. (2004): Use of organic applications to increase productivity of high density apple orchards. Acta Horticulture 638: 347-356.
7. Skroch W.A. and Shribbs J.M., (1986): Orchard floor management: an overview. HortScience 21: 390– 393.