ORIGINAL SCIENTIFIC PAPER

Study of the Effect of Different Groundcover Matters on the Leaf Micronutrient Content in an Integrated Apple Orchard in Eastern Hungary

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Abstract

In this study the effects of different groundcover materials on plant nutrition were investigated. Trees of apple cv. 'Idared'/MM.106 (*Malus domestica* Borkh.) were planted into lowland chernozem soil in the spring of 1999. 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. Leaf and soil samples were collected for chemical analysis.

The best results were obtained when cow manure was applied as cover matter in the orchard. Different groundcover matters affected all examined leaf micronutrient status but the effects were inconsistent across treatments. The effect of year was notable in the orchard.

In the year of treatment, higher Zn and Cu but lower Mn and B contents were measured in apple leaves than in the following year.

Keywords: apple, groundcover, soil and leaf analysis, micronutrients, orchard floor management

Introduction

According to Libik and Wojtaszek (1973) the practise of mulching, well known to horticulture, is perhaps as old as agriculture itself.

In the last few years ground covering technique has spread all over the world due to applying of it mostly in organic and integrated fruit farming (Skroch and Shribbs, 1986). So, the importance of this topic is getting improves as it looks a nutritional tool in organic production systems.

Mulching has several benefits which were summarized by Merwin et al., (1994). Mulches 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.

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

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Stiles, 1994). Moreover, mulching enhances apple fruit storage quality (Lang et al., 2001).

Despite of these, there are only little information about orchard floor management and its application in Central-Europe.

The aim of present paper is to study the effect of different groundcover materials on micronutrient contents of apple leaf in an orchard situated in Eastern Hungary and produce more data in this topic.

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 cv. '*Idared*' which was planted in plots. Each plot consisted of 10 trees. The orchard has been treated according to the Integrated Fruit Production guidelines.

Between rows the soil was covered with grass. Orchard has irrigation system and applying if the weather conditions require but between 2005 and 2006 the sampling site was not irrigated. 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.

Plant samples (leaf) were taken at the end of July both in 2005 and 2006. Leaves were collected from all trees of each plot according to the Hungarian sampling guidelines.

The applied treatments of examined orchard part shows in Table 1.

Table 1. Treatments in orchard

Treatment	Code of treatments	Applied dosage (m^3/plot)
Control	C	-
Black foil	BF	0.5 mm thickness of a layer
Straw	S	2.475
Pine bark mulch	PBM	0.5
Cow manure	CM	1.65
Horse manure	HM	1.65
Pig manure	PM	1.65

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 matters 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 at all treatments.

Pretreatment 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 macro- and micronutrients were measured. For establishing the content of easily soluble and available 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 Zn, Cu and Mn content of soil the conventional extracting Lakanen-Erviö solution (LE) was used (Lakanen and Erviö 1971). The humus content of soil calculated from organic carbon content of soil, which determined by dry combustion method (Nagy, 2000).

Pretreatment of plant samples

Pretreatment of the plant samples involve drying, grinding and washing. The samples were washed to remove dust and possible remains of pesticide, than firstly dried outdoors in an airy place under air

temperature and secondly in a well-ventilated drying oven at 40 °C to avoid N losses. Then the material was finely grounded and homogenized.

The dried and grounded samples should be stored in paper bags in a cool and dry place protected against direct sunlight.

The amount of Zn, Cu and Mn were determined by atom absorption spectrophotometry, B by colorimetry using Azomethin-H method.

Results and discussion

Results of soil analysis

Besides conventional soil testing procedures (using LE extractant and determination of humus content) the 0.01 M $CaCl_2$ was used to give further information about the easily soluble and available nutrient forms of soil. Obtained results of soil analysis are represented in Table 2.

Table 2. Results of soil analysis (2005)

Method	Depth			
	0-20	20-40	40-60	0-60
pH ($CaCl_2$)	7.43	7.36	7.54	7.44
H%	2.95	2.83	2.58	2.79
K_A*				45.00
			mg/kg	
K ($CaCl_2$)	60.34	37.71	21.93	39.99
P ($CaCl_2$)	0.59	0.61	0.5	0.57
NO_3-N ($CaCl_2$)	13.05	8.29	5.25	8.86
NH_4-N ($CaCl_2$)	1.05	0.76	0.19	0.67
Zn (LE)	1.81	1.56	1.1	1.49
Cu (LE)	2.98	2.72	1.7	2.50
Mn (LE)	159	132	154	148.00

* - Plasticity index according to Arany (It was established in the 0-60 cm layer, only.)

The pH of soil was near the neutral value. The physical category of soil was clay loam.

As the micronutrient status of soil can not establish without the macronutrient content of soil the most important content of macronutrients were measured as well.

The amount of 0.01 M $CaCl_2$ soluble N forms was low and mainly appearance as nitrate-nitrogen. The nitrate and ammonium content of soil decreased according to depth.

The amount of 0.01 M $CaCl_2$ soluble phosphate fraction was low and was not change among layers significantly. Amount of easily soluble K was major and decreased according to depth as well. It is explained by the high dosage of applied organic manure (60 t/ha) before planting. Content of micronutrients were low especially Zn and Cu while Mn content of soil was notable (Table 2.).

Results of leaf analysis

The results of plant samplings are showed in Table 3.

Our results pointed out that the Zn content of leaves was optimum in all treatments. The highest value was measured in the CM treatment while the lowest in the S and PBM treatments. Lower leaf Zn was measured in all treatments in 2006 than in the year of groundcover application. In this year, only the CM treatment had significant positive effect on leaf Zn (Table 3).

Optimum growth of apple trees is associated with Cu contents of leaf, approximately 5-20 mg/kg dry matter according to Hungarian standards (Papp, 1997).

In 2005, the lowest Cu content was measured in the PBM and the PM treatments, while the highest in the CM treatment. Significant effect of treatment was observed only in these treatments. In 2006, lower leaf Cu values were measured independently the treatments (Table 3.).

From results of 2005 it was evident that all treatments increased the leaf Mn compared the control. This increasing was statistically significant (P=5% level) at all treatments except at BF and HM treatments. This

effect was not clear in 2006 but higher leaf Mn content was measured in the treatments of different livestock manures than the control. Furthermore, in all treatments higher values were measured in 2006 than in 2005. This effect was observed at leaf boron determination as well. All applied treatments increased the leaf boron concentration significantly compared to the control in 2005. This effect was inconsistent in 2006.

It was found that use of different groundcover matters affected leaf micronutrient status but the effects were inconsistent across treatments. Moreover the effect of year was notable. In the year of application higher Zn and Cu but lower Mn and B contents were measured in apple leaves than in 2006.

Summarized obtained results, the best results were achieved when cow manure was applied as cover matter in the orchard.

In general, it seemed that the treatments of livestock manures are better than applying mulch-matters. It was connection with the micronutrient supply ability of livestock manures.

Hereby, our results confirmed that the applied treatments could be divided into two groups according to their origin and plant nutritional aspects.

Table 3. Results of leaf analysis (2005-2006)

	Zn		Cu		Mn		B	
	mg/kg of dry matter							
	2005	2006	2005	2006	2005	2006	2005	2006
Control	35.48	30.80	12.40	5.60	141.90	189.10	26.84	32.20
Black foil	30.64	25.00	12.80	6.50	155.60	177.80	29.17	33.78
Straw manure	26.73	26.50	12.00	4.60	170.00	176.80	29.75	40.72
Pine bark mulch	26.11	19.30	11.50	3.80	170.80	170.20	30.05	30.93
Cow manure	38.25	35.60	13.20	5.10	181.40	224.90	30.63	60.29
Horse manure	29.29	28.10	12.90	5.10	151.40	201.80	30.63	41.67
Pig manure	30.73	20.90	11.50	1.60	210.40	229.80	29.17	27.46
Mean	31.03	28.03	12.33	4.61	168.79	195.77	29.46	38.15
SD	4.43	6.74	0.68	1.57	22.71	23.89	1.30	11.03
$LSD_{5\%}$	3.28	5.00	0.51	1.16	16.83	17.70	0.97	8.17

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