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CHANGES IN GREEN WEIGHT PRODUCTION AND IN SOIL NUTRIENT SUPPLYING CAPACITY IN CASE OF ORGANIC AND NPK FERTILIZED ONION CULTIVATIONS

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Abstract. *In our comparative greenhouse experiment we examined the effect of EM- 1 microbial yield enhancing vaccine, an organic cow manure and an NPK fertilizer on the nutrient supplying capacity of the soil. The test plant was onion (Allium cepa L.) and the applied soil was humic sandy soil. The wet and dry matter production and the element content of plant samples were also determined, from which the element uptake was calculated. We also determined the amount of readily available nutrients in the soils of several treatments. The 0.01M $CaCl_2$ soluble K, Mg, Mn, NO_3^- -N, NH_4^+-N, organic-N, total-N contents, pH of soil, and the AL soluble P_2O_5, K_2O, Ca, Mg of soil also were determined. The increasing effect of NPK fertilizer on the yield was greater than that of organic manure and EM-1 + straw. The green mass production of NPK fertilized plants were withdrawn from most of the soil nutrient. In the growing season the soil pH reduced as an effect of NPK fertilizers, which can cause problems in further cultivations. Organic fertilization had a positive effect on the mineralization of nutrients in the soil.*

Keywords: onion, fertilization, mineralization

1. Introduction

The main task of today's agriculture is to ensure sufficient and appropriate quality food and to generate industrial raw material. Nutrients uptaken by yield is replaced mainly by fertilizers in addition to organic fertilizers which improper use or overdose can be harmful to the environment [1]. The application of high doses of fertilizers can cause soil acidification [2, 3, 4, 5].

Soil pH has a direct or indirect effect on the life of plants, on the quantity and quality of their yields. Its direct effect prevails on the dissolution of nutrients and their uptake. The indirect effect of soil pH is the influence of the life of soil microbes which modify the mobilization of nutrients.

Today, it is important for farmers to decrease or eliminate the environmental load and the use of chemicals. From this concern environment-friendly organic farming methods evolved out in our country and throughout the developed world,

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which retain and even improve soil fertility without the use of chemical products [6, 7, 8, 9]. It maintains soil structure and the balance of soil organisms. The increase of organic matter in soil reduces the leaching of mineral nutrients.

The organic farming has very strict rules. Organic plants can not be treated with synthetic chemicals (fertilizers, pesticides). The nutrient supply is provided by organic manure, green manure and bacterial products, and biological pest control can only be used [10, 11].

The question can be raised whether plants are able to uptake the required amount of nutrients in all developmental stages in organic production. Thus in our paper we compared the crop yields and the nutrient supply capacity of soils from organic cultivation versus integrated cultivation

2. Material and Methods

A pot experiment was carried out in spring 2015 at the University of Debrecen in Hungary. The test plant was onion (Allium cepa L.) The main physico-chemical characteristics of the soil are shown in Table 1.

Table 1) The characteristics of humic sandy soil from Pallag

Humusz %	1.4
pH ($CaCl_2$)	5.84
$CaCl_2$-os NO_3^- /N (mg kg-1)	6.15
$CaCl_2$-os NH_4^+ /N (mg/kg)	1.91
$CaCl_2$-os szerves N (mg/kg)	7.55
$CaCl_2$-os összes N (mg/kg)	15.6
$CaCl_2$-os K (mg/kg)	159
$CaCl_2$-os Mg (mg/kg)	9.65
$CaCl_2$-os Mn (mg/kg)	11.75
AL-P_2O_5 (mg/kg)	274
AL-K_2O (mg/kg)	286.6
AL-Ca (mg/kg)	1185
AL-Mg (mg/kg)	117

Based on the data the soil nutrient supply is the following: moderate for nitrogen, good for potassium, and high for phosphorus. [12, 1]

During the experiment, 60 pots were used, we filled the pots with 2.5 kg soil and sown 4 onions per pots. 15 pots got (NPK) fertilizer application, another 15 pots treated with organic cattle manure (BIO.1.), and again 15 pots with wheat straw and yield enhancing vaccine (EM-1) (BIO.2.), 5 pots got no treatment (control). The applied treatments are shown in Table 2.

Table 2) Applied treatments

Treatments	Nutrient dose (g/pot)
NPK	0.25 g N 0.15 g P_2O_5 0.27 g K_2O
BIO.1.	0.25 g N 0.15 g P_2O_5 0.27 g K_2O
BIO.2.	0.25 g N 0.11 g P_2O_5 0.6 g K_2O
CONTROL	-

Nitrogen and phosphorus are added to the soil as ammonium dihydrogen phosphate and ammonium nitrate solution and potassium was added as potassium chloride solution. We tried to apply the same amount of nutrients by BIO.1. treatment with mature cattle manure and by BIO.2. treatment with wheat straw. The breakdown of straw was enhanced by the EM-1. vaccine. EM-1. is a microbial yield enhancing vaccine that contains useful and effective microorganisms in high concentration and in high spectrum of bacteria species. It contains micro and actinomycetes and various symbiotic bacteria in nearly equal proportions. So it enhances N fixation and P exploration.

Onion sets were planted.

Soils were kept at constant moisture by daily irrigation at 60% of field water capacity.

The onion was harvested as green onions. Soil and plants samples were collected at this time.

For determining P and K contents, first homogenized plant samples (0.5 g each sample) were digested with cc. 5 cm^3 H_2SO_4 and 5 cm^3 H_2O_2 in a heating block digestor, at 220 ^oC until full digestion. Then phosphorus was quantified by colorimetrically with phosphomolybdovanadate method using a spectrophotometer. [13] Potassium content was determined by flame atom emission spectrophotometry. For determining Ca, Mg and Mn contents, homogenized plant samples (0.5 g each sample) were digested with cc. 10 cm^3 HNO_3 until full digestion. Amount of Ca, Mg and Mn were determined by atomic absorption spectrophotometry using a Varian SpectrAA-10 Plus spectrophotometer.

The total nitrogen content of plants was measured by dry combustion method [14].

Concentrations of water soluble nitrogen forms were measured in 0.01 M $CaCl_2$ extracts after 2 h shaking with 1:10 soil:solution ratio [15]. NO_3^-, NH_4^+ and total N was determined by Contiflo device, the organic-N concentration was calculated as the difference between total nitrogen and inorganic nitrogen (NO_3^-+NH_4^+) as described by Houba et al. [16]. The pH of the 0.01 M $CaCl_2$ extract was measured with glass-calomel combination electrode (Radelkis OP-0808P digital pH meter), and Mg and Mn contents were determined by atomic absorption spectrophotometer (Varian AA10 Plus).

Phosphorus content of the AL extract [17] was measured with UV-VIS spectrophotometer [17], while the amount of K, Ca and Mg was measured with flamephotometer (Unicam SP90B) and by atomic absorption spectrophotometer.

Significant differences were examined by One way Anova test using the statistical package of Microsoft Excel.

3. Results and Discussion

3.1. The yield results

Table 3 shows the wet mass of onion in case of the different treatments. It can be seen that the yield increased in all treatments compared to the control. The yield increasing effect of fertilizers was higher than that of organic manure and the EM-1 + straw application. The NPK fertilization increased the yield mass significantly compared to the control treatment as well as to the BIO.1., BIO.2. treatment, while the yield increasing effect of BIO.1. and BIO.2. treatments can not be proven statistically.

Table 3) Wet matter content and the amount of nutrients extracted from the biomass plant

QUANTITY	CONTROL	NPK	BIO.1.	BIO.2.
Wet weght (g)	193.1	342.7	210.9	197.3
$LSD_{5\%}$	70.10			
N (mg)	571.2	1013	623.9	592.3
$LSD_{5\%}$	205.5			
P (mg)	101.5	108,9	77.08	83.13
$LSD_{5\%}$	14.71			
K (mg)	652.9	887,2	590.8	620.7
$LSD_{5\%}$	132.6			
Ca (mg)	184.6	315,8	191.8	187.8
$LSD_{5\%}$	62.65			
Mg (mg)	43.95	77.73	46.93	44.82
$LSD_{5\%}$	15.97			
Mn (mg)	29.42	44.19	30.27	30.12
$LSD_{5\%}$	6.99			

Discernible, to produce higher green mass the plants took more nutrients from the soil up. The fertilized plants were withdrawn from most of the fertilising element from the soil. The NPK - control treatments between quantities (excluding P), the difference is statistically justified. The BIO.1. and BIO.2. treatments plant tendency more nitrogen, calcium, magnesium and manganese were withdrawn from the soil than in the control plants.

3.2. The results of 0.01 M $CaCl_2$ soil extracts

From the data of Table 4 it can be concluded that the different treatments changed the soil pH variously.

At the beginning of the experiment the soil pH was 5.84 and in case of control and BIO.2. treatments it decreased slightly, while the NPK fertilization acidified the soil significantly. The application of organic manure (BIO.1. treatment) increased soil pH, it became more favorable to the end of the experiment. The effect of NPK and BIO.1. treatments on soil pH were statistically justifiable compared to the control by the end of the season.

At the end of the vegetation period the 0.01 M $CaCl_2$ soluble total N contents of soil show large differences in the treatments (Table 4). At the beginning of the growing season the amount of added nitrogen was the same for all treatments, but the added N forms were different. By NPK treatment the amount of yield was higher than that of the other two treatments and the control, therefore the plant withdrew more nitrogen from the soil here. Based on our results however we can conclude that the most 0.01 M $CaCl_2$ soluble total nitrogen content remained in case of this treatment. This result can be explained by the fact that most of the N forms of BIO.1. and BIO.2. treatments was not directly available for the plants thus it was in 0.01 M $CaCl_2$ soluble form nor at the beginning neither at the and of the experiment. Our results show that the EM-1 vaccine contributed to the degradation of straw in soil, since 0.01 M $CaCl_2$ soluble total N content of the BIO.2. treatment was greater than that of the BIO.1. treatment and the control.

The method of nutrient supply also affects the amount of 0.01 M $CaCl_2$ soluble nitrogen forms. In case of NPK treatment the largest amount of nitrogen is in nitrate- ion, while at the BIO.1., BIO.2. treatments and control the dominant N forms were organic forms and ammonium ion.

Comparing the soil 0.01 M $CaCl_2$ soluble K contents it can be stated that by the end of the growing season, the K contents reduced in all treatments compared to the initial K contents although this element was replaced. We found no significant difference between the K content of control and the treatments. The different fertilization treatments resulted differences in soil 0.01 M $CaCl_2$ soluble K contents as well.

Table 4) The pH and N - K- Mg - Mn -concentrations (0.01M $CaCl_2$ extraction) in the soils with different fertilizers

0.01M $CaCl_2$ extraction	**CONTROL**	**NPK**	**BIO.1.**	**BIO.2.**
pH	5.17	5.6	6.11	5.63
$LSD_{5\%}$	0.37			
N (mg kg^{-1})	4.612	52.62	5.142	10.15
$LSD_{5\%}$	23.71			
NO_3^- /N (mg kg^{-1})	0.101	44.23	0.312	0.101
$LSD_{5\%}$	21.62			
NH_4^+ /N (mg kg^{-1})	1.372	4.471	1.262	4.031
$LSD_{5\%}$	1.551			
organic N (mg kg^{-1})	3.233	3.922	3.588	6.122
$LSD_{5\%}$	1.377			
K (mg kg^{-1})	107.1	154.7	144.1	124.6
$LSD_{5\%}$	20.68			
Mg (mg kg^{-1})	9.051	8.702	9.603	9.164
$LSD_{5\%}$	0.367			
Mn (mg kg^{-1})	8.601	14.31	5.401	6.421
$LSD_{5\%}$	3.901			

Among the measured nutrients we did not add magnesium and manganese to the soil with the fertilizer (NPK) treatments, but organic cattle manure (BIO.1.) and straw (BIO.2.) contained the former two elements. Our results also support this.
The results of the experiment showed that the soil $CaCl_2$ soluble Mg content in the organic treatments (BIO.1.-2.) hardly reduced by the end of the growing season (Table 4. The lowest Mg concentration was measured by NPK fertilization. The initial concentration (9.65 mg kg^{-1}) decreased by almost 10%. This result also shows that the integrated production mode should take care of the Mg nutrient replacement as well.
For Mn it can be stated that although the NPK fertilized plants removed the most Mn from the soil yet at the end of the experiment, the easily available Mn content was the greatest in case of these treatments. The high Mn content that was more than at the beginning of the experiment (11.75 mg kg^{-1}), can be explained by the acidification of soil. Our result is statistically justified.

3.3. The results of AL soil extracts

Table 5 shows the AL soluble phosphorus content of the soils at the various treatments. It can be seen that the soil P content increased compared to initial state (274 mg kg^{-1}) except for the control.

P reserve was remained at the end of the growing season from the different nutrient supplying methods. Compared to the control it is statistically justified.

The soils treated with NPK fertilizer contained less AL- P_2O_5 than the soils of BIO.1. and BIO. 2. treatments, which can be explained by the higher yield. The difference between BIO.1 and BIO.2. treatments, which was not statistically justified, can be explained by the fact that straw contains proportionately less P.

Table 5) The P_2O_5-, K_2O-, Ca – and Mg -concentrations (AL extraction) in the soils with different fertilizers

AL extraction	CONTROL	NPK	BIO.1.	BIO.2.
P_2O_5 (mg kg^{-1})	262.4	285.3	292.2	286.6
$LSD_{5\%}$	12.87			
K_2O (mg kg^{-1})	239.7	303.0	291.3	251.1
$LSD_{5\%}$	30.02			
Ca (mg kg^{-1})	964.1	968.7	1127	1320
$LSD_{5\%}$	164.7			
Mg (mg kg^{-1})	111.1	116.3	133.3	115.6
$LSD_{5\%}$	9.567			

The AL soluble potassium content (Table 5) of the soils at the various treatments. According to it, the AL soluble K contents increased significantly at the end of the growing season compared to the initial K content (286.6 mg kg-1) for NPK treatment and organic cattle manure treatment (BIO. 1.). The AL-soluble potassium content increased parallel with the 0.01 M $CaCl_2$ soluble K content. The AL-soluble Ca content of soils due to the decreased production (exception:BIO.2). In the control and NPK treatments the change large. In the BIO.1. treatment of the decline is smaller.The straw treatment plants (BIO.2.) less amounts of calcium were withdrawn from the soil, such as NPK and BIO.1. treatment plants. Straw also contains calcium, the EM-1 helped the Ca into the soil. Of soil the BIO. 2. treatment more quantities contained than other treatments.The effect is statistically justified.

The AL-soluble Mg content of soils due to the decreased production (exception: BIO.1.).

Conclusions

Based on our results the yield increasing effect of NPK fertilizer on the yield was greater than that of organic manure and EM-1. + straw. In the applied fertilizers the nutrients are present in readily available form, while in mature organic fertilizer and wheat straw the nutrients can be only utilized after transformation by soil microorganisms. Thus on the basis of our experimental results it can be concluded that organic manures and stalks must be applied sooner, than fertilizers. To produce higher green mass the plants took more nutrients from the soil up.

The NPK - control treatments between quantities (excluding P), the difference is statistically justified.

In the growing season the soil pH reduced as an effect of NPK fertilizers, which can cause problems in further cultivations. In case of organic treatments (BIO.1. és BIO.2.) the soil pH increased slightly so that the soil properties in the next growing season became more favorable. The way of nutrient supply influences the amount of 0.01M $CaCl_2$ soluble total nitrogen, the quality and quantity of nitrogen forms. Contrary to NPK treatment in case of BIO.1. and BIO.2. treatments even at the end of the experiment most of the N forms was not in 0.01 M $CaCl_2$ soluble form, that is readily available for plants. Our results show that the EM-1 vaccine contributed to the degradation of straw in soil. The different fertilization treatments resulted in differences in soil 0.01 M $CaCl_2$ soluble K concentrations as well. At the end of the growing season the soil $CaCl_2$-soluble Mg content for organic treatments (BIO.1.-BIO. 2.) declined only slightly, whereas for NPK fertilizer the decline was nearly 10%. This result also shows that the integrated production mode should take care of the Mg nutrient replacement as well. By the end of the experiment the 0.01 M $CaCl_2$-soluble Mn content of the soils increased in spite of the increased plant uptake, which can be explained by the acidifying effect of fertilizers. In case of a soil with poor pH buffering capacity the long term use of NPK fertilizers can cause Mn dissolution to such an extent which can be toxic for plants. This problem does not arise by organic fertilized soils.

The 0.01 M $CaCl_2$ soluble nutrient contents of the soil are proportional to the AL soluble nutrients. The AL soluble phosphorus content of the soils at the various treatments increased compared to initial state. The AL soluble K contents increased significantly at the end of the growing season compared to the initial K content. The AL-soluble potassium content increased parallel with the 0.01 M $CaCl_2$ soluble K content. The AL-soluble Ca and Mg content of soils the end of the growing season due to the decreased.

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