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Original Article

Hairy Vetch and Common Vetch for Soil Improvement and Conservative Tillage Establishment in the Republic of Moldova

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Abstract

The aim of the research was to test hairy and common vetch as possible cover crops for no-till implementation in conditions of the Republic of Moldova. The influence of vetch on soil physical and chemical properties was esteemed. Besides it was appreciated the effect of cover crops on cash crop yields. It was established that vetch had a positive influence on soil quality and fertility and can be used as cover crop in conditions of the Republic of Moldova.

Keywords: hairy vetch, common vetch, soil quality, soil fertility, organic matter, crop yield.

1. Introduction

Conservative tillage systems are being used worldwide for a long time, but they a relative new for the Republic of Moldova. According to the data of the Ministry of Agriculture and Food Industry of Republic of Moldova (MAFI) on February 2013 no-till technology was implemented by 18 farmers on 5% of country arable land (MAFI official website). Taking into consideration that the Ministry sustains and promotes the implementation of soil conservation technologies, it is expected an expansion of areas where no-till is implemented.

The use of no-till technology is inextricably linked with the presence of cover crops in crop rotation in order to assure biodiversity, increase and sustain soil quality, provide nutrition for plants etc.

This is particularly important for soils of Moldova because of about 77% of them are fine textured and strongly require additional supplies of organic matter. Under such circumstances it was decided to test hairy vetch and common vetch as a soil remedy before no-till implementation and potential cover crop plants in conditions of the Republic of Moldova.

2. Material and Method

The research was carried out in 2010-2012 in the central part of Moldova, Orhei district, Ivancea village, at the experimental station of Institute of Pedology, Agrochemistry and Soil Protection "Nicolae Dimo". The purpose of our investigations was to test the influence of hairy vetch and common vetch on soil quality and fertility. The experiment was established on arable greyzems, with average humus content about 2.32%, clay loam texture, moderate phosphorus and potassium content and pH = 6.3 - 6.5. In order to determine initial soil state soil samples were collected before the experiment. In

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literature it is recommended to sow hairy vetch late August – September [3].In our case it was sown in September. So, in autumn 2010 the experimental plot was sown with a mix of hairy vetch and winter wheat with the ratio 80 : 20. In April 2011 hairy vetch was incorporated into the soil with harrow disk at a depth of 12 cm. After that the plot was divided into two parts: the first one was sown with the mix of common vetch and rye and the second one with sunflower. Sunflower was also sown on a control-plot in order to determine the influence of hairy vetch on cropyield. In the middle of July common vetch was mowed for hay and the remains were incorporated into the soil with disk harrow.

Sunflower was collected in September. In October 2011 both plots were sown with winter wheat which was collected in June 2012. Average crop yields were determined by manually collecting arbitrarily selected five squares of size 1 x 1 m. Soil samples were collected after each cover crop and before winter wheat planting. In the research were used the approved laboratory and field research methods. Soil bulk density was determined by core method, total porosity by calculation.

Degree of compaction was calculated using formula given by [3]. The organic matter content was determined by Tiurin method, total nitrogen content by Kjeldahl method, mobile phosphorus and potassium by Machighin method, soil pH by electrometric method [1].

3. Results and Discussions

Hairy vetch and common vetch were never tested in conditions of Moldova in aspect of soil remediation. The results of our investigations showed that the selected cover crops have a positive influence on soil quality. Visual comparison of soil profiles before the experiment and after consecutive growing of hairy and common vetch (Figure 1) revealed that greyzems, initially poorly structured and compacted, as a result of roots activity acquired granular structure, increased pore space and loosened. A layer about 12 cm thick enriched with organic matter begin to form due to accumulation of plant residues and living roots.

Soil laboratory analysis revealed the improvement of soil physical state (table 1). Bulk density reduced significantly in the first 12 cm of soil from 1.36 to 1.17 g/cm^3.There were smaller changes in the next two soil layers where soil bulk density decreased from 1.52 - 1.56 g/cm^3 to 1.45 - 1.52 g/cm^3. No changes were observed in the layer 34 - 50 cm. Because of the initial high compaction plant roots were unable to penetrate it. Soil total porosity also improved. As regards soil porosity the most important changes were produced in the first 12 cm of topsoil where total porosity values increased from medium to high. Some slight changes were observed in 12 - 20 cm: total porosity values rose from very low to low and no changes were detected in the next layers. Besides this parameters changed in positive direction the degree of compaction of greyzems. The effect of vetch on soil degree of compaction had similar trends: soil became loose in 0 - 12 cm layer and a positive tendency was fixed in 12 - 20 cm layer.

The amount of organic matter in greyzems was also positively influenced by use of hairy and common vetch (table 2). In natural ecosystem (forest) greyzems have the weighted average humus content 3.76% in 0 - 34 cm layer [7]. According to the recent research conducted at the same experimental station, greyzems, being introduced in agriculture about one hundred years ago, lost about 1.43% of humus from 0 - 34 cm soil layer or 38% of its initial content. The reserves of organic matter in arable layer 0 - 34 cm decreased by about 70.5 t/ha [7]. The present research showed that the consecutive growth of winter and common vetch added an average 0.32% of fresh organic matter in 0 - 12 cm of the soil.

Winter vetch alone increased organic matter content by 0.16% in the same layer. It is noticeable that by the month of October the fresh organic matter began to decompose and its levels went down by 0.11%. The results are not as high as expected because of very dry weather in fall 2010 that resulted in low yield of winter vetch.

Total nitrogen content in the soil is closely linked to the organic matter content and it increased respectively).

The best result was obtained on the plot where two vetches were grown consecutively. Here the values of total nitrogen content rose from low to medium in the first 20 cm of soil where the main amount of fresh organic matter was concentrated. Significant changes in the amount of total nitrogen were detected on the second plot where its values increased in the first two layers of soil from 0.141% to 0.168% (0 - 12 cm) and from 0.130% to 0.168% (12 - 20 cm).

It is claimed that the use of cover crops helps to nutritive elements uptake from the depth to the upper layers of soil [6, 9].

Unfortunately that did not happen in our case because, as it was mentioned before, the roots of vetch couldn't penetrate the compacted 34 - 50 cm layer of the soil. So, the results of the laboratory analysis showed a small rise of mobile forms of phosphorus and potassium in soil but the data are not statistical reliable.

Figure 1. a) Initial state of arable greyzems; b) greyzems under *Vicia Sativa* L.

Table 1. Influence of vetch on physical properties of greyzems

Soil depth	Initial soil state, autumn 2010	Soil state after hairy vetch	Soil state after common vetch	Soil state three months later after incorporation of common vetch (before winter wheat planting)
Bulk density, g/cm^3				
0-12	1.36	1.17	1.17	1.22
12-20	1.52	1.46	1.45	1.41
20-34	1.56	1.52	1.50	1.51
34-50	1.62	1.61	1.61	1.61
Total porosity, % v/v				
0-12	48.2	55.0	55.0	53.1
12-20	41.8	43.8	44.2	45.8
20-34	40.2	41.8	42.5	42.1
34-50	39.5	39.5	39.5	39.5
Degree of compaction, %				
0-12	5.8	-5.3	-5.3	-1.6
12-20	18.3	15.7	15.0	12.0
20-34	21.5	18.9	17.4	18.2
34-50	24.2	22.9	22.9	22.9

The use of vetch had no influence on soil pH that remained constant during the experiment.

Hairy vetch is known to fix significant amounts of nitrogen, from 50 to 100 N_2 kg/ha $^{-1}$[4]. Incorporation of legume crops into the soil had a favorable consequence for sunflower and winter wheat harvest due to additional organic matter and respectively nitrogen input and as a consequence a better water retention.

The increase of sunflower crop sown after hairy vetch was 0.4 t/ha while the yield of sunflower on the control plot was 2 t/ha.

Table 2. Influence of vetch on chemical properties of greyzems

Soil depth	Humus	Total nitrogen %	Mobile forms, mg/100g		pH
			P_2O_5	K_2O	
Initial soil state, autumn 2010					
0-12	2.41	0.141	2.80	19	6.5
12-20	2.18	0.130	2.00	16	6.3
20-34	1.59	0.130	1.50	11	6.1
34-51	0.87	0.117	1.00	10	6.1
Soil state after hairy vetch					
0-12	2.57	0.196	2.54	19	6.2
12-20	2.13	0.168	2.12	13	6.3
20-31	1.86	0.151	2.00	13	6.4
31-50	1.04	0.146	1.10	11	6.3
Soil state after common vetch					
0-12	2.73	0.224	6.78	16	6.0
12-20	2.15	0.190	4.50	14	6.1
20-34	1.92	0.157	3.80	13	6.2
34-50	0.96	0.134	2.10	13	6.1
Soil state three months later after incorporation of common vetch (before winter wheat planting)					
0-12	2.62	n/a	2.68	19	6.1
12-20	2.17	n/a	1.76	17	6.1
20-35	1.72	n/a	1.50	11	6.2
35-50	1.06	n/a	1.10	10	6.2

The biggest yield of winter wheat was obtained in the case of wheat sown after hairy and common vetch, it made 4.1 t/ha. The result was very good taking into consideration dry weather conditions of that year, for comparison the control plot yield was 2.4 t/ha. From the second experimental plot (winter wheat after sunflower and hairy vetch) it was collected an average 3.2 t/ha.

The positive effect of legume crops on winter wheat plants was observed even in the field (Figure 2). The difference between the control plot (from the left side of the picture) and winter wheat after vetch (from the right side of the picture) could be seen with the naked eye: plants after vetch were better supplied with water and nutrients having a greener color and being more developed.

Figure 2. Winter wheat after vetch (on the right) and control plot (on the left)

4. Conclusions

It was established that hairy and common vetch can be used for phytoremediation and preparation of soil for no-till implementation in conditions of Moldova. As a result of consecutive growing of two vetches a layer rich in organic residues and living roots was formed.

Introduction of vetch in crop rotation enhanced soil quality. The most significant results were obtained in terms of soil bulk density, total porosity and organic matter content.

In other tillage systems vetch also can be used as cover crop and green manure for soil remediation, nutrients retention and increase of crop yields. Despite the dry conditions of the year during the experiment the use of vetch as green manure increased significantly yields of cash crops.

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