Bulgarian Journal of Agricultural Science, 23 (No 5) 2017, 816–819
Agricultural Academy

DRY MASS YIELD AND AMOUNT OF FIXED NITROGEN IN SOME FORAGE LEGUME CROPS AFTER TREATMENT WITH ORGANIC FERTILIZER HUMUSTIM

VILIANA VASILEVA*; TODOR KERTIKOV; ANNA ILIEVA
Agricultural Academy, Institute of Forage Crops, BG-5800, Pleven, Bulgaria

Abstract

Vasileva, V., T. Kertikov and A. Ilieva, 2017. Dry mass yield and amount of fixed nitrogen in some forage legume crops after treatment with organic fertilizer Humustim. *Bulg. J. Agric. Sci.*, 23 (5): 816–819

The study aimed to establish some changes in agronomic indicators of spring forage peas (*Pisum sativum* L., variety Pleven 4) and vetch (*Vicia sativa* L., variety Obrazets 666) after application of organic fertilizer Humustim. The experiment was carried out on the experimental field of the Institute of Forage Crops, Pleven, Bulgaria in three consecutive years. The fertilizer was applied through i) presowing treatment of seeds, ii) during vegetation and iii) combination of both. The observations showed that dry mass yield in both crops increased significantly after presowing treatment of seeds with Humustim at the dose of 1.2 L/t + one treatment during vegetation (in vetch with 19.8%, and in peas with 20.1%), under high sustainable yield index. The amount of fixed nitrogen in peas was found increased to 20.8% (presowing treatment of seeds at the dose of 1.2 L/t + one treatment during vegetation), and in vetch, to 21.3% (presowing treatment of seeds at the dose of 1.2 L/t + two treatments during vegetation). The treatment with Humustim increased the efficiency of utilization of nutrients of peas. The peas plants accumulated in their dry mass to 4.25 kg/da more nitrogen after presowing treatment of seeds with Humustim at the dose of 1.2 L/t + one treatment during vegetation. The treated plants, both peas and vetch was more effective over nontreated with regard to important agronomic indicators. Based on the positive results, it is recommended the use of Humustim organic fertilizer in the technologies of cultivation of spring forage peas and vetch in modern trends of the organic farming.

Key words: organic fertilizer; spring forage peas; vetch; nitrogen fixation

Introduction

Legumes are the key to the construction of sustainable agriculture (De Vliegher et al., 2011; Lusher et al., 2014). With its unique ability to establish symbiotic relationships with *Rhizobium bacteria* and fixation of atmospheric nitrogen, they are an important component for ecology friendly forage systems and allow obtaining high yields using fewer resources (Graham and Vance, 2003).

The spring forage (*Pisum sativum* L.) and vetch (*Vicia sativa* L.) are valuable forage legumes with multifunctional purpose. They have a short vegetation period, high dry matter productivity and fixed to 150 kg N/ha under favourable conditions (Unkovich and Pate, 2000; Voisin et al., 2003).

The development of sustainable agriculture with preservation the environment is the main vision of the strategy for sustainable development of agriculture. Interest has turned to the use of environmentally friendly products because chemical fertilizers pollute soil and groundwater and selectively accumulated environmentally harmful chemical elements by prolonged use (Singh et al., 1990; Das, 2011; Nacheva et al., 2012; Enchev and Kikindonov, 2015).

Humustim is a registered fertilizer for use in organic production in Bulgaria. It is a liquid organic humate fertilizer and growth stimulator. Its application by seeds treatment and/or leaf application promote growth and development of plants and ensure high and qualitative yields from the crops.

**Corresponding author*: viliana.vasileva@gmail.com

The aim of this investigation was to access some changes in agronomic indicators such as dry mass yield, efficiency of utilization of nutrients, accumulation of nitrogen in the dry mass, amount of fixed nitrogen in spring forage peas and vetch after application of organic fertilizer Humustim.

Materials and Methods

The investigation was conducted on the experimental field of the Institute of Forage Crops, Pleven, Bulgaria on leached chernozem soil subtype without irrigation during three consistent years. Long plots method, with 10 m^2 plot size was used. The action of organic fertilizer Humustim (the composition of the liquid formulation is shown at the end of this section was tested on spring forage peas cv. Pleven 4 and vetch cv. Obrazets 666. They were sown at row spacing 15 cm with a sowing rated at 110 (for peas) and 200 (for vetch) germinated seeds/m^2. The next variants in 4 replications were studied: Control – nontreated seeds (NS); Nontreated seeds + one treatment during vegetation (TDV) (NS + one TDV); Nontreated seeds + two treatments during vegetation (NS + two TDV); Treated seeds 0.6 L/t (TS 0.6 L/t); Treated seeds 0.6 L/t + one treatment during vegetation (TS 0.6 L/t + one TDV); Treated seeds 0.6 L/t + two treatments during vegetation (TS 0.6 L/t + two TDV); Treated seeds 1.2 L/t (TS 1.2 L/t); Treated seeds 1.2 L/t + one treatment during vegetation (TS 1.2 L/t + one TDV); Treated seeds 1.2 L/t + two treatments during vegetation (TS 1.2 L/t + two TDV). The seeds were treated for 24 hours before sowing. The treatment during vegetation was done at the stages of growing up and from the beginning of flowering to full flowering with the dose of fertilizer 40 ml/da.

The next indicators were investigated: dry mass yield (from fresh mass yield and % of dry matter) (dried at 60°C); sustainable yield index according to the formulae of Singh et al. (1990): SYI (Sustainable yield index) = (Ym-Sd)/Ymax, where: Ym – mean yield, Sd – standard deviation, Ymax – the maximum yield; nitrogen in dry mass yield as productivity of dry mass multiplied by nitrogen content in dry mass (% of dry matter) (for peas); efficiency of utilization of nutrients (a physiological parameter), kg of harvested dry mass/kg total N in plant (a formulae of Bowen and Zapata, 1991) (for peas); amount of fixed nitrogen according to the formula of Carlsson and Huss-Danell (2003) for roughly estimation in the field conditions. The data were averaged and statistically processed using SPSS 2012.

The composition of the liquid formulation of organic humate fertilizer Humustim is as follows: total N – 3.0%; total P – 0.4%; K – 9.7%; humic acids – 32.0%; fulvic acids – 4.0%; macro elements Ca, Mg, Zn, Cu, Co, Mb, B, S, etc.; ash – 18.0%.

Results and Discussion

The obtained results showed a higher yield of dry mass in the variants with presowing treatment of the seeds for both, peas and vetch (Table 1). The exceeding in dry mass yield as compared to the control were similar (10.5-12.0%) for the treatment of pea's seeds with Humustim at the dose of 0.6 L/t and one, or two treatments during vegetation did. A higher yield of dry mass was obtained upon treatment with the higher dose (1.2 L/t) and exceedings as compared to the control reached 19.8% for the treatment of seeds with Humustim at the dose of 1.2 L/t and one treatment during vegetation. No evident difference between the yields obtained after treatment of the seeds and the combination of treatments during the vegetation.

Table 1
Dry mass yield and sustainable yield index (SYI) from forage peas and vetch after treatment with organic fertilizer Humustim

Variants	Forage peas		Vetch	
	dry mass, kg/da	SYI	dry mass, kg/da	SYI
NS (Control)	834.4	0.312	704.7	0.125
NS + one TDV	848.0	0.338	745.3	0.132
NS + two TDV	859.6	0.341	754.0	0.137
TS 0.6 L/t	921.6	0.355	776.7	0.142
TS 0.6 L/t + one TDV	925.6	0.358	790.0	0.146
TS 0.6 L/t + two TDV	934.8	0.368	798.0	0.148
TS 1.2 L/t	962.0	0.378	822.0	0.150
TS 1.2 L/t + one TDV	1000.0	0.399	839.8	0.155
TS 1.2 L/t + two TDV	980.0	0.396	846.7	0.155
Average	918.4	0.361	786.3	0.143
LSD 5%	59.5		49.1	

The dry mass yield from vetch was lower as compared to peas, but the same trends were found. The highest was dry mass yield when the treatment of seeds at the dose of 1.2 L/t + two treatments during vegetation were done and the exceedings of 20.1% as compared to the control was found. Sustainable yield index increased in proportion to the doses applied for the both crops.

Nitrogen in dry mass yield is an important characteristic and is related to the quality of the forage. In our study, it is defined only in peas and in all variants tested was found higher than that of the control (Table 2). In variants with only treatment with Humustim during the vegetation nitrogen in dry mass yield was found by 12.3-13.2% higher as compared to the control – for the lower dose (treatment of seeds at the

dose of 0.6 L/t) – from 19.4 to 21.9%, and for the highest dose (treatment of seeds at the dose of 1.2 L/t) – from 25.4 to 26.7%. The highest nitrogen content in dry mass yield was obtained at presowing treatment of seeds at the dose of 1.2 L/t + one treatment during vegetation.

Table 2
Nitrogen in dry mass from forage peas after treatment with organic fertilizer Humustim

Variants	N in dry mass yield	To the control+	
	kg/da	%	kg/da
NS (Control)	15.94	–	–
NS + one TDV	17.90	12.3	1.96
NS + two TDV	18.04	13.2	2.10
TS 0.6 L/t	19.24	20.7	3.30
TS 0.6 L/t + one TDV	19.43	21.9	3.49
TS 0.6 L/t + two TDV	19.04	19.4	3.10
TS 1.2 L/t	20.10	26.1	4.16
TS 1.2 L/t + one TDV	20.19	26.7	4.25
TS 1.2 L/t + two TDV	19.99	25.4	4.05
Average	18.88		
SE (P=0.05)	0.45		

The amount of nitrogen accumulated in dry mass from peas was from 1.96 to 4.25 kg/da more for treatment with Humustim variants in comparison with the untreated control.

Physiological efficiency of utilization of nutrients was found significant increased only when the highest dose Humustim was used (Figure 1).

The spring forage peas and vetch are nitrogen fixing crops. Significant higher amount of fixed nitrogen was found when treatment with Humustim at the dose of 1.2 L/t and treatments during vegetation were done (Figure 2). There were no evident differences between the variants for this dose tested. The amount of fixed nitrogen was from 2.17 to 2.82 kg/da more than the control.

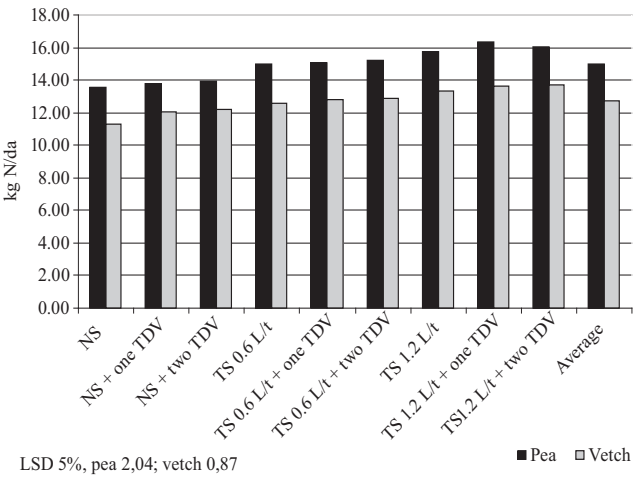

Fig. 2. Amount fixed nitrogen from spring forage peas and vetch after treatment with organic fertilizer Humustim

The amount of fixed nitrogen in vetch increased with increasing the doses of fertilizer. When pea's seeds were treated with Humustim at the dose of 1.2 L/t and treatments during vegetation were done it was found nitrogen from 1.99 to 2.41 kg/da more than the amount nitrogen fixed from the control plants. We assume higher amount of fixed nitrogen after treatments with Humustim resulted from the well-developed root system, due to the humic acids included in the composition of Humustim. Humic acids stimulate the growth of the root system of plants, including that of root hairs, where nod-

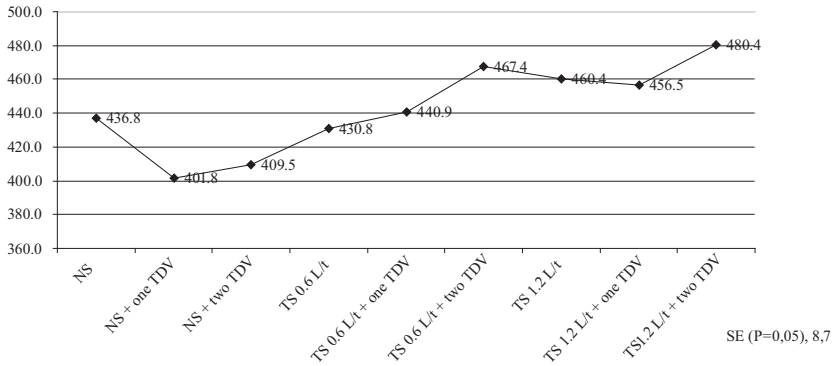

Fig. 1. Physiological efficiency of utilization of nutrients in spring forage peas after treatment with organic fertilizer Humustim

ules can be located (Datta et al., 2011). In our study, with the experimental doses of Humustim we introduced humic acids (%) as follows: with one treatment during vegetation – 12.8; with presowing treatment at the dose of 0.6 L/t seeds – 0.19, with presowing treatment at the dose of 1.2 L/t seeds – 0.38, respectively. The presence of molybdenum in the composition of the product also has a positive effect on the nitrogen fixation process.

As whole, treated plants with Humustim, both peas and vetch was more effective over nontreated in regard to important agronomic indicators.

Conclusions

The treatment of spring forage peas and vetch with organic fertilizer Humustim contributes to the higher and sustainable dry mass yield, more effectively utilization of nutrients and accumulation of higher amount of fixed nitrogen. In the modern trends such as sustainable agriculture it is recommended the use of Humustim in the technologies of cultivation of spring forage peas and vetch.

References

Bowen, G. D. and F. Zapata, 1991. Efficiency in uptake and use of N by plants. In: Proceeding Series Stable Isotopes in Plant Nutrition Soil Fertility and Environmental Studies, IAEASM 313/130, Vienna, Austria, 349-362.

Carlsson, G. and K. Huss-Danell, 2003. Nitrogen fixation in perennial forage legumes in the field. *Plant and Soil*, **253**: 353-372.

Das, D. K., 2011. Introduction to Soil Science. *Kalyani Publication*, India, pp. 645

Datta, S., C. Kim, M. Pernas, N. Pires, H. Proust, T. Thomas, P. Vijayakumar and L. Dolan, 2011. Root hairs: development, growth and evolution at the plant-soil interface. *Plant Soil*, **346**: 1-14.

De Vliegher, A., S. Kratovalieva, T. Mihovsky, M. Vlahova, L. Tosev and L. Carlier, 2011. Leguminous crops as basis for organic farming in Macedonia. *Journal of Mountain Agriculture on the Balkans*, **14**: 548-563.

Enchev, S. and G. Kikindonov, 2015. Influence of mineral nitrogen and organic fertilization on the productivity of grain sorghum. *Agricultural Science and Technology*, **7** (4): 441-443.

Graham, P. H. and C. P. Vance, 2003. Legumes: Importance and constraints to greater use. *Plant Physiology,* **131**: 872-877.

Luscher, A., I. Mueller-Harve, I. F. Soussana, R. M. Rees and J. L. Peyraud, 2014. Potential of legume-based grassland-livestock systems in Europe: a review. *Grass and Forage Science*, **69**: 206-228.

Nacheva, I., D. Miteva, Y. Todorov, K. Loginovska and Tsv. Tsvetkov, 2012. Modern high technology solutions for quality and long term vegetable preservation. *Bulgarian Journal of Agricultural Science*, **18**: 161-165.

Singh, R. P., S. K. Das, B. U. M. Rao and N. M. Reddy, 1990. Towards Sustainable Dryland Agricultural Practices. *Central Research Institute Dryland Agriculture*, Hyderabad, India, 106 p.

SPSS, 2012. Version 20.0. SPSS Inc., 233 S. Wacker Drive, Chicago, 2012, Illinois.

Unkovich, M. and J. Pate, 2000. An appraisal of recent field measurements of symbiotic N_2 fixation by annual legumes. *Field Crops Research,* **65:** 211-228.

Voisin, A. S., C. Salon., C. Jeudy and F. R. Warembourg, 2003. Symbiotic N2 fixation activity in relation to C economy of *Pisum sativum* L. as a function of plant phenology. *Journal of Experimental Botany*, **54**: 2733-2744.

Received June, 6, 2017; accepted for printing September, 14, 2017