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ROOT BIOMASS ACCUMULATION IN VETCH (*Vicia sativa* L.) AFTER TREATMENT WITH ORGANIC FERTILIZER

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Abstract. Effect of the treatment with organic fertilizer Humustim on root biomass accumulation in vetch (*Vicia sativa* L.) (cv. Obrazets 666) was studied in a field trial carried out at the Institute of Forage Crops, Pleven, Bulgaria. Several doses of fertilizer were applied to the seed as a pre–sowing treatment, and during the vegetation growth phase (growing up and flowering stage), and as a combination between them. It was found that Humustim applications at all stages and rates resulted in increased root biomass. Plants accumulated from 661 to 717 kg/ha fresh, and from 254 to 280 kg/ha dry root biomass, which was 17.3 and 19.7%, respectively more than the untreated control. Humustim represent an excellent fertilizer in the modern trends such as sustainable agriculture and organic farming.
Keyword: Humustim, organic fertilizer, root biomass, vetch

Introduction

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.

Vetch is a valuable forage legume with multifunctional role.

It is characterized by a short vegetation growth period, a desire preceding legume crop in crop rotations, and has a great agro technical importance [MIHAILOVICH *et al.*, 2006].

Green mass and grain of vetch are rich in protein and other nutrients [ĆUPINA *et al.*, 2004].

Vetch has well developed root system, fixed from 50 to 125 kg N/ha, enriching the soil with nitrogen and providing nitrogen for the next crop [BRADY, 2000; HADJIPANAYIOTOU and ECONOMIDES, 2001; KUSVURAN *et al.*, 2014].

The effect of treatment with Humustim on the sowing qualities of seeds and grain yield of vetch, as well as the nitrate reductase activity and plastid pigments content were studied [VASILEVA and KERTIKOV, 2006; ILIEVA and VASILEVA, 2014].

The objective of this study was to investigate the changes in fresh and dry root biomass accumulation in vetch after different application methods and rates of the organic humate fertilizer Humustim.

Material and methods

The experimental work was carried out on the experimental field of Institute of Forage Crops, Pleven, Bulgaria, under no irrigation and leached chernozem soil subtype.

Long plots method and size of experimental plot of 10 m^2 were used.

The action of Humustim (composition of the liquid formulation is shown at the end of chapter) was tested on vetch cv. "Obrazets 666", sown at row spacing 15 cm, with a sowing rate, rated at 200 germinated seeds/m^2.

The next variants in 4 replications were studied:

1) Control–untreated seeds;
2) One treatment during vegetation;
3) Two treatments during vegetation;
4) Treated seeds at the dose of 0.6 L/t seeds;
5) Treated seeds at the dose of 0.6 L/t seeds + one treatment during vegetation;

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6) Treated seeds at the dose of 0.6 L/t seeds + two treatments during vegetation;
7) Treated seeds at the dose of 1.2 L/t seeds;
8) Treated seeds at the dose of 1.2 L/t seeds + one treatment during vegetation;
9) Treated seeds at the dose of 1.2 L/t seeds + two treatments during vegetation.

Seeds were treated 24 hours before sowing.

Treatment during vegetation was done at the stages of growing up and flowering stage with the dose of preparation 400 ml/ha.

Soil monoliths (20/30/40 cm) were taken at the beginning of flowering stage of vetch; roots of 10 plans were washed.

Weight of fresh root mass was measured (g/plant) after which dried at 60^{o}C, and weight of dry root mass recorded (g/plant).

Fresh root mass (kg/ha) and dry root mass (kg/ha) were calculated using the common methodology based on the sowing rate of the plants [SIDOROVA *et al.*, 2010].

Experimental data were statistically processed using SPSS 10.0 computer program.

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;
- ash–18.0%.

Results and discussion

Releasing more nutrients in root zone of plants is one of the advantages of using organic fertilizers.

In our study, fresh root biomass formed by plant increased for all the variants with Humustim treatment (Table 1).

Fresh root biomass after treatments during vegetation was from 9.5 to 9.9% higher than the control plants.

Table 1. Fresh root biomass accumulation in vetch after treatment with Humustim

Treatments	Fresh root mass	
	g/plant	kg/ha
Nontreated seeds	0.305	611
Nontreated seeds+one TDV*	0.334	668
Nontreated seeds + two TDV	0.335	671
Treated seeds 0.6 L/t	0.339	679
Treated seeds 0.6 L/t + one TDV	0.334	668
Treated seeds 0.6 L/t + two TDV	0.346	692
Treated seeds 1.2 L/t	0.330	661
Treated seeds 1.2 L/t + one TDV	0.342	684
Treated seeds 1.2 L/t + two TDV	0.358	717
SE (P=0.05)	0.047	9
min/max	0.305/0.358	611/717
STDEV	0.014	28
average	0.336	672

*TDV – treatment during vegetation

The increasing as compared to the control was higher for the variants with pre–sowing treatment of seeds.

For the dose of 0.6 L/t seeds + two vegetation treatments they reached to 13.4%, and for 1.2 L/t seeds + two vegetation treatments, to 17.5%, respectively.

Significantly higher were the differences for the higher dose tested (1.2 l/t), where fresh root biomass increased with increasing of the dose of fertilizer.

In regard to the fresh root biomass formed by unit area can be seen that it varied from 611 (control) to 717 kg/ha (1.2 L/t seeds + two vegetation treatments).

For the variants with treatments during vegetation differences between numbers of treatments performed were not significant.

Fresh root biomass was 668–671 kg/ha which exceeded the control by 9.3 and 9.7%, respectively.

In the variants with higher doses of Humustim for pre–sowing treatment of seeds more amount fresh root biomass was accumulated.

Thus, at a dose of 0.6 L/t seeds + two vegetation treatments, fresh root biomass reached to 692 kg/ha, and for the dose of 1.2 L/t seeds + two vegetation treatments, to 717 kg/ha, respectively, which exceeded the control by 13.2 and 17.3%.

Plants after pre–sowing treatment of seeds showed a better physiological status which the data for activity of nitrate reductase activity and plastid pigment content indicated [ILIEVA and VASILEVA, 2014; BUTU *et al.*, 2014, BUTNARIU *et al.*, 2014, BUTNARIU and CAUNII, 2013, SAMFIRA *et al.*, 2013].

The data for dry root biomass accumulation are shown on Figure 1.

Dry root biomass was equal for the pre–sowing treatment of seeds at the two experimental doses and exceeded the control by 8.5%.

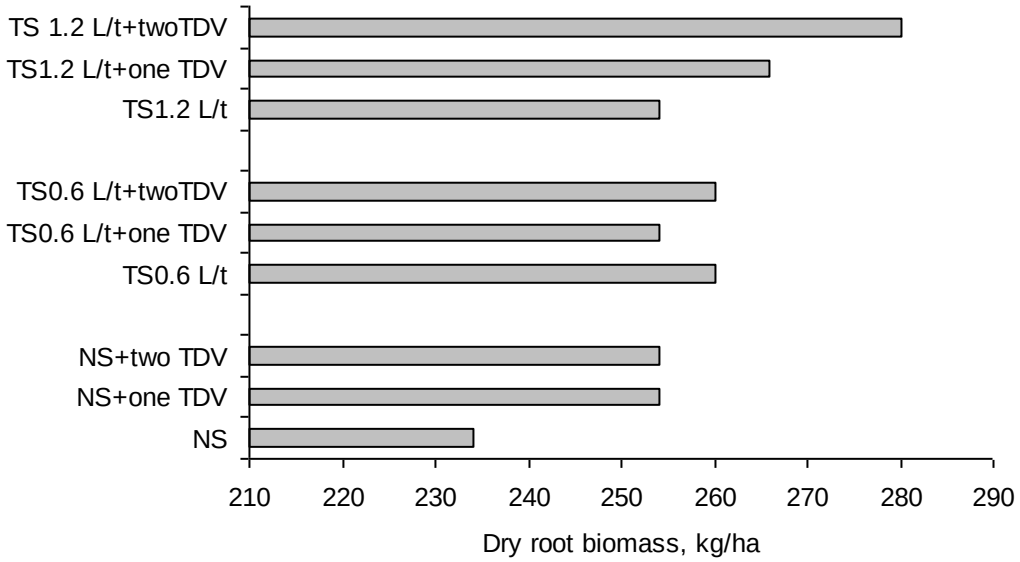

Figure 1. **Dry root biomass in vetch after treatment with Humustim**

For the pre–sowing treatment of seeds at a dose of 0.6 L/t seeds and treatments performed during vegetation there was no evidence of differences.

Dry root biomass accumulation reached to 260 kg/ha which is by 11.1% over the control.

Treatments performed during vegetation in the variant with pre–sowing treatment of seeds at a dose of 1.2 L/t seeds affect dry root biomass formed by the plants.

For one treatment performed dry root biomass was 266 kg/ha, or by 13.7% over the control, and for the two treatments, 280 kg/ha, respectively, or by 19.7% more than the control.

Humic acids were included in the composition of Humustim and they stimulate the growth of the root system of the plants.

Humic acids (%) were submitted with the experimental doses as follows:

- with one treatment during vegetation–12.8;
- with pre–sowing treatment of seeds at the dose of 0.6 L/t seeds–0.19;

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– with pre–sowing treatment of seeds at the dose of 1.2 L/t seeds–0.38.

When applied the fertilizer through pre–sowing treatment of seeds the differences between root biomass were significant and the relationship was shown on Figure 2.

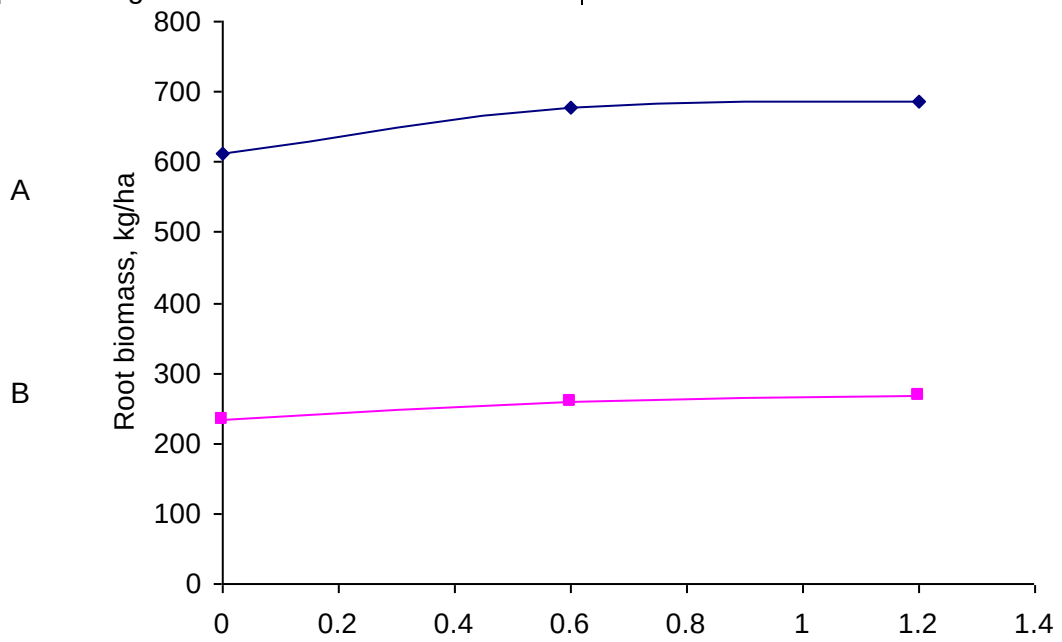

Figure 2. Relationship between fresh (upper regression line, A) and dry (lower regression line, B) root biomass in vetch and doses of Humustim for pre–sowing treatment of vetch seeds

A greater proportion of roots would allow plants to capture more of the nutrients phosphorus for example [LAMBERS *et al.*, 2006, FERENCZ *et al.*, 2012; BUTNARIU *et al.*, 2012; PUTNOKY *et al.*, 2013].

Phosphorus contributed to the protein synthesis, sugar transportation and growth of root system [ARMSTRONG, 1999; MAGANI and KUNCHIDA, 2009, BUTNARIU *et al.*, 2005; BUTU *et al.*, 2014; GAITIN *et al.*, 2013] including that of the root hairs.

Thus, the radius of the root system and the soil area used increased which is a prerequisite for more efficient use of water from the soil [DATTA *et al.*, 2011, IANCULOV *et al.*, 2005; BUTNARIU *et al.*, 2012; ANDREEA *et al.*, 2013, BUTNARIU *et al.*, 2006].

Conclusions

Using the organic fertilizer Humustim for treatment of vetch during the vegetative growth stage increased fresh and dry root biomass by 9.7 and 8.5%, respectively.

For pre–sowing treatment of seeds with Humustim the greater amount of root biomass was formed for the dose of 1.2 L/t seeds + two treatments at the vegetative growth stage, and exceeded the control by 17.3 (for fresh root biomass) and by 19.7% (for dry root biomass).

Humustim represent an excellent fertilizer in the modern trends such as sustainable agriculture and organic farming.

In vetch cultivation the treatment with Humustim is an effective measure.

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