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Short Communication

Aboveground to root biomass ratios in pea and vetch after treatment with organic fertilizer

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ABSTRACT: Some growth parameters of pea (cv. Pleven 4) and vetch (cv. Obrazets 666) after treatment with organic fertilizer were studied in a field trial carried out at the Institute of Forage Crops, Pleven, Bulgaria. Humustim as organic fertilizer was applied through presowing treatment of seeds, treatment during vegetation and combination between both, at different doses. Ratios of aboveground weight to root system weight, aboveground height to root system length, as well as specific root length were determined. It was found that the growth variables of plants were positively influenced by organic fertilizer. The aboveground weight to root system weight ratios of pea ranged from 4.80 to 6.29 and was higher than vetch. Aboveground height to root system length ratio in pea ranged from 6.95 to 7.93, and in vetch from 5.30 to 7.39. The use of organic fertilizer at the dose of 1.2 L/t and treatment during vegetation resulted in better performance of root system and specific root length was 78.6 for pea and 84.3 for vetch.

Keywords: *Aboveground weight, Organic fertilizer, Pea, Specific root length, Vetch*

INTRODUCTION

Legumes have well developed root system and through effective biological nitrogen fixation absorb from the air up to 70% from the nitrogen needs (Kretovich, 1997; Vance, 2001). Pea (*Pisum sativum* L.) and vetch (*Vicia sativa* L.) are valuable forage legumes with multifunctional role. Under favourable conditions they fixed to 150 kg N/ha and 45–70 kg N/ha accumulated in the soil (Unkovich and Pate, 2000; Clayton *et al.*, 2004; Voisin *et al.*, 2013; Kusvuran *et al.*, 2014). They have a short vegetation period and mineralization of root biomass occurs rapidly after harvest (Jensen, 1994; Mihailovich *et al.*, 2006). Pea can formed to 39.6 kg/da and vetch to 100 kg/da dry root biomass at the stage of flowering (Sidorova *et al.*, 2010; Kusvuran *et al.*, 2014). Root biomass contains approximately 40% C, 18% of the root C for year falls in humus (Barber, 1979; Kwabiah *et al.*, 2005). Thus they contributed to maintain and enhance soil fertility (Brady and Weil, 2002; Cupina *et al.*, 2004; Pypers et al., 2007; Havlin *et al.*, 2007; Nemecek *et al.*, 2008; Ryabceva, 2009; Das, 2011; Kulak *et al.*, 2013).

The development of sustainable agriculture with preservation the environment is the main vision of the strategy for sustainable development of agriculture.

The aim of this work was to study some growth parameters of pea and vetch, i.e. the ratios of aboveground weight to root system weight, aboveground height to root system length, as well as specific root length after treatment with organic fertilizers.

The experimental work was conducted on the experimental field of the Institute of Forage Crops, Pleven, Bulgaria during 2002-2004.

MATERIALS AND METHODS

The trial was carried out under no irrigation and leached chernozem soil subtype. Long plots method, 10 m^2 were used in these experiemnts. The action of organic fertilizer Humustim (Composition of the liquid formulation is shown at the end of this chapter) was tested on spring forage pea cv. Pleven 4 and vetch cv. Obrazets 666. They were sown at row spacing 15 cm with a sowing rate rated at 110 (for pea) and 200 (for vetch) germinated seeds/m^2.

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The next variants in 4 replications were studied as: 1. Control – nontreated 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; 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 starting flowering to full flowering with the dose of fertilizer 40 ml/da.

Soil monoliths (20/30/40 cm) were taken at the beginning of flowering stage of vetch and roots of 10 plants were washed (Beck *et al.,* 1993). Aboveground height (cm), root system length (cm), aboveground weight (g/plant) (dried at 60 ^{o}C), root system weight (g/plant) (dried at 60 ^{o}C) were recorded. Specific root length was found as root length/root weight (cm/g). Experimental data were statistically processed using SPSS computer program.

Humustim is liquid organic humate fertilizer and growth stimulator, a product of high quality substrate with 100% cleaner. It is an authorized fertilizer for use in organic production. 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

Formation of biomass of the plants and its various organs is the result of the assimilation activity of photosynthetic tissues, as well as of the root system functioning (Novikova, 2012). In pea 70% from the root mass is located in the upper 15 cm of the soil profile (Evans *et al.,* 2001; Williams *et al.,* 2013). In this study the treatment with organic fertilizer affects the aboveground weight to root system weight ratio of both, pea and vetch (Table 1). For pea, when two treatments during vegetation were applied the value of aboveground weight to root system weight ratio was significantly lower as compared with the same for one treatment. For the dose of Humustim 0.6 L/t + one and two vegetation treatments the values were similar, and the most favourable was this ratio for the dose of 1.2 L/t + two vegetation treatments.

The differences for the variants with nontreated seeds were insignificant. For the dose of 1.2 L/t, analogically to pea, the most favourable was the aboveground weight to root system weight ratio when two treatments during vegetation were performed.

According to Buyanovsky and Wagner, (1986) aboveground weight to root system weight ratio in pea is closed and remains relatively unchanged under different climatic conditions. Kwabiah *et al.,* (2005) found aboveground weight to root system weight ratio for this crop is 10.8.

Because of the large amount of root biomass in vetch the aboveground weight to root system weight ratio was lower and ranged from 2.86 to 3.24. The present results are in agreement with Vollert *et al.,* (2013). They found the values ranging between 1.18 and 2.41.

The aboveground height to root system length ratio in pea was the most favourable for two treatments during vegetation, dose of the fertilizer 0.6 L/t + two treatments during vegetation, and 1.2 L/t + two treatments during vegetation. With increasing the doses of organic fertilizer for the variants with seeds treatment, the aboveground weight to root system length ratio decreased due to the better development of root system.

Humic acids were included in the composition of Humustim and they stimulate the growth of plants root system. Humic acids (%) were submitted with the experimental doses as follows: with one treatment during vegetation – 12.8; with presowing treatment of seeds at the dose of 0.6 L/t seeds – 0.19; with presowing treatment of seeds at the dose of 1.2 L/t seeds – 0.38.

A large amount of root biomass formed after treatment with organic fertilizer enhanced the possibility for capture of some nutrients necessary for the better plants development (Armstrong, 1999; Lambers *et al.,* 2006; Magani and Kunchida, 2009; Datta *et al.,* 2011).

The aboveground height to root system length ratio in vetch was favorable when two vegetation treatments were applied and for the doses of 0.6 and 1.2 L/t of the fertilizer.

Coefficients of correlation between the aboveground weight to root system weight and aboveground height to root system length ratios were r= + 0.8034 for pea and r = + 0.2059 for vetch. The results confirm with those of Naumkina, (2007).

Specific root length was lower when root system of the plants was better developed. For two treatments with fertilizing during vegetation the specific root length was significant lower (Fig. 1).

The values of this characteristic were close after treatment with Humustim at the dose of 0.6 L/t. The similar was the tendency for vetch. Specific root length

Table 1: Aboveground to root biomass ratios of pea and vetch after treatment with organic fertilizer

Treatments	Aboveground weight/ root system weight		Aboveground height/ root system length	
	pea	vetch	pea	vetch
Nontreated seeds	5.96	3.02	7.33	6.14
Nontreated seeds+one TDV*	5.25	2.99	7.38	6.71
Nontreated seeds + two TDV	4.80	3.02	7.10	5.92
Treated seeds 0.6 L/t	5.87	2.86	7.89	5.30
Treated seeds 0.6 L/t + one TDV	4.98	3.24	7.33	6.56
Treated seeds 0.6 L/t + two TDV	4.89	2.98	6.95	7.39
Treated seeds 1.2 L/t	6.29	3.06	7.93	5.48
Treated seeds 1.2 L/t + one TDV	5.95	3.20	7.74	6.02
Treated seeds 1.2 L/t + two TDV	5.71	2.86	7.27	5.97
SE (P=0.05)	0.18	0.04	0.11	0.21
Average	5.52	3.02	7.43	6.16
Min/max	4.80/6.29	2.86/3.24	6.95/7.93	5.30/7.39
SD	0.55	0.13	0.34	0.64

*Treatment during vegetation (TDV)

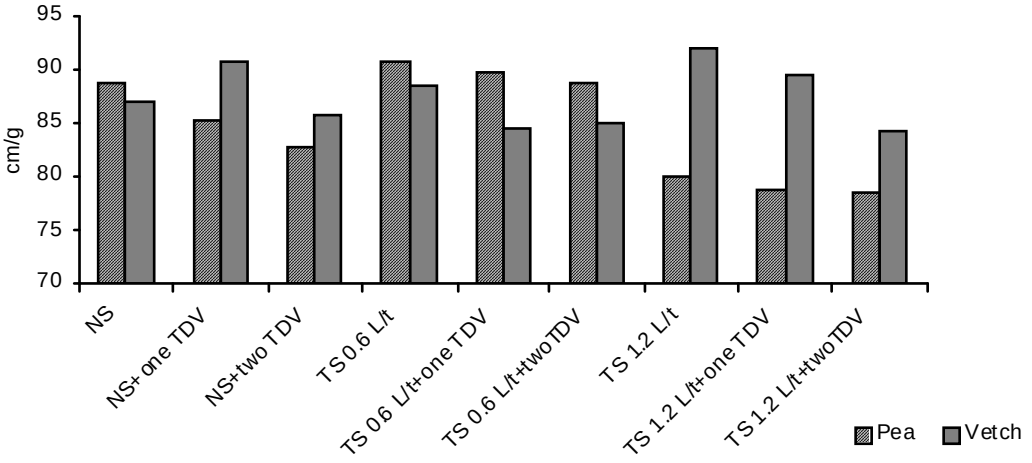

Fig. 1: Specific root length (cm/g) of pea and vetch after treatment with organic fertilizer

was at the lowest level for the dose of 1.2 L/t + two vegetation treatments due to the greater weight of root biomass. Coefficients of correlation between specific root length and aboveground height to root system length ratios were r = – 0.1904 for pea, and r = – 0.3951 for vetch.

CONCLUSION

Treatment with organic fertilizer Humustim positively influenced the growth variables in pea and vetch. The aboveground weight to root system weight ratios of pea ranged from 4.80 to 6.29 and was higher than vetch (2.86 to 3.24). Aboveground height to root system length ratio in pea ranged from 6.95 to 7.93, and in vetch from 5.30 to 7.39. The use of organic fertilizer at the dose of 1.2 L/t and treatment during vegetation resulted in better performance of root system and specific root length was 78.6 for pea and 84.3 for vetch.

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