

Effect of pre-sowing fertilization to the level of pea lodging

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Abstract

The aim of the research was to establish the effect of complex NPK fertilizer rate to the level of lodging of pea for human consumption. The two-year average level of pea lodging was 45.1%. In both studied years statistically the lowest lodging level was observed at the earliest cultivar 'Tamiš' (30.2 and 28.2% in 2007 and 2008, respectively), except in comparison with the cultivar 'Fruškogorac' in 2008 (38.0%). Regularity in lodging was not expressed from the aspects of treatment with different pre-sowing NPK fertilizer rates. Increased yield per plant caused a higher degree of pea plants lodging.

Key words: vegetable, *Pisum sativum* L., cultivars, fertilization, lodging

Introduction

In plant production there are trends to produce larger quantities of food with maximum rationalization of the mineral fertilizers application. Growth of garden pea (*Pisum sativum* L.) has long lasting tradition in Serbia. Short vegetation period and high nutritive value of grain stimulate pea production and consumption (Gvozdenović et al., 2002; Jovičević et al., 2002). Accessible nutrients, especially nitrogen, are usually the limiting factor in obtaining a high yield of agricultural plant dry matter. Grain legumes contain large amounts of protein and for their and yield creation, greater quantities of nitrogen are necessary. However, one significant part of the required nitrogen they insure through biological fixation from the atmosphere. Phosphorus is of great importance in plant production, since its deficiency in soil often limits plant growth and development, while potassium has very important role in plant water regime (Kastori, 1998). Potassium is also important for generative development of plants, flowering, fertilization and grain filling. As summer pea cultivars have a short vegetation period and shortened period of adoption of plant assimilates for additional plant nutrition, only mineral NPK fertilizers are used (Glamočlija, 1997; Gvozdenović et al., 2007). Besides this, seed bacterisation is also recommended in growing peas, because it achieved higher number of pods and seeds per plant, 1000 grain weight and grain weight per plant (Uher, 2006).

Slight lodging occurs immediately after the formation of pods and grains, due to they grow and gain weight during their development. If in that period and/or later appeared abundant precipitation, followed by stormy wind, lodging of crops occur. If plant density is small and plants are not well linked to each other by tendrils, lodging is more pronounced. Mineral nutrition has great impact on the lodging of plants, especially if too much nitrogen fertilizers are added. Influence of variety also has an impact to the lodging of crop. High and middle varieties are more prone to lodging than low. Lodging leads to a yield reduction of peas combining for industrial processing, due to technical inability of combine head to raise and detach beans from the soil. Such peas are losing in their quality, because lying on the soil causes rotting of pods, and consequently grains, by pathogenic and saprophytic fungi. The aim of this study was to determine the degree of pea cultivars lodging affected by different pre-sowing doses of NPK fertilizer.

Material and methods

In order to solve the given task in experimental economics of Secondary Agricultural School in Bačka Topola, during 2007-2008 trials were derived on carbonate chernozem soil type. The basic cultivation was performed in the fall at the depth of 30 cm, and by the end of the winter pre-sowing cultivations were finished. Pre-crop in 2007 was onion, and 2008 pepper. In research five cultivars of different maturity groups were observed. Three cultivars ('Tamiš', 'Dunav' and 'Fruškogorac') were developed in Institute of Field and Vegetable Corps in Novi Sad while two are of Dutch origin ('Orcado' and 'Joff'). 'Tamiš' is very early cultivar, 'Danube' early, 'Fruškogorac' middle early, 'Orcado' middle late and 'Joff' late cultivar. The two factor experiment was designed as split-plot method, according to the plan of divided plots in replications. The basic plots were cultivars, and within them sub-plots were three treatments of pre-sowing complex NPK fertilizer 15-15-15 rate (300, 500 and 0 kg ha⁻¹ as control variant). The area of basic plot was 5 m². In harvest maturity, for the purpose of analysis, 10 plants were taken from central rows. Height of plants (cm) and stem length (cm) were measured in the field. Degree of pea plants lodging (%) was determined upon mathematical calculations. Data were processed by analysis of variance. LSD test was applied to establish significant difference among treatments (Hadživuković, 1991). Data on temperatures and precipitation were obtained from referent meteorological station in Bačka Topola.

Results and discussion

Pea is species that grows in moderately moist and chilly climate (Gvozdenović et. al., 2007). Both years of study were marked by very high temperatures and notable precipitation with very unfavourable schedule.

Table 1 Mean monthly, decade and long-term air temperature during pea vegetation period, Bačka Topola.

Month	Mean air temperature (°C)								
	Decade						Monthly		Long-term (1975-2006)
	I		II		III		2007	2008	
2007	2008	2007	2008	2007	2008	2007	2008		
March	9.0	7.3	11.0	7.5	8.3	7.4	9.4	7.4	6.5
April	12.2	10.9	15.0	13.8	16.3	14.4	13.7	13.1	11.5
May	16.6	14.9	19.2	19.2	20.8	21.7	18.9	18.7	17.3
June	22.1	22.0	24.8	20.4	24.4	25.6	23.8	22.7	20.6

Mean monthly temperatures in 2007 were not in compliance with the long-term monthly average for pea vegetation period (Table 1). During the pea vegetation period in 2007 precipitation sum was higher for 30.6% in comparison with long-term average. Precipitation had very unfavourable schedule, because in April fell only 1.2 l·m⁻¹ rain, due to the initial growth of peas was slowed. In May fell even 171.3 l·m⁻¹ (Table 2). In 2008 temperatures of all vegetation months were also above the long-term average. As well, during the pea vegetation period of 2008, 26% more precipitation was measured in relation to long-term average, although in April was twice less precipitation. However, very important factor in the technology of production, especially in conditions without irrigation, is the schedule of precipitation that significantly affect the dynamics of growth and development of plants and the formation of a stable yield (Dozet, 2009).

Table 2 The decade, monthly and long-term precipitations sum during pea vegetation period, Bačka Topola

Month	Precipitation sum (mm)								
	Decade						Monthly		Long-term average (1975-2006)
	I		II		III		2007	2008	
2007	2008	2007	2008	2007	2008	2007	2008		
March	36.1	26.8	0.3	24.5	21.4	20.6	57.8	71.9	34.7
April	0	4.2	1.2	17.5	0	1.3	1.2	23.0	46.1
May	87.2	14.6	14.6	5.1	69.5	21.9	171.3	41.6	53.9
June	16.6	30.2	5.0	85.8	17.7	7.6	39.3	123.6	71.8

The average level of pea lodging for both years of the study was 45.1%, while in 2007 it was 47.3% and in 2008 year 42.8% (Table 3). In both studied years the smallest degree of lodging had the earliest cultivar 'Tamiš' (20.2 cm, i.e. 28.2%), which is statistically significantly lower lodging in comparison to all other tested cultivars, except 'Fruškogorac' in 2008.

Table 3 Effect of cultivar and pre-sowing fertilizer rate on level of pea lodging in the field (%)

Fertilizer rate (kg·ha ⁻¹)	Cultivar					\bar{X}
	Tamiš	Dunav	Fruškogorac	Orcado	Joff	
2007						
0	26.8	44.4	44.3	57.5	54.5	45.5
300	36.9	44.5	40.7	48.4	59.9	46.1
500	26.8	57.5	46.7	57.6	63.2	50.4
\bar{X}	30.2	48.8	43.9	54.5	59.2	47.3
Treatment	LSD 5%		LSD 1%			
Cultivar	6.1		8.5			
Fertilizer rate	5.0		6.7			
Cultivar×Fertilizer rate	11.2		14.9			
2008						
0	24.9	42.3	50.0	57.5	53.3	45.6
300	32.4	47.0	29.1	52.9	52.4	42.8
500	27.2	45.6	35.0	56.2	36.3	40.1
\bar{X}	28.2	45.0	38.0	55.5	47.3	42.8
Treatment	LSD 5%		LSD 1%			
Cultivar	11.7		16.2			
Fertilizer rate	4.9		6.6			
Cultivar×Fertilizer rate	11.0		14.7			
Average 2007 - 2008						45.1

During both years of the research there was no regularity in terms of treatment with different pre-sowing levels of fertilization. In 2007 doses of fertilizer did not significantly affect the level of pea lodging, while in 2008 control treatment had significantly higher percentage of lodged plants compared to treatment with 500 kg·ha⁻¹ of NPK. Observation of the interaction (cultivar × fertilizer) in 2007 showed that all cultivars tested, except 'Tamiš', had the highest degree of lodging at the largest applied fertilizer rate. However, only by the cultivar 'Danube', the difference was significantly higher than the control.

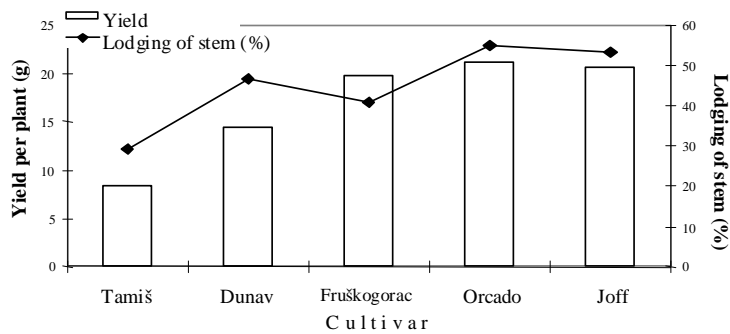
In 2008, the largest, statistically equal pea lodging was reported in following combinations of cultivars and fertilizer rates: 'Orcado' × 0, 300 and 500 kg·ha⁻¹, 'Joff' × 0 and 300 kg·ha⁻¹, 'Fruškogorac' × 0 kg·ha⁻¹ and 'Dunav' × 300 kg·ha⁻¹ (57.5, 52.9, 56.2, 53.3, 52.4, 50.0 and 47.0%, respectively). The smallest pea lodging, without statistical differences had combinations of cultivar 'Tamiš' with all studied fertilizer rates and cultivar 'Fruškogorac' with 300 kg·ha⁻¹ (24.9, 32.4, 27.2 and 29.1%, respectively).

In 2008 the dose of fertilizer did not significantly affect the lodging level of cultivars 'Tamiš', 'Danube' and 'Orcado', since the proportion of lodged plants was in the range 24.9 to 32.4% at 'Tamiš', 42.3 to 47.0% at 'Dunav' and 52.9 to 57.5% at 'Orcado'.

Combination of cultivar 'Fruškogorac' and control variant had greater lodging (50.0%) compared with the variations of fertilization by 300 kg ha⁻¹ (29.1%) and 500 kg ha⁻¹ of NPK (35.0%). The combination of 'Fruškogorac' × 300 kg·ha⁻¹ NPK recorded the lodging of 29.1% which was significantly lower than at the combination of the same fertilizer range and cultivars 'Orcado' (52.9%), 'Joff' (52.4%) and 'Dunav' (47.0%). The combination of fertilization by 500 kg ha⁻¹ of NPK and cultivar 'Tamiš' recorded statistically significantly lower degree of lodging (27.2%) compared with the variety 'Dunav' (45.6%) and 'Orcado' (56.2%). At the control fertilization, 'Tamiš' had highly statistically significantly lower percentage of lodging in relation to the combination of this level of fertilizer with all studied cultivars.

Increased yield per plant caused a higher degree of pea plants lodging. Varieties of shorter vegetation lodged less, and also yielded less per plant (Graph 1).

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Graph 1 Yield per plant affecting pea lodging

Conclusion

Based on results, conclusions are the following:

The average level of pea lodging for both studied years was 45.1%. The lowest level of lodging was for the earliest cultivar 'Tamiš' and it was statistically very significant decrease compared to all other tested varieties, except in comparison with the variety 'Fruškogorac' in 2008. Regularity in lodging was not established from the aspects of treatment with different pre-sowing levels of NPK fertilizer. Increased yield per plant caused a higher degree of pea plants lodging. Cultivars of a shorter vegetation lodged less, and also yielded less per plant.

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sa2011_0407