GROWTH AND YIELD RESPONSES OF GARDEN BEAN *(PHASEOLUS VULGARIS L.)* TO NITROGEN AND SULPHUR FERTILIZATION

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Abstract

A greenhouse pot experiment was conducted to investigate the effects of nitrogen (N) and sulphur (S) fertilization on the yield of garden bean (Phaseolus vulgaris L.). Four levels of nitrogen (0.36, 0.66, 0.96, 1.27 g pot^{-1} as NH_4NO_3 and $NH_4H_2PO_4$) in combination with three levels of S (0.23, 0.46, 0.92 g pot^{-1} as K_2SO_4) were tested as treatments.
Results indicated that significant response to yield was observed for N and S application. N fertilization significantly increased the total fresh and dry weight of bean pods, but the highest N doses delayed the ripening of bean.

With increasing of applied S doses (on the same N level) increased pod fresh weights. At higher sulphur levels the majority part of pods came to maturity already for the first harvest, so the improved sulphur supply accelerated ripening.

On the basis of our results it can be concluded, that neither nitrogen, nor sulphur did not have any statistical effect on the quantity of straw, they increased only the weight the pods. With increasing nitrogen the ratio of fresh and dry weights of crop yield to straw increased significantly.

Keywords: nitrogen, sulphur, garden bean, yield

INTRODUCTION

The fact that application of different fertilizers influences to a great extent on the yield and quality of vegetable plants is well known (Fageria et al., 1997, Sharma et al., 1993). Among the pulses the common bean is one of the most important crop (food crop) worldwide (Singh, 1999, Graham and Ranalli, 1997). Globalisation of trade in agricultural products will increase the pressure to improve bean yields. Bean environment, for example nutritional supply vary widely in their productivity (Bressani, 1983).

Nitrogen is the major limiting nutrient for most crop species. Nitrogen fertilization may affect vegetative growth as well as yield and quality of pods of bean plants (Peck and MacDonald, 1984, Bengston, 1991). Sulphur is considered as the fourth major nutrient element for crops. Sulphur nutrition of bean and other plants is important, since its application not only increases growth rate but also improves the quality of their production (Ligero and Lluch, 1982, Clarkson et al., 1989, Platou and Jones,

1982). In the literature, there are some reports which are dealing with the nitrogen fertilization of the bean, but little attention has been given to study the effects of sulphur and nitrogen fertilization of bean.

The objective of this research was to evaluate the effects of different nitrogen and sulphur rates on the growth and yield of garden bean.

MATERIALS AND METHODS

The greenhouse pot experiment was performed with a loamy soil with next properties: pH_{CaCl2}= 7.68; *Hu% = 2.22*; K_A= 41.4; (K_A: plasticity index according to Arany).

The bi-factorial trials were arranged in a randomized complete block design with four replications, applying four levels of N and three levels of S. For the treatment applied see Table 1.

Table 1.

Scheme of treatments applied

Treatment code	N doses (g pot^{-1})	S doses (g pot^{-1})
N1S1	0.36	0.02
N1S2	0.36	0.04
N1S3	0.36	0.08
N2S1	0.66	0.02
N2S2	0.66	0.04
N2S3	0.66	0.08
N3S1	0.96	0.02
N3S2	0.96	0.04
N3S3	0.96	0.08
N4S1	1.27	0.02
N4S2	1.27	0.04
N4S3	1.27	0.08

P and K doses applied were identical in all pots (0.29 g P_2O_5 pot^{-1} and 0.79 K_2O g pot^{-1}). Nitrogen, phosphorus, potassium and sulphur were added in solution made of NH_4NO_3, $NH_4H_2PO_4$, KCl and K_2SO_4, respectively.

10 kg soil was weighed into Mitscherlich type pots. The indicator plant was garden bean (*Phaseolus vulgaris var. nanus)*. Sex seeds of bean were sown into the soil per pot on 18-04-2008. After emergence four plants were left per pot. Ion exchanged water was added to all pots to keep the soil at constant moisture (60% of the water-holdig capacity) using daily weighing. First and second gathering of pods were accomplished on the 58. and 70. days after germination, respectively. At the end of the vegetation period plant samples (pods, stems and leaves) were collected and fresh and dry biomassweight were determined.

Analysis of variance was carried out on the data in order to provide a statistical comparison between the treatment means. The least significant difference (LSD) test was used to detect differences between means.

RESULTS AND DISCUSSIONS

Yield of bean

The effects of N and S doses on fresh and dry weights of pods of the first and second harvests are given in Figures 1, 2, 3, 4., the results of statistical analysis can be seen in Table 2.

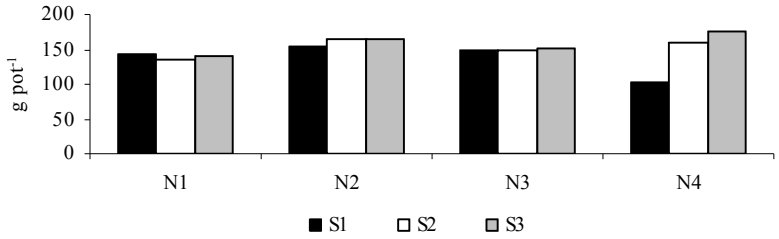

Figure 1. Means of fresh weights of pods of the first harvest (g pot^{-1}) as influenced by different N and S doses

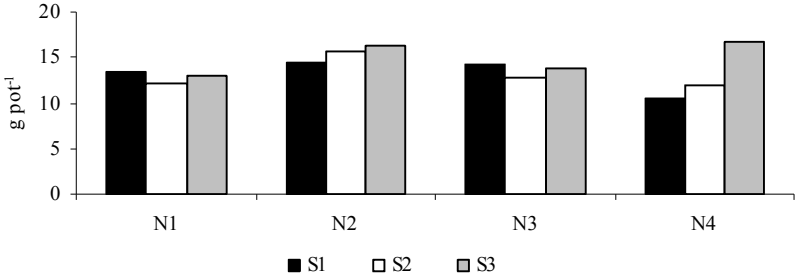

Figure 2. Means of dry weights of pods of the first harvest (g pot^{-1}) as influenced by different N and S doses

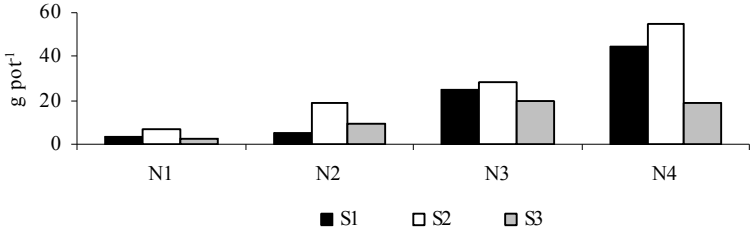

Figure 3. Means of fresh weights of pods of the second harvest (g pot^{-1}) as influenced by different N and S doses

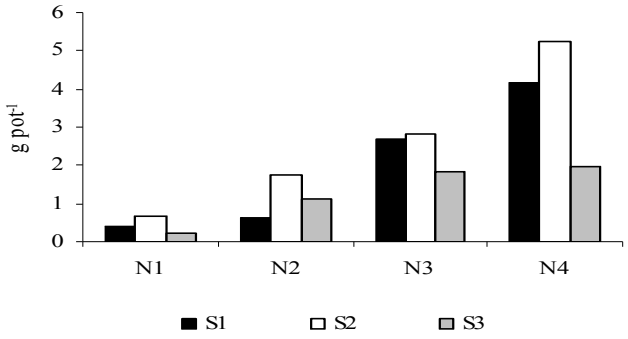

Figure 4. Means of dry weights of pods of the second harvest (g pot^{-1}) as influenced by different N and S doses

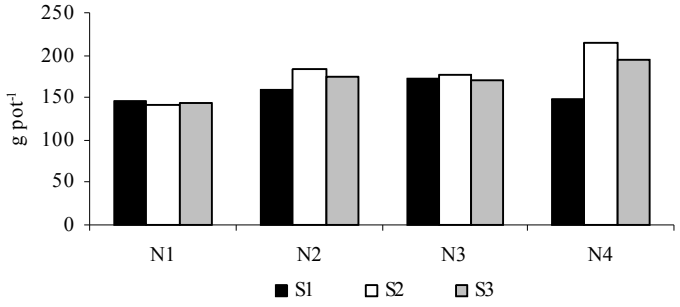

Figure 5. Means of total fresh weights of pods (summary of the first and second harvest (g pot^{-1}) as influenced by different N and S doses

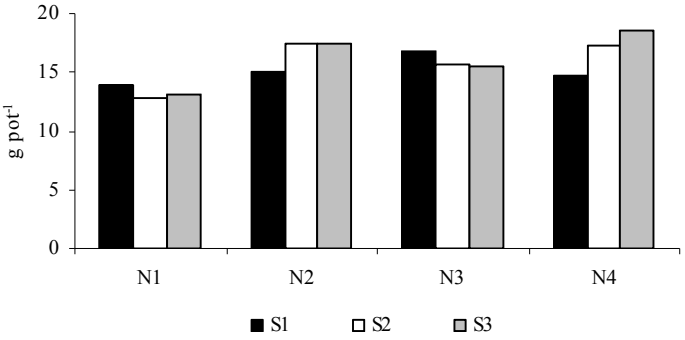

Figure 6. Means of total dry weights of pods (summary of the first and second harvest (g pot^{-1}) as influenced by different N and S doses

Table 2.

Summary of ANOVA (F-test) for different source of variance

Source of variation	fresh weight					
	First harvest		Second harvest		Total yield of pods	
	significance	$LSD_{5\%}$	significance	$LSD_{5\%}$	significance	$LSD_{5\%}$
N doses	***	10.94	***	20.98	***	18.21
S doses	***	9.48	n. s.	-	*	15.77
	dry weight					
N doses	n. s.	-	***	1.98	***	1.65
S doses	n. s.	-	n. s.	-	n. s.	-

n.s.:non-significant; ***:significant at P<0.1%; *:significant at P<1%

The fresh pod weights of first harvest were much higher in all plots than in the case of pods of second harvest. The pod weights of first harvest ranged 102.73 - 165.93 g pot^{-1}, in the second harvest ranged 2.38 – 54.95 g pot^{-1} and the total yield of pods ranged 140.8 – 185.5 g pot^{-1}, respectively. In the first harvest the highest fresh yield of pods (176.3 g pot^{-1}) was produced by applying the highest N and S doses, and in the second harvest by applying the N4 nitrogen and S2 sulphur levels.

On the basis of ANOVA test it can be concluded that N fertilisation significantly increased the total fresh and dry weight of bean pods (Fig.3.), but it can be seen in Figures 1., 2. and 3., 4. that at the lowest sulphur level (S1), the highest N doses (N3, N4) delayed the ripening of the bean. At these treatments the considerable part of pods came to maturity for the second harvest only.

With increasing rates of applied S doses (on the same N level) increased pod fresh weights significantly in the first harvest. At higher sulphur levels (S2, S3) on the other hand the considerable part of pods came to maturity already for the first harvest. It can be said for this reason, that the improved sulphur supply accelerated ripening. This fact was the reason that in the second harvest sulphur had no significant effect on the yield of pods because most of pods came to maturity already for the first harvest.
The good influence of sulphur supply appears in increasing of total yield of pods even if significance of this effect was not so high.

Yield of straw

The effects of N and S doses on fresh and dry weights of straw are given in Tables 3.,4.

Tables 3., 4.

Means of fresh and dry weights of straw (g pot^{-1}) as influenced by different N and S doses

fresh weight of straw					
	S1	S2	S3	*mean*	*$LSD_{5\%}$(N)*
N1	112.8	108.4	113.1	*111.4*	
N2	114.9	113.4	118.7	*115.7*	
N3	116.6	111.2	119.2	*115.7*	n. s.
N4	112.7	**130.9**	113.8	*119.1*	
mean	*114.3*	*116.0*	*116.2*	***101.2***	
$LS_{5\%}$(S)	n. s.				

dry weight of straw					
	S1	S2	S3	*mean*	*$LSD_{5\%}$(N)*
N1	28.2	26.9	28.5	*27.9*	
N2	29.7	29.1	28.8	*29.2*	
N3	28.0	26.6	28.4	*27.6*	n. s.
N4	25.8	28.7	27.0	*27.2*	
mean	*27.9*	*27.9*	*28.2*	***27.9***	
$LSD_{5\%}$(S)	n. s.				

The fresh and dry weights of straw ranged between 108.3-130.9 g pot^{-1}, and 25.8-29.7 g pot^{-1}, respectively. The highest fresh weight of by-product was measurable in pots having the maximum nitrogen level, N4 and S2 doses.

On the basis of statistical analysis it can be concluded, that neither nitrogen, nor sulphur did not have any statistical effect on the quantity of straw.

The ratio of the biomass of crop yield to straw

The effects of N and S doses on the ratio of fresh and dry weights of crop yield to straw are given in Table 5.

Table 5.

Ratios of fresh and dry weights of crop to straw as influenced by different N and S doses

the ratio of the fresh mass of crop and straw					
	S1	S2	S3	*mean*	*$LSD_{5\%}$(N)*
N1	1.29	1.32	1.27	*1.29*	
N2	1.39	1.62	1.48	*1.50*	
N3	1.48	1.64	1.45	*1.52*	0.214
N4	1.35	1.65	**1.76**	*1.59*	
mean	*1.38*	*1.55*	*1.49*	***1.47***	
$LSD_{5\%}$(S)	n. s.				
the ratio of the dry mass of crop and straw					
	S1	S2	S3	*mean*	*$LSD_{5\%}$(N)*
N1	0.49	0.48	0.46	*0.48*	
N2	0.52	0.61	0.60	*0.58*	
N3	0.61	0.60	0.56	*0.59*	0.065
N4	0.57	0.60	**0.69**	*0.62*	
mean	*0.55*	*0.57*	*0.58*	***0.57***	
$LSD_{5\%}$(S)	n. s.				

The ratios of fresh and dry weights of pods to by product ranged between 1.27 – 1.76, and 0.46 – 0.49, respectively. On the basis of our experimental data it can be concluded, that with increasing of nitrogen doses both fresh weight and dry weight ratios of crop to straw significantly increased. Application of increasing sulphur doses did not have any statistical effect on the ratios mentioned above. Despite of this it is mentionable, that the highest fresh weight ratio of crop to by-product we measured in pots having the N4S3 treatment.

CONCLUSION

Results indicated that significant response to yield of bean was observed for N and S application. Both N and S fertilization improved significantly the yield of pods. The highest fresh yield of pods was observed when full dose of N and S2 treatments were applied.

N fertilisation significantly increased the total fresh and dry weight of bean pods, but (at the lowest sulphur level (S1) application) the highest N doses (N3, N4) delayed the ripening of the bean.

Increasing S doses (on the same N level) increased pod fresh weights significantly in the first harvest and accelerated ripening of pods.

Our results revealed, that both nitrogen and sulphur supply increased only the weight the pods and there were not any effect on the weight of vegetative part of bean. With increasing nitrogen, the ratio of fresh and dry weights of crop yield to straw increased significantly.

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