

EFFECT OF NITROGEN AND PHOSPHORUS ON SOYBEAN YIELD AND NUTRITIVE VALUE¹

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Abstract: The objective was to study the effect of different amounts and rates of nitrogen and phosphorus on yield and quality of soybean using inoculated and non-inoculated seeds. The experiments were conducted on the tchernozem soil type of the trial sites of the Institute Tamiš, Pančevo in 2003 and 2004.

Based on the results obtained it can be concluded that on average higher soybean yield was achieved (by 70 kg/ha, 1.4% only) using inoculated compared with the non-inoculated seeds variant. On average, in both trial years nearly all nitrogen and phosphorus variants showed a small but positive effect on soybean seed yield. The highest increase ranging from 6.2% (N₁₀₀P₃₅ non-inoculated variant) to 9.1% (also N₁₀₀P₃₅ but in the inoculated seeds variant) was noted in the variant using a combination of both nitrogen and phosphorus. The year 2004 compared with 2003 may be considered more favourable for soybean production because a higher seed yield was achieved (on average by 1.69 t/ha, 41.3%).

The application of different amounts and rates of N and P nutrition had no significant effect on the changes in the protein and oil content (ranging on average from 31.7-32.8% for proteins and 20.8-21.4% for oil) in soybean seeds compared with the control variant.

Key words: nitrogen, phosphorus, inoculation, yield, proteins, oil.

Introduction

Numerous investigations which refer to determine optimal amount of mineral nutrient in purpose of forming conditions for high, stable and profitable soybean production (Evans et al, 1963, Henderson et al, 1970, Nenadić et Nedić, 1978, Nedić et sar., 1996 and 2001, Nenadić et al, 2001 and 2002, Živanović et al, 2000 etc.). Consequently, question of mineral nutrition of soybean was actual in previous period and also nowadays is.

It is very important to point at circumstances that among investigators exist certain differences connected with the nutrition of this plant. Mostly, the researches from previous period confirm that the soybean expends higher amount of nutrient according to one point of view (Evans et al., 1963, Aldrich et al, 1976 and others). Recent researches show lower reaction of soybean yield on mineral nutrition, which depends on the characteristics of soil (Nedić and Zarić, 1994, Nedić et al, 1996 and 2001, Nenadić et al, 2001 and 2002, Živanović et al, 2000, Raičević Vera et al, 2005).

From all the nutrients for soybean, the most significant is nitrogen. It is logical because soybean is protein plant. For yield of 100 kg seeds and for corresponding vegetative mass soybean takes from 7,7 to 9,6 kg of nitrogen (Henderson et al, 1970). The effect of nitrogen in soybean nutrition depends on numerous factors (soil productivity, precipitation amount, genotype, seed inoculation, etc.), which confirm different researches (Nenadić and Slović, 1994, Jovanović et al, 1999, Živanović et al, 2000, etc.).

Phosphorus is very important for soybean nutrition too (in subtle physiological processes-makes the structure of nucleic acid and nucleoproteids, and these compounds are in tight connection with processes of growing and protein biosynthesis; *Sarić, 1975*).

According to aforesaid, we have set apart for studying the influence of amount and relations between nitrogen and phosphorus in accurate field plot microexperiments, with application of inoculated and non-inoculated seed, on grain yield and protein and oil content in it.

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Materials and method

Researching the effect of nitrogen and phosphorus, and seed inoculation on soybean yield, raw protein and oil seed content, the bifactorial field plot microexperiments have been realized in 2003 and 2004.

The experiments were conducted on the tchernozem soil type of the trial sites of the Institute "Tamiš" Pančevo.

This research includes nine variations of fertilization and they are:

1. control (without fertilization), 2. N₅₀ kg/ha, 3. N₁₀₀ kg/ha, 4. P₃₅ kg/ha, 5.

P₇₀ kg/ha, 6. N₅₀P₃₅ kg/ha, 7. N₅₀P₇₀ kg/ha, 8. N₁₀₀P₃₅ kg/ha and 9. N₁₀₀P₇₀ kg/ha.

Sowing has been achieved using inoculated and non-inoculated seeds (factor B). Pure culture of nodule producing bacteria *Bradyrhizobium japonicum* (preparation NS nitragin) has been used for inoculation.

Variety "Balkan" (first group of maturation) was utilized as a material in researches. Fertilizers were used in pre-sowing soil preparation. Hand sowing were done in half of april, and after the plants emerge, the crop was thin out on thickness of 400 000 per ha on 13 % moisture. The results of yield was elaborated by variation-statistics analysis, and the valuation of significance between differences by LSD test.

Content of all proteins and oils in seed was determined by instrument DICKEY-JOHN, NIR analyzer.

Agrometeorological conditions

Basic information about chemical characteristics of soil point that the soil has low alkaline reaction (pH-7,21), good provision in phosphorus (19,2 mg/100g of soil), average provision in potassium (16,0 mg/100g of soil) and also has high contents of humus.

Meteorology conditions were significantly different in the years of research, especially moisture conditions. They were more favourable in 2004, when 420 mm of water precipitate fell over during the vegetation period of soybean (April September). Different from this year, in 2003 was registered almost for 50 % less precipitation in the same period (245,2 mm).

These moisture conditions as consequence had higher yields of soybean seed in 2004.

Results of research and discussion

The results of our researches have shown that higher soybean yield was realized by sowing of inoculated seed related with variant without inoculum and only for 70 kg/ha (1,40%), table 1. This can be explained by soil quality which have more favourable physical-chemical characteristics.

Our results from previous period of researches have been confirmed with this (Nedić *et al*, 2004), and they point to the influence of seed inoculation on soybean yield which depends on the significant degree of the soil characteristics.

Table 1. Effect of fertilization and seed inoculation on soybean yield (t/ha)

Nutrition variants (A)	2003.		2004.		average				
	t/ha	%	t/ha	%	t/ha	%			
with inoculation – (B)									
Control	3,99	100,0	5,65	100,0	4,82	100,0			
N50	4,11	103,0	5,99	106,0	5,05	104,8			
N100	3,71	93,0	5,93	105,0	4,82	100,0			
P35	4,23	106,0	5,72	101,2	4,97	103,1			
P70	4,22	105,8	5,78	102,3	5,00	103,7			
N50P35	4,11	103,0	5,49	97,2	4,80	99,6			
N50P70	4,28	107,3	5,31	94,0	4,79	99,4			
N100P35	4,69	117,5	5,83	103,2	5,26	109,1			
N100P70	4,34	108,8	6,15	108,8	5,24	108,7			
average	4,19	-	5,76	-	4,97	-			
without inoculation –									
Control	3,99	100,0	5,36	100,0	4,67	100,0			
N50	3,84	96,2	5,80	108,2	4,82	103,2			
N100	3,89	97,5	5,91	110,3	4,90	104,9			
P35	4,16	104,3	5,56	103,7	4,86	104,1			
P70	4,29	107,5	5,90	110,1	5,09	109,0			
N50P35	4,08	102,3	5,96	111,2	5,02	107,5			
N50P70	3,78	94,7	5,62	104,9	4,70	100,6			
N100P35	3,95	99,0	5,97	111,4	4,96	106,2			
N100P70	3,94	98,7	6,17	115,1	5,05	108,1			
average	3,99	-	5,81	-	4,90	-			
		2003.				2004.			
		A	B	B*A	A*B	A	B	B*A	A*B
LSD	0,05	0,55	0,18	0,55	0,67	0,53	0,29	0,87	0,81
	0,01	0,76	0,25	0,76	0,93	0,73	0,40	1,19	1,11

Almost all variations of nitrogen and phosphorus fertilization have been shown small, but positive influence on average soybean yield connected with the control of variant (without fertilization). The highest increase of grain yield was in variant of combined application of nitrogen and phosphorus and it took from 6,2% (variant NP-without inoculum) to 9,1% (also NP-with inoculum), table 1. Our results are almost equal to the results of *Nenadić and Nedić (1978 and 1983)*, *Nenadić et al. (1994)*, *Nedić et al. (1996)*, which also show that the fertilization effect in soybean production mostly depends on type of soil.

Phosphorus had higher influence than nitrogen on soybean yield. Maximum average increasing of yield for phosphorus is 9,7% (variant P-without inoculum), and for nitrogen is 4,9% (variant N-without inoculum too). This is logical because soybean is plant which has the possibility of nitrogen air fixation and generally in that manner settles its needs in it.

The significantly higher seed yield was realized in 2004 approximately for 1,69 t/ha (41,3%). This yield is result of more favourable conditions of moisture in 2004 than 2003.

Taken on the average and during the years separately, application on different amounts and relations between nitrogen and phosphorus didn't have significant effect on variation of protein and oil contents in soybean seed, corresponding to control variant. This variation takes from 31,7% to 32,8% for proteins and from 20,8% to 21,4% for oil (table 2).

Table 2. Effect of fertilization and seed inoculation on soybean seed protein and oil content (%)

Nutrition variants (A)	proteins			oil		
	2003.	2004.	average	2003.	2004.	average
with inoculation – (B)						
Control	32,1	32,6	32,3	21,4	21,0	21,2
N50	32,9	31,8	32,3	21,2	21,4	21,3
N100	33,1	31,6	32,3	21,2	21,3	21,2
P35	32,9	32,1	32,5	21,3	20,7	21,0
P70	32,0	32,7	32,3	21,6	20,8	21,2
N50P35	32,6	32,1	32,3	21,2	21,0	21,1
N50P70	32,8	31,9	32,3	21,0	21,1	21,0
N100P35	32,9	32,8	32,8	21,2	20,4	20,8
N100P70	33,1	32,5	32,8	21,2	20,9	21,0
average prosek	32,7	32,2	32,4	21,3	20,9	21,1
without inoculation –						
Control	32,6	32,5	32,5	21,5	21,3	21,4
N50	32,7	32,0	32,3	21,4	21,0	21,2
N100	33,3	31,2	32,2	21,2	21,2	21,2
P35	32,7	32,2	32,4	21,4	21,0	21,2
P70	32,2	31,3	31,7	21,4	21,2	21,3
N50P35	33,0	30,9	31,9	20,9	21,5	21,2
N50P70	32,8	31,9	32,3	20,6	21,3	20,9
N100P35	32,5	31,4	31,9	21,1	21,3	21,2
N100P70	33,1	31,2	32,1	21,1	21,5	21,3
average	32,8	31,6	32,2	21,2	21,2	21,2

On this soil type seed inoculation didn't show the effect on the contents of protein and oil in seed. But the differences can be ignored. (table 2).

The higher contents of protein and oil was realized in 2003 (approximately 32,75% respectively 21,25%), although year 2004 had more moisture (31,90% respectively 21,05%).

Conclusion

From the obtained results of these researches following conclusions can be conducted:

- By sowing the inoculated seed insignificantly higher yield of soybean seed develops on chernozem. In our researches average increase is only 70 kg/ha (1,40%);

- Nitrogen and phosphorus, separately and in combined application, have shown small but positive influence on soybean yield. The highest increase of grain yield was in variant of combined application of nitrogen and phosphorus and it took from 6,2% (variant NP-without inoculum) to 9,1% (same variant of fertilization with inoculum);

- The significantly higher soybean yield realized in 2004 approximately for 1,69 t/ha (41,3%), is a consequence of more favourable condition of moisture than in 2003;

- Nitrogen and phosphorus didn't have significant effect on variation of protein and oil contents in seed corresponding to variant without fertilization. The highest average difference for proteins is 1,10% and for oil is 0,60%. The similar happens with the seed inoculation.

- Higher content of proteins and oil in seed was realized in 2003 (approximately 32,75% for proteins and 21,25% for oil) than in 2004 (31,905 and 21,05%).

UTICAJ AZOTA I FOSFORA NA PRINOS I HRANLJIVU VREDNOST SOJE

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Rezime

U ovom radu prikazan je uticaj različitih količina i odnosa azota i fosfora na prinos i kvalitet soje setvom inokulisanog i neinokulisanog semena. Eksperimenti su izvedeni na zemljištu tipa černoze na oglednom polju Instituta "Tamiš" Pančevo u 2003. i 2004. godini.

Rezultati naših istraživanja su pokazali da je, u proseku, ostvaren neznatno veći prinos soje setvom inokulisanog semena i to za samo 70 kg/ha (1,4%) u odnosu na varijantu bez inokuluma. U proseku za obe godine, skoro sve varijante đubrenja azotom i fosforom ispoljile su mali, ali pozitivan uticaj na prinos semena soje. Najveće povećanje bilo je u varijanti kombinovane primene azota i fosfora i kretalo se od 6,2% (N₁₀₀P₃₅, varijanta bez inokuluma) do 9,1% (takođe N₁₀₀P₃₅, ali varijanta sa inokulumom). Ostvaren je veći prinos semena u 2004. godini, prosečno za 1,69 t/ha (41,3%), koja je ocenjena znatno povoljnijom za proizvodnju soje od 2003. godine. Primena različitih količina i odnosa NP hraniva nije uticala na značajniju promenu sadržaja proteina i ulja u semenu u odnosu na kontrolnu varijantu. Variranja se kreću prosečno od 31,7-32,8% za proteine i 20,8-21,4% za ulje.

Ključne reči: azot, fosfor, inokulacija, prinos, proteini, ulje.

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