THE MINERAL FERTILIZATION INFLUENCE ON SOYBEAN QUALITY

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***Abstract**: Soybean is the most important source of protein known to mankind; it is also one of the cheapest and most readily available sources of protein with high nutritional value, similar to animal proteins. Soybean is the first place in the legumes group, because of its high protein content and the fat, lecithin, vitamins and enzymes it contains, and it is hard to find another plant that in such a short time or able to synthesize such a large amount of valuable substances. This paper addresses the influence of mineral fertilization on the protein and oil content of the Felix variety, the ARDS Turda creation. The research was carried out at ARDS Lovrin, on a typical chernozem, in a long-term fertilizing experience. The role of unilateral and combined fertilization with nitrogen and phosphorus was studied. The doses of nitrogen administered were $N_{0, 25, 50, 75, 100}$ and doses of phosphorus $P_{0, 40, 80, 120, 160}$. By combining these doses have resulted 25 experimental variants. The obtained results were interpreted by the variant analysis method. The value of the protein increases with increasing fertilizer doses to a certain level after which here is a capping. The lowest percentage of the protein is recorded in the control, unfertilized variant, 32.4%, and the highest by the combined application of the two types of fertilizer, in the variant $N_{75}P_{120}$ - 41.4%. The study of the fat content in the Felix variety revealed that the best results were obtained under the conditions of the interaction between the two studied macroelements, with the highest recorded value of 20.15%. Analyzing the results we can state that the percentage of protein and oil increase with increasing doses of nitrogen administered, are relatively constant in case of unilateral application of phosphorus and achieves the highest values for the combined application of nitrogen and phosphorus.*

***Keywords**: soybean, protein, oil content, fertilization.*

INTRODUCTION

The soybean is an important source of protein and vegetable fats. It is also a major oilseed crop in the world providing 58% of world oil seed production (BOARD J.E., 2013).

The proteins represent 27-50% of the grain mass, the soybean specific protein being glycine, which is characterized by a high degree of digestibility and a high content of essential amino acids, being close to animal protein (meat or egg protein) (ION VIOREL, 2010; TSUBOKURA Y., 2013). The soybean protein content in lysine is 6-7% (OHYAMA T., 2013; SPECHT J.E., 1999).

The lipids represent 17-25% of the grain mass. Soybean oil contains 15-25% saturated fatty acids and 75-85% unsaturated fatty acids, 30-35 oleic acid, 44-55% linoleic acid and 5-10% linolenic acid (BOARD J.E. 2013).

Sustainable agriculture is characterised by the introduction of more diversity in crops, and it should ensure fertility of soil and nitrogen balance (SUGANUMA T., 2001). Plants of the Fabaceae family have low input requirement and enhance diversification in crop rotation (TÝR ET AL., 2009; FAZEKAŠOVÁ ET AL., 2011).

Soybean plants can use nitrogen released by mineralization, residual soil nitrogen, fertilizer nitrogen or atmospheric nitrogen, which is converted into a usable form in root nodules through a symbiotic relationship between *Bradyrhizobium japonicum* bacteria and the soybean plant (HUNGRIA M.,2015; OHYAMA T., 2011; HARPER J.E., 1974). While the soil is the primary source of nitrogen for many crops, soybean obtains 65 % – 85 % of its needs through the symbiotic nitrogen fixation process (RAO AND REDDY, 2010; TEWARI K., 2011).

The protein and oil content of seeds is different from one variety to another, being influenced by environmental factors and cultivation technology (Chaturvedi 2012). Nitrogen fertilization and seed treatment with nitrogen fixative bacteria prior to sowing increase the protein content of the seeds (TAKAHASHI Y., 1993).

MATERIAL ȘI METHOD

The research was carried out at Agricultural Research and Development Station Lovrin, under a long-term experience with fertilizers (founded in 1967), on a weakly-gleizated and weakly-alkalinised semicarbonatic chernozem (pH in $H_2O = 6.90$) with a mobile P content of 75.7 ppm, mobile K of 205 ppm and a humus content of 3.47%. The average yearly rainfall is about 500 mm, and the average temperature of 10.8 ° C.

The experimental device comprises the next graduation of the experimental factors: $N_{0,25,50,75,100}$ si $P_{0,40,80,120,160.}$ The method of place in the field is subdivided parcels method. The sowing variety is the Felix variety, created at ARDS Turda. Protein and oil content were determined using the Perten Inframatic 9200. The results were interpreted by the variance analysis method (ANOVA).

RESULTS AND DISCUSSIONS

It is well known that protein and fat content of soybean varies with genotype. However, there are few studies on the influence of the main macroelements on the quality of culture.

This paper presents the results obtained on 15 experimental variants: the unilateral application of five doses of nitrogen, five doses of phosphorus and five combined doses of nitrogen and phosphorus.

The results obtained on protein content are shown in Tables 1,2 and 3.

Table 1

The nitrogen influence on the protein content

Variant	Protein content %			Average	Difference	Significance
	RI	RII	RIII			
N_0P_0	32.4	31.3	33.6	32.4	**mt**	
$N_{25}P_0$	33.6	35	34.8	34.5	2.10	
$N_{50}P_0$	36.6	37	36.2	36.6	4.20	**
$N_{75}P_0$	37	38	38.8	37.9	5.50	***
$N_{100}P_0$	36.4	33.2	32.5	34.0	1.63	

DL 5% = 2.50 % ; DL 1% = 3.64 ; DL 0.1% = 5.47

On unilateral application of chemical fertilizers with nitrogen are obtained distinctly significant and very significant increases, compared to the unfertilized control variant (Table 1). If in control the protein content is 32.4%, by applying a nitrogen dose of 50 kg / ha, active substance, is obtained an increase of 4.2%, statistically assured as distinctly significant for the level of transgression α = 1%. The highest value of the protein is recorded in variant 4 - N75P0, 37.9%, with 5.5% more than the control variant, statistically assured value as very significant for the level of transgression α = 0.1%. The nitrogen dose of 100 kg / ha inhibits the accumulation of the protein, its value showing the lowest increase compared to the control, of only 1.63%, not statistically assured, lower than the application of the quantity of 25 kg per hectare of nitrogen.

Table 2

The phosphorus influence on the protein content

Variant	Protein content %			Average	Difference	Significance
	RI	RII	RIII			
N_0P_0	32.4	31.3	33.6	32.4	**mt**	
N_0P_{40}	33.4	31.4	33.1	32.6	0.20	
N_0P_{80}	33.9	33.4	31.9	33.1	0.70	
N_0P_{120}	30.9	30.3	32.6	31.3	-1.10	
N_0P_{160}	30.4	30	33.6	31.3	-1.10	

DL 5% = 2.18 , DL 1% = 3.17 , DL 0.1% = 4.76

Fertilization with phosphorus does not bring significant increases, statistically assured, compared to unfertilized variant. The highest percentage of protein is recorded at the dose of 80 kg / ha phosphorus, 33.1%, with 07% more than the control. When high doses of phosphorus are given, 120 and 160 kg/ha active substance, there was a significant decrease in protein content, 1.1% less than control (Table 2).

Table 3

The influence of nitrogen-phosphorus combinations on the protein content

Variant	Protein content %			Average	Difference	Significance
	RI	RII	RIII			
N_0P_0	32.4	31.3	33.6	32.4	mt	
$N_{25}P_{80}$	33.6	34.2	33.9	33.9	1.50	
$N_{50}P_{80}$	36.9	38	38.7	37.8	5.40	***
$N_{75}P_{80}$	40.3	41.9	42	41.4	9.00	***
$N_{100}P_{80}$	36.9	36.4	35.9	36.4	4.00	***

DL 5% = 1.52 % DL 1% = 2.21 DL 0.1% = 3.31

The highest percentage of protein is obtained by the combined administration of fertilizers with nitrogen and phosphorus (Table 3). The highest difference to the control variant , 9%, was obtained on the $N_{75}P_{80}$ agrofond, followed by $N_{50}P_{80}$ with a difference of 5.4% and $N_{100}P_{80}$, by 4%.

Regarding the contribution of the experimental factors (Figure 1) on the protein content, the highest contribution brings the combination of the two types of fertilizers- 95.6%, followed by the unilateral application of nitrogen - 79.8% and the unilateral application of phosphorus - 30.5%.

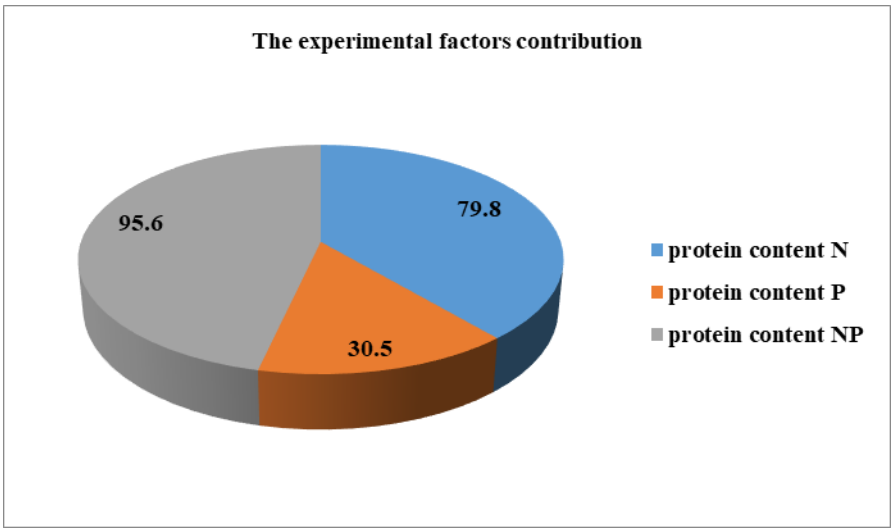

Fig. 1. The contribution of experimental factors to the accumulation of protein in soybeans

The soybean oil content is correlated negatively with protein content. The influence of the two types of fertilizer on soybean oil accumulation is presented in Tables 4, 5 and 6.

Table 4

The nitrogen influence on the oil content

Variant	Protein content %			Average	Difference	Significance
	RI	RII	RIII			
N_0P_0	18.2	18.7	19.4	18.8	**mt**	
$N_{25}P_0$	20	20.6	19.9	20.2	1.36	
$N_{50}P_0$	19.4	19.8	18.3	19.2	0.36	
$N_{75}P_0$	20.2	17.6	18	18.6	-0.20	
$N_{100}P_0$	20.4	20.6	21	20.6	1.87	

DL 5% = 1.64 % DL 1% = 2.39 DL 0.1% = 3.59

Under the influence of nitrogen, as the percentage of protein increases, the oil content in the grain decreases. The highest percentage is recorded in fertilized variant with 50 kg / ha nitrogen, and the lowest is recorded to applying 75 kg / ha nitrogen, by 0.2% less than the unfertilized control (Table 4).

Table 5

The phosphorus influence on the oil content

Variant	Protein content %			Average	Difference	Significance
	RI	RII	RIII			
N_0P_0	18.2	18.7	19.4	18.8	**mt**	
N_0P_{40}	19.7	19	19.4	19.4	0.60	
N_0P_{80}	19.6	18.9	19.8	19.4	0.60	
N_0P_{120}	20.4	20.4	19.6	20.1	1.30	*
N_0P_{160}	21	20	20.4	20.5	1.70	**

DL 5% = 0.93 % DL 1% = 1.35 DL 0.1% = 2.02

The phosphorus administration in the high dose determines the increase of the oil content by 1.3%, respectively 1.7%, increases statistically ensured as significant and distinctly significant for the probability of transgression $\alpha = 5\%$ and $\alpha = 1\%$.

Table 6

The influence of nitrogen-phosphorus combinations on the oil content

Variant	Protein content %			Average	Difference	Significance
	RI	RII	RIII			
N_0P_0	18.2	18.7	19.4	18.8	**mt**	
$N_{25}P_{80}$	18.6	18.2	19	18.6	-0.17	
$N_{50}P_{80}$	18.5	19.4	20	19.3	0.53	
$N_{75}P_{80}$	20.4	20.6	22	21.0	2.23	***
$N_{100}P_{80}$	19.4	20.1	20.2	19.9	1.13	**

DL 5% = 0.65 % DL 1% = 0.95 DL 0.1% = 1.43

The highest percentage of oil is obtained by the combined administration of fertilizers with nitrogen and phosphorus. The highest difference from the control, 2.23%, is obtained on the agrofond $N_{75}P_{80}$, with a percentage of 21% oil, statistically assured as very significant, followed by N100P80, -1.13%, the percentage of oil 19.9%, statistically assured as distinctly significant.

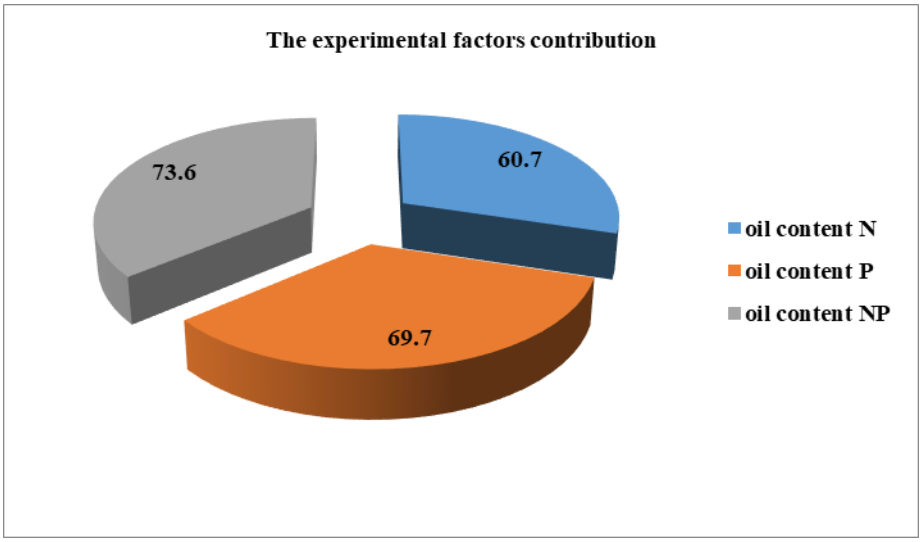

Fig. 2. The contribution of experimental factors to the accumulation of oil in soybeans

Among the experimental factors, the nitrogen-phosphorus combination brings a contribution of 73.6% to oil accumulation in soybeans, unilaterally applied phosphorus fertilizers - 69.7% and unilateral nitrogen application of 60.7% (Fig. 2).

CONCLUSIONS

The mineral fertilizers with nitrogen and phosphorus, administered both unilaterally and in various combinations, have a significant effect on the soybean quality.

The lowest percentage of the protein is recorded in the control, unfertilized variant, 32.4%, and the highest by the combined application of the two types of fertilizer, in the variant $N_{75}P_{120}$ - 41.4%. The study of the oil content in the Felix variety revealed that the best results were obtained under the conditions of the interaction between the two studied macroelements, with the highest recorded value of 20.15%.

Analyzing the results we can say that the protein content increase with increasing doses of nitrogen administered, while the oil content decreases with the increase in protein content.

The protein and oil content is relatively constant in case of unilateral application of phosphorus and achieves the highest values for the combined application of nitrogen and phosphorus.

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