Behavior of some Soybean Genotypes to Fertilization in the Climatic Condition of 2019

Vasilena SUCIU^{1,2*}, Teodor RUSU¹, Camelia URDĂ², Raluca REZI², Eugen MUREȘANU², Adrian NEGREA², Felicia MUREȘANU²

¹University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, 3-5 Calea Manastur, 400372 Cluj-Napoca, Romania

²Agricultural Research and Development Station Turda, 27 Agriculturii, 401100, Turda, Romania

*corresponding author, e-mail: vasilena.suciu@gmail.com

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Abstract

Soybeans (*Glycine max* L. Merrill) is the world's most important seed legume and she is considered a basic food with a high nutritional value. The aim of this study is to evaluate the influence of two types of chemical complex fertilizers (NPK 27:13.5:0 and NPK 16:16:16) with four levels of fertilization (unfertilized, 150 kg/ha, 200 kg/ha and 250 kg/ha) on the main soybean growing stages in 2019. Field experiments were conducted in the soil and climate conditions of the Agricultural Research and Development Station from Turda. The vegetation stages of the studied soybean genotypes were influenced by: atypical climatic conditions of this year and also the type of fertilizer and the fertilization dose. By analyzing the experimental data, it was noted that one genotype had longer growing season (Raluca TD variety: 135-140 days), and three genotypes had shortest growing season (Perla variety: 122-125 days; Carla TD variety: 121-123 days; T-295 line: 121-123 days).

Keywords: climate change, fertilization, soybean.

INTRODUCTION

The interest in conventional soybean culture is steadily growing, being the main source of good quality protein as well as vegetable oil (Probst and Judd, 1973). Soybeans are considered a basic food with a high nutritional value. The importance is given by their use as raw material in the food and animal feed industry (Addo and Oguntona, 1993). Yield and grain quality can be influenced by climatic conditions during vegetative growth (Urdă *et al.*, 2019) and by nitrogen, phosphorus and potassium soil supply.

Fertilization is one of the main economic and health-promoting factors in crop cultivation. High yielding soybeans require large amounts of nitrogen (N), phosphorus (P) and potassium (K), as well as a smaller amount of sulfur (S) and some micronutrients (Kahraman, 2017). Farmers

frequently neglect the fertilizer needs of soybeans, directing their attention instead at fertilizing other crops in the rotation.

Soybean yields decrease when essential nutrients are deficient, so farmers should develop comprehensive fertilizer programs to maximize soybean production (www.mssoy.org). NPK has important roles in cell division, energy transformation, and fat metabolism which eventually affected seed production (Achmad *et al.* 2016).

The aim of this study is to evaluate the influence of two types of chemical fertilizers (NPK) with four levels of fertilization on the main soybean growing stages and yield in the climatic conditions of 2019. The experiment was conducted at the Agricultural Research and Development Station from Turda (ARDS Turda) on a phaeozem soil type.

MATERIALS AND METHODS

To achieve the objective of this experience from ARDS Turda (Figure 1), the soybean varieties studied are experimented by the subdivided parcel method. Studied biological material contains thirteen soybean genotypes created at ARDS Turda (seven varieties and six prospective lines, in advanced generations of the breeding process). Fertilization was carried out with NPK 27:13.5:0 and NPK 16:16:16 complex fertilizer applying the following doses: unfertilized (control), 150 kg/ha, 200 kg/ha and 250 kg/ha.

The phenological growth stages were evaluated with the American Code from Fehr and Caviness (1977) (Figure 2).

RESULTS AND DISCUSSIONS

Meteorological conditions have a major impact on plant growth (Popović *et al.*, 2013, Ikanović *et al.*, 2014). Soybean plants are very susceptible to environmental conditions, such as climatic conditions (temperature, and rainfall), and soil conditions (pH, soil fertility, mineral nutrition) (Bohloul *et al.*, 1992; Keyser and Li, 1992).

Atypical climatic conditions during 1st April 2019 - 31st August 2019 may be considered as less favourable for soybean crop for the reference area, with consequences on the main plant growth stages. The temperatures and rainfall registered a high or very high variation from one day to another and from one month to another, with big differences from the multinational average (Tab. 1). The vegetation stages of the studied soybean

Figure 1. Study location and fertilization levels

Figure 2. Vegetation stages

Table 1. Temperature and rainfall in Turda during 1st April 2019 - 31st August 2019

Temperature (°C)						
Month		April	May	June	July	August
Monthly average		11	14	22	20	22
Range		11.4	15.5	9.7	11.9	9.7
Range	Minimum	7	4.9	15.9	14.1	17
	Maximum	18.4	20.4	25.6	26	26.7
Monthly multiannual average	(60 years)	9.9	15	17.9	19.7	19.3
Deviation from multiannual average		1.4	-1.4	3.9	0.7	2.8
Characterization of the month		warm	cool	warm	normal	warm
Rainfall (mm)						
Monthly average		4.82	7.26	5.73	3.50	9.11
Range		13.8	24.2	24.8	15	24.4
Range	0.4	0.2	0.2	0.2	1.2	
	14.2	24.4	25	15.2	25.6	
Monthly multiannual average	(60 years)	45.9	68.7	84.8	77.1	56.5
Deviation from multiannual average		16.7	83.7	-16	-42.1	7.2
Characterization of the month		very rainy	excessive rainfall	slightly dry	excessive drought	slightly rainy

Table 2. Experimental data obtained for soybean genotypes studied at different fertilizer doses (NPK 16:16:16)

NPK 16:16:16														
No.	Genotype	VE	Control			150 kg/ha			200 kg/ha			250 kg/ha		
			R 1	R 7	R 8	R 1	R 7	R 8	R 1	R 7	R 8	R 1	R 7	R 8
1	Perla	19	48	108	124	45	106	124	47	107	125	46	106	122
2	Onix		47	110	125	48	111	123	49	110	123	47	111	127
3	Felix		48	108	125	47	108	122	49	109	124	47	109	125
4	Carla TD		48	111	122	48	111	121	50	111	124	49	111	122
5	Caro TD		48	115	133	48	114	133	48	115	131	50	115	133
6	Ada TD		47	113	133	47	114	133	48	113	132	48	114	134
7	Raluca TD		51	117	137	51	117	136	52	119	140	52	118	136
8	T 161		47	109	124	47	108	122	49	108	127	48	109	123
9	T 295		50	108	122	51	107	121	50	106	121	52	107	122
10	T 165		47	109	126	48	109	126	48	110	127	48	109	123
11	T 6126		55	118	129	57	117	132	58	119	134	58	118	131
12	T 6117		48	110	126	47	108	125	47	110	128	48	109	124
13	T 166		47	113	126	47	114	130	47	115	132	47	114	131
Average		19	48	111	127	48	111	127	49	111	128	49	111	127

genotypes were influenced by both: atypical climatic conditions of this year and also the type of fertilizer and the fertilization dose.

The experimental data are summarized in Tab. 2 and Tab. 3, highlighting one genotype with longer growing season (Raluca TD variety: 135-

Table 3. Experimental data obtained for soybean genotypes studied at different fertilizer doses (NPK 27:13.5:0)

NPK 27:13.5:0														
No.	Genotype	VE	Control			150 kg/ha			200 kg/ha			250 kg/ha		
			R 1	R 7	R 8	R 1	R 7	R 8	R 1	R 7	R 8	R 1	R 7	R 8
1	Perla	19	47	109	125	47	107	122	47	107	122	48	108	123
2	Onix		48	115	129	49	112	127	49	110	123	49	112	127
3	Felix		47	110	123	49	108	125	48	109	124	48	109	127
4	Carla TD		47	112	122	48	113	123	47	111	123	49	111	123
5	Caro TD		50	116	133	49	115	133	51	115	134	49	115	133
6	Ada TD		48	115	134	50	114	133	48	114	133	47	113	134
7	Raluca TD		52	118	137	53	118	137	53	118	135	52	118	138
8	T 161		47	109	128	47	110	125	48	110	125	48	110	125
9	T 295		51	107	122	53	108	123	51	108	122	53	108	122
10	T 165		48	111	123	48	111	127	48	111	126	49	111	127
11	T 6126		56	118	134	57	117	133	59	117	133	58	116	133
12	T 6117		48	111	127	49	111	124	49	112	128	48	110	128
13	T 166		47	114	127	47	114	131	48	114	130	47	115	132
Average		19	49	113	128	49	112	128	49	112	127	49	112	128

Figure 3. Relationship between beginning of maturity (R7) and growing season (R8) for each type of fertilizer and doses (NPK 16:16:16)

140 days), and three genotypes with shortest growing season (Perla variety: 122-125 days; Carla TD variety 121/123 days; T-295 line: 121-123 days). The studied genotypes reacted differently to fertilization doses, the best results

being recorded at Raluca TD variety and the T-166 line (NPK 16:16:16 complex fertilizer, 200 kg/ha). The yield increased with 534 kg/ha respectively 849 kg/ha compared to the unfertilized variant. In the climatic conditions of 2019, at the 150

Figure 4. Relationship between beginning of maturity (R7) and growing season (R8) for each type of fertilizer and doses (NPK 27:13.5:0)

Table 4. Effect of complex fertilizer with four levels of fertilization on yield (kg/ha)

Nr. crt	Soi	NPK 16:16:16			NPK 27:13.5:0			Control
		150 kg/ha	200 kg/ha	250 kg/ha	150 kg/ha	200 kg/ha	250 kg/ha	
		Yield (kg/ha)						
1	Perla	1874	1967	1727	1862	1713	1898	2164
2	Onix	2102	2302	2132	2128	1409	1623	2408
3	Felix	1847	1533	1701	1994	2185	2035	2344
4	Carla TD	1966	2029	1805	1670	2048	1798	2201
5	Caro TD	2361	2221	2104	1446	1531	1752	2453
6	Ada TD	2272	2386	2259	2235	1751	1978	2340
7	Raluca TD	1921	2998	2827	2445	2499	2201	2464
8	T 161	1998	1993	2426	2172	2346	2363	2357
9	T 295	1790	2143	1532	1919	1915	1958	1924
10	T 165	2371	2224	2095	2345	2009	2075	2270
11	T 6126	1694	2539	2126	1988	1683	2179	2334
12	T 6117	2538	2284	1776	2085	2223	2184	2245
13	T 166	2164	2989	2471	3149	2507	2593	2140

kg/ha dose there were no significant differences regarding obtained yield compared to control. The genotypes: Raluca TD, T-166 and T-6126 have achieved the maximum yields at the highest fertilizer dose (250 kg/ha) (Tab. 4). According to Achmad *et al.* (2016) the responses to NPK doses vary with soybean varieties. In his experiment Volnei *et al.* (2010) have noticed that there was no significant effect of fertilizer over soybean yields. The fertilizer doses impact on soybean genotypes yield in the climatic conditions of this year reveals that in average the nutritional support offered did not determine the increase of the yield.

By analyzing the correlations coefficient between beginning of maturity (R7) and the end of maturity (R8), we can see that it is positive, high and very significant in every type of fertilizer and fertilization doses (Figure 3 and Figure 4).

CONCLUSION

Given the climate change and growing interest in soybean crop, monitoring the reaction of soybean varieties to fertilization becomes essential. The experimental data shows that one genotype had longer growing season (Raluca TD variety, 140 days), meanwhile three genotypes had shorter growing season (varieties: Perla- 122 days; Carla TD- 121 days; T-295 line- 121 days).

The obtained data reveals that in the pedoclimatic conditions from Turda, in 2019, most genotypes responded negatively to the application of NPK 27: 13.5: 0 complex fertilizer.

In the case of NPK 16:16:16 mineral fertilizer, Raluca TD variety and lines: T-6126 and T-166 had a production increase of 20%, 10% and 14% respectively by applying the dose of 200 kg/ha.

Preliminary obtained data in 2019 emphasize that, regarding yield, the genotypes reacted differently depending on the type of fertilizer and the applied doses. Most of the genotypes responded negatively to fertilization. It is possible that this reaction is due to the long cultivation of soybeans in agricultural **crop rotation** at ARDS Turda.

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