ROMANIAN AGRICULTURAL RESEARCH, NO. 38, 2021
Print ISSN 1222–4227; Online ISSN 2067–5720

VARIABILITY OF YIELD AND CHEMICAL COMPOSITION IN SOME ROMANIAN SOYBEAN GENOTYPES

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ABSTRACT

Soybean can play an important role in securing the European protein resources. The goal of the breeder was to create highly productive soybean varieties, followed by quality grain. In this regard soybean breeding program at NARDI Fundulea has been involved in improving the genetic yield and quality potential to meet the need of farmers in different parts of the country. The objective of this study was to evaluate the variability of five soybean genotypes (created at NARDI Fundulea) from different maturity groups, grown at the National Agricultural Research and Development Institute Fundulea in 2017-2019, for yield, protein content and oil content. The year had statistically significant effect for the studied agronomic traits, $p<0.01$.

The average yield for all genotypes was 2952 kg/ha. The highest grain yield on an average was recorded in genotype Crina F (41/9%). The average protein content of all examined genotypes was 40.07%. 2017 was the most favorable year for protein synthesis.

The average oil content for all examined genotypes was Camelia F (23/77%). The most favorable year for oil synthesis was 2019 (23/48%).

This research had evidentiated that new soybean genotypes created at NARDI Fundulea are suitable for new climatic conditions and can constitute the basis for further soybean breeding adapted to farmers' requirements.

Keywords: soybean, yield, protein content, oil content.

INTRODUCTION

The evolution of human society has generated, especially in recent decades, the most diverse problems, including a major one nutrition. Because of the explosive growth of the world population, an increase of the food efficiency of the crop production that is obtained in a more intensive agriculture is naturally required (Cociu et al., 2010; Cociu et al., 2011; Popovic et al., 2013; Luca, 2012; Luca et al., 2013 and 2016).

Soybean has great economic importance, primarily due to the chemical composition of the seeds, which have high protein (about 40%) and oil contents (about 20%). The total production of soybean in the world was 334 million tones (Fouda et al., 2019). It is used in food industry, as in many others. Soybeans a “top product” on the world market. The entire soybean trade is very important, and especially soybean products, like flour, soybean oil, etc. (Cvijanovic et al., 1988; Popovic, 2010).

Soybean is the first in the group of vegetables used for beans due to the high content of protein, fat, lecithin, vitamins and enzymes. It is very hard to find another plant that, within such a short growing season, is able to synthesize such a large amount of valuable substances (Penas et al., 2011; Coreţchi et al., 2014).

Yield and grain quality are polygenically inherited and strongly influenced by environmental factors. When the plant population shows phenotypic variability of some quantitative trait, the expressed variability is attributed to genetic differences and/or different environmental impacts. Genetic factors of varieties are an important factor that affects the chemical composition of the seeds, but these properties are influenced by the environment, up to 50% (Brumm and Hurburgh, 2002).

Received 6 October 2020; accepted 5 November 2020. First Online: November, 2020. DII 2067-5720 RAR 2021-37

Of the climate changes, and drought, influences and planning of adequate response are the biggest challenges today. Climate changes and drought occurrence influences negatively the plant development. These can be mitigated by finding appropriate measures. The most important adaptation measures are earlier sowing, irrigation, selection of tolerant soybean varieties adapted to different climates (Popovic et al., 2016).

Given these considerations, the identification of genotypes with high ecological plasticity, capable of forming reasonable harvests from one year to the next or in less favourable geographical areas, becomes a new challenge for the NARDI Fundulea breeding team.

These prerogatives could be materialized by testing the material (varieties) under various pedoclimatic conditions or by using the hybridization works of genetically differentiated.

The objective of this paper was: to determined of productivity and stability of examined varieties grain yield and quality.

MATERIAL AND METHODS

The biological material that was the object of this experiment was represent by five soybean varieties of different maturity groups: Daciana, Crina F, Camelia F (0 MG) and Triumf F and Fabiana F (I MG), created at NARDI Fundulea, by the hybridization method followed by selection. The study was conducted over a three year period (2017, 2018 and 2019) from the National Agricultural Research Development Fundulea (Table 1).

The trials were set up as randomized block design in three replicates whit a basic plot size of 6 m². Soybean was planted on April 11, 2017, April 16, 2018 and April 25, 2019, the plant density was 500,000 plants ha.

In order to prevent negative effects of weeds, the trials were treated in the phase of 2-3 well-developed leaf blades with herbicides: Corum 1.9 l/ha + Dash 1 l/ha in 2017-2019. Crop were harvested mechanically on September 1, 2017, September 6, 2018 and September 4, 2019. Yield was measured after harvest and average samples were taken from each trial replicate to determine oil and protein content in grain. Chemical composition of soybean genotypes (oil and protein content of seeds) was determined by near-infrared (NIR) method using a Grain Analyzer (Infratech 1241, Foss Tecator).

The obtained results were statistically evaluated by ANOVA. The dispersion of yield, protein content and oil content in time were estimated by Coefficient of variance (CV) (Ceapoiu, 1968) and significance was calculated based on LSD test for probability levels 0.05% and 0.01%.

Table 1. Main agronomic characteristics of the soybean genotypes tested in this study in 2017-2019

Genotype / Traits	Daciana	Crina F	Camelia F	Triumf F	Fabiana F
Maturity group	0	0	0	I	I
Plant height (cm)	80	75	55	70	65
Height first pods insertion (cm)	7	17	10	8	15
Leaflet shape	lanceolate	ovate	lanceolate	lanceolate	lanceolate
Pubescent color	gray	gray	reddish	reddish	gray
Flower color	violet	white	violet	violet	violet
Type of growth	unlimited	determined	unlimited	unlimited	unlimited

Regarding meteorological conditions, NARDI Fundulea area is characterized by a continental temperate climate, with uneven distribution of rainfall by months.

The data regarding temperature and rainfall registered during the years of testing, delivered by the Weather station of NARDI Fundulea, are presented in Figures 1 and 2.

Mean monthly temperature in 2017 was 19.3°C. During the soybean vegetation period in 2018 average monthly temperature was 20.64°C which exceeded average in 2017 and

2019 by 1.34°C and 0.8°C (Figure 1). The monthly distribution of rainfall over the three experimental years compared to the multiannual average reflects a significant variation. The quantity of precipitation during soybean growing period in long time was 352 mm, in 2018 was 273.4 mm, and in 2017 was 456 mm. In 2019 was recorded the most pronounced water deficit, which was by 315.2 mm less than long term average for Fundulea, especially in August in the pod formation. However, hasn't been recorded a considerable impact on the yield potential of the studied variants (Figure 2).

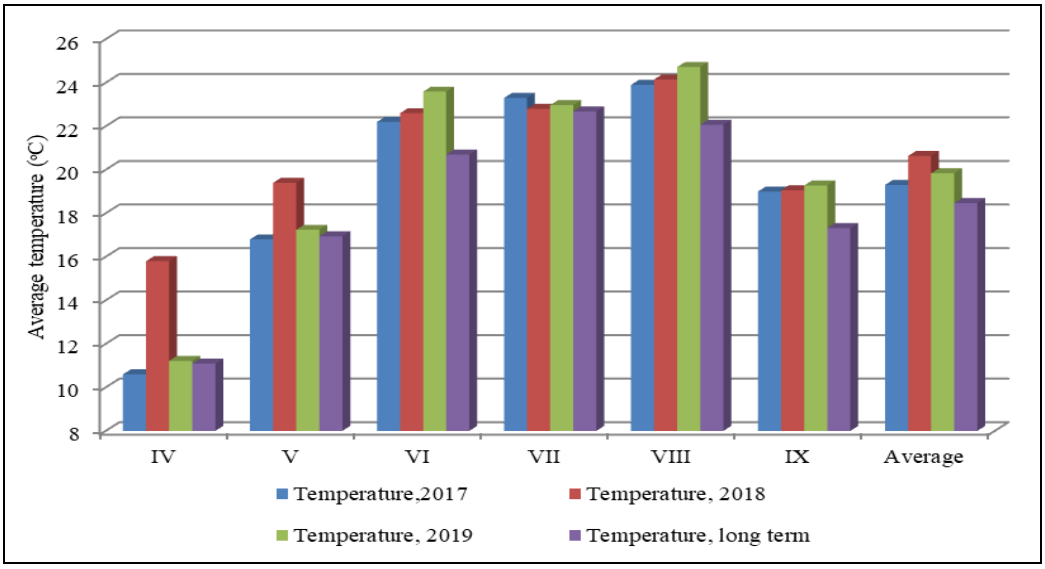

Figure 1. Average temperatures during soybean vegetation, Fundulea

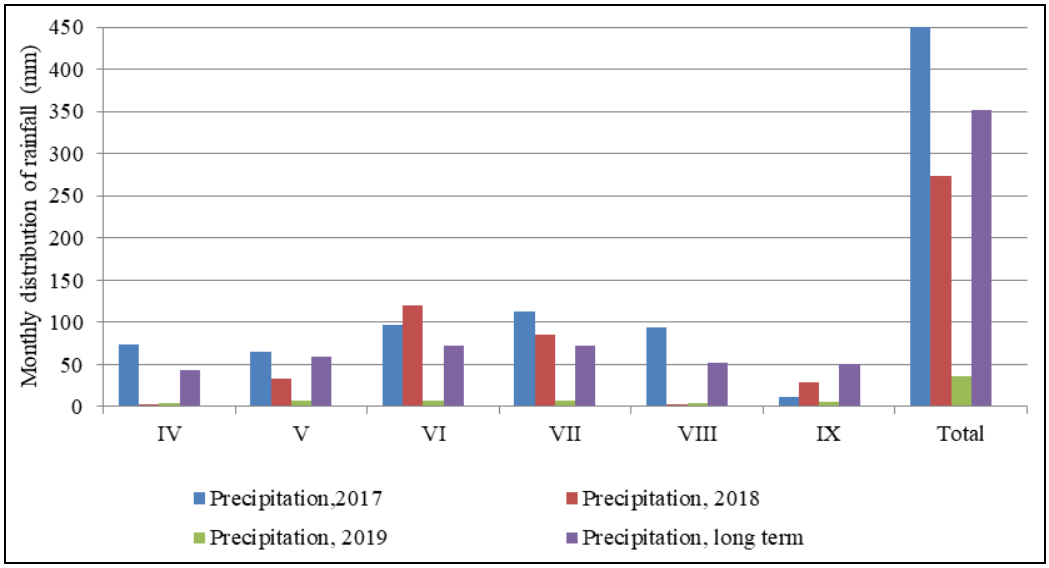

Figure 2. Precipitation distribution during soybean vegetation, Fundulea

RESULTS AND DISCUSSION

Grain yield

Looking at the average of the examined soybean genotypes yield in 2017, 2018 and 2019, evidently average yields among years were statistically highly significantly different. The year had statistically significant effect on the grain yield level. In 2019 and 2017, on average, for all tested genotypes, highly statistically significantly higher yields were recorder (3304 kg/ha and 2933 kg/ha) compared with 2018 (2619 kg/ha) (Table 2).

The average yield for all genotypes was 2952 kg/ha. 0 MG genotype Crina F and Fabiana F of I MG recorded greater yield stability, as compared the other genotypes analyzed. Genotypes Daciana and Camelia F recorded the highest yield variation (CV=19.25%, CV=17.47%). Standard for average yield, for all genotypes, was 343 (Table 2). The highest grain yield per unit area had an average genotypes Triumf F (3134 kg/ha), Crina F (2945 kg/ha), Camelia F (2920 kg/ha), and Fabiana F (2908 kg/ha). Genotype Daciana recorder lower yield compared to genotype Triumf F (Table 2).

Table 2. The yield (kg/ha) and soybean stability (%)

No.	Genotype	Yield (kg/ha)			Average	Rang	Std.	Stability
		2017	2018	2019	2017-2019			C.V. (%)
1.	Daciana	2744	2368	3450	2854	5	549	19.25
2.	Crina F	3080	2715	3039	2945	2	200	6.79
3.	Camelia F	3212	2331	3217	2920	3	510	17.47
4.	Triumf F	2705	3086	3611	3134	1	455	14.52
5.	Fabiana F	2924	2595	3205	2908	4	305	10.50
Average		2933	2619	3304	2952	-	343	13.84

Genotype Camelia F had in 2017 significantly higher yield compared with all genotypes tested in period 2017, but in 2018-2019 genotype Camelia F had significantly lower yield compared with all genotypes tested, $p<0.05$, $p<0.01$.

Genotype Triumf F had a significantly higher yield in 2018 and 2019 compared to all tested genotypes in this study period. (Table 2). Genotype Triumf F represent the maturity group I, and confirm the results obtained by Popovic et al. (2016) and Malik et al. (2007), namely, the varieties with the late maturity group have proven to be more productive regardless of climatic conditions.

The study of the interaction between the genotype (G) and Year (Y) provides good estimates of breeding genotype value. To cope with unpredictable environmental conditions, the emphasis was on stable varieties creating suitable for growing in different environmental conditions. The most suitable genotypes for examined growing region were Camelia F, Triumf F and Daciana.

Protein content

The average protein content in all examined genotypes was 40.06%. A statistically significantly higher content of protein had, on average, genotype Crina F (41.90 %) compared to Daciana and Camelia F, $p<0.05$, $p<0.01$.The highest stability of the protein content had genotypes Camelia F, Daciana and Crina F (CV=0.68%, CV=0.82%, CV=1.65%). Standard for average protein content, for all genotypes, was 0.42 (Table 3).

Protein content is correlated negative with yield and oil content, similar results were found by Jagtap and Choudhary (1993) and Malik et al. (2007). Leffel and Rhodes (1993) also reported that high-protein varieties were superior for seed protein concentration, whereas inferior for seed yield and oil concentration.

Table 3. The yield (kg/ha) and soybean stability (%)

No.	Genotype	Protein content (%)			Average	Rang	Std.	Stability
		2017	2018	2019	2017-2019			C.V. (%)
1.	Daciana	38.9	38.8	39.4	39.03	4	0.32	0.82
2.	Crina F	41.5	42.7	41.5	41.90	1	0.69	1.65
3.	Camelia F	38.7	39.1	38.6	38.80	5	0.26	0.68
4.	Triumf F	42	39.3	39	40.10	3	1.65	4.12
5.	Fabiana F	41	41.1	39.5	40.53	2	0.90	2.21
Average		40.42	40.20	39.60	40.07	-	0.42	3.62

2017 was the most favorable year for protein synthesis. Statistically highly significantly highest protein content was recorded in 2017 (40.42%) and 2018 (40.20%) compared with 2019 (39.60%). The higest protein content in 2017 had genotypes Triumf F (42%), Crina F (41.5%) and Fabiana F (41%) compared to genotypes Daciana (38.9%) and Camelia F (38.7%) (Table 3).

The highest stability of the protein content had genotypes from 0 MG - Camelia F and Daciana (CV=0.68%, CV=0.82%) (Table 3).

Oil content

The average oil content for all genotypes was 22.97%. The highest oil content, on average, was recorded in genotype Camelia F (23.77%), significantly higher compared with genotype Crina F (21.7%). The highest content oil per year had genotypes Camelia F (23.4-23.8%) and Daciana (23.2-23.9%) in 2017 and 2018, Camelia F (24.1%) and Triumf F (24%) in 2019. The highest stability of oil had genotype Camelia F and Daciana from 0 MG (CV=1.48%, CV=1.53%). Standard for average oil content, for all genotypes, was 0.52 (Table 4).

The most favorable year for oil synthesis was 2019 (23.48%). Statistically significantly higher oil content was achieved in 2019 (23.48%) compared with 2018 (22.98%) and very significantly than in 2017 (22.44%).

Table 4. Oil content (%) in soybean grain and stability (%)

No.	Genotype	Oil content (%)			Average	Rang	Std.	Stability
		2017	2018	2019	2017-2019			C.V. (%)
1.	Daciana	23.2	23.9	23.7	23.6	2	0.36	1.53
2.	Crina F	21.7	21.3	22.1	21.7	5	0.40	1.84
3.	Camelia F	23.4	23.8	24.1	23.77	1	0.35	1.48
4.	Triumf F	21.6	23.3	24	22.97	3	1.23	5.37
5.	Fabiana F	22.3	22.6	23.5	22.80	4	0.62	2.74
Average		22.44	22.98	23.48	22.97	-	0.52	3.94

Analyses of variance were performed considering years as a random factor and genotypes a fixed factor.

The table 5 shows the analysis of variance for average values for the traits evaluated for five soybean genotypes. ANOVA indicated that the effect of years was significant for yield, genotypes was significant for protein content, genotypes and years were significant for oil content.

Table 5. Anova for average grain yield, protein content, oil content for soybean genotypes, NARDI Fundulea, 2017-2019 period

	Grain yield				Protein content			Oil content		
Source of variation	ss	df	F	P-value	ss	F	P-value	ss	F	P-value
Genotypes	137225.1	4	0.4377*	0.7785	18.756	5.7078*	0.0179	8.02	8.234*	0.006
Years	1177179	2	7.5099	0.0145	1.8013	1.0963	0.3794	2.705	5.555*	0.030
Interaction	626996.1	8	-	-	6.572	-	-	1.948	-	-
Total	1941400	14	-	-	27.129	-	-	12.673	-	-

CONCLUSIONS

Following conclusions can be drawn on bases of this research results:

- in the experiments from NARDI Fundulea, the soybean yields were influenced by the weather conditions of the agricultural year. The most favorable year was 2019, when the average yield was 3304 kg/ha;

- the analysis of the genotypes under very different climatic condition, allows to identify genotypes with a good general adaptation capacity;

- the highest average grain yield, on average, had genotype Triumf F (3134 kg/ha) and for the protein content and oil content was remarked genotype Camelia F (41.90% and 23.77%);

- the most suitable genotypes for examined growing region were Camelia F, Triumf F and Daciana;

- the most favorable year for protein content was 2017, this was the richest in precipitation and the favorable year for oil synthesis was 2019, year with very lower precipitation;

- for yield high we recommend growth the varieties with the late maturity group and those varieties early for a yield with superior quality indices (protein and oil content).

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