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The Effect of Plant Density on Yield and Yield Components on the Soybean Late Maturing Genotypes in the North of Khozestan

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ABSTRACT: In order to study the reaction of new genotypes obtained from generations of segregation, to soybean plant density changes in weather conditions in the north of Khuzestan, the research was conducted in research center in Safiabad, Dezful in summer 2014. Four soybean genotypes including G_3=SG10-90064, G_2=MIGMAT, G_1=SG_4-90064, Salnd: G_4 (control test) in four different densities D_4=65, D_3=50, D_2=35, D_1=20, G_1=SG_4-90064, G_2=MIGMAT, G_3=SG10-90064, plantper square meter (in a completely factorial randomized block design)with threereplicationswere investigated.Analysis of variance showed that grain yield in treatment between the genotypes and plant density and interaction was significant at the probability of error of one percent. The comparison of the average statistical data showed that the highest and lowest of grain yieldwas related with genotypes of G_3 with 4117 and G1 with 2992 kg per hectare respectively. In the interaction between genotype and density, G_3D_3 with 4733 kilograms per hectare, hadthe highest and G_1D_4 with 2105 had the lowest grain yield respectively. Among the yield components, pods per plant and seeds per pod in the treatment of genotype and plant density and interactions genotype and plant density were significant at the probability of error of one percent.
Seed weight was significant only in the treatment of genotype at 1% probability level. The results suggest that genotype G_3 (SG10-90064) with 50 plants per square meter had the highest grain yield.

Keywords: soybean, variety, density, Dezful

INTRODUCTION

Soybean (*Glycine max* (L) Merrill) is one of the oldest cultivated plants and one of the major sources of oil and plant protein (Khajehpour, 2006). In appropriate crop circumstances, increased plant density to achieve maximum performance is essential. By reducing the spacing between rows and increasing plant density on soybean, grainyield is maximized (Shafshak *et al.,* 1989). It was recommended that soybeans were sown in narrow in rows 40 cm and a significant increase in performance compared to the row of 75 cm, was observed respectively (Egli, 1988). Increased grain yieldin a more narrow line can be due to increased exposure, especially during the critical grain size (Andrade *et al.,* 2002). Maximum performance is achieved when firstlyplant communities in the growth phase have the maximum leaf area, and secondly, the equal culture conditions are existed to minimize competition between plants (Narne *et al.,* 2002). Rachana and Viswanathan evaluated 24 soybean genotypes; the results showed that the number of pods per plant, seeds per plant and seed weight was significantly and positively correlated with grain yield (Seiter *et al.,* 2004). By examining 90 soybean genotypes, correlation of different attribute with the performance showed that the number of pods per plant, harvest index and biological function in the plant is considerable in the selection of genotypes for high yield in soybean (Rahman *et al.,* 2005).

Shefshek *et al.,* (1989) in their investigation on the effect of sowing different densities (8, 16, 32, 64) per square meter on the grain yield of soybean showed that changes in grain yield and dry matter (g per plant) at different densities of sowing changes had reverse relationship with the changes in the number of pods and seeds per plant and a significant negative correlation was observed between these components and grain yield of the product (Taware *et al.,* 1997).

In view of the favorable characteristics of soybean and the effect of various factors to achieve the maximum performance of the test, the effect of plant density on yield and its components were evaluated.

MATERIALS AND METHODS

The research was conducted in an agricultural center in Safiabad, Dezful in crop year 2013. Geographically, it was located in the north of the province, with an altitude of 82 meters above sea level and latitude at 32 degrees 22 minutes north, with longitude at 48 degrees 26 minutes east. The average rainfall is 250 mm in the city per year, with no summer rainfall and a dry climate.

Based on soil tests, soil tissue of the research was silty clay with Ph equal to 8/7, respectively. The study has 16 treatments including four different densities (D_1 = 20, D_2 = 35, D_3 = 50 and D_4 = 65 plants per square meter) and consists of four soybean genotypes G_1 = SG_4-90064, G_2 = MIGMAT, G_3 = SG10-90064.

G4=SALEND(controltest) was implemented in a factorial experiment with acompletely randomized block designwith threereplications. Land operation was carried out including plow, two disksperpendicular to each otherandtrowel. Urea chemical fertilizers were calculated separately by 50 kg per hectare and phosphorus for 150 kg per hectare in the form of P_2O_5 and potassium fertilizer at a rate of 100 kg per hectare in a K_2O after soil testing and critical rate of theseelements and then by complete mixing, three fertilizers were distributed and then proceeded to disk and by furrower machine, stocks were built at a distance of 75 cm. After determining theviabilityby drying method, soybeanseeds were sown in plant density higher than expected and on the two rows. Each cert including two-row 3 stacks was considered in the length of5 meters and between certs a stock. Irrigation was done immediately after planting and watering other plants were embargoed if was necessary. To accurately determine the density levels of plant density after ensuring the uniformity of germination of farm, additional plants were sparse in two or three leafletsinplants with respect to the distance between the two plants according to the treatments in stronger and healthier plant as well as with other plants.

Weeds were wed by hand. To determine the yield and yield components, the margin of the row related to the performance of 3 square meters up was eliminated and then after counting, the number of pods per plan was isolated from per pod and grain yield was calculated with 14% moisture content. Finally, statistical data was analyzed by MASTAC software and means were compared by Duncan testand diagramming was carried out by EXCEL software.

RESULTS AND DISCUSSION

Analysis of variance of grain yield in table 1 shows that genotype treatment and different densities as well as the interaction between genotype and densitywere significant in the probability of error 1% (Table 1). Comparison of means shows that (Table 2) among different genotypes, G_1 with yields 4117kg per hectare and G_3 by 2992kg per hectare had the highest and lowestyield respectively. Among the different plant density, D_2 and D_4 with 3086 kg ha kg per hectare had the highest and lowest yield. The interaction of genotype and density, G_3D_3 treatment with 4733 kg perhectare and G_1D_4 treatment to 2105 kg accounted for the highest and lowest yield, respectively. It seems that increased plant density decreases the yield. So we can say with increasing plant density competition increased and performance was reduced. Between D_4 and D_4, performance can be explained in such a way that the number of pods per plant is the most important component in grain yield, and in low density, D_2. It was resulted in the increased grain yield in D_2 density. Number of seeds per pod and number of pods per plant have a direct positive effect on grain yield (Seiter *et al.*, 2004). Increasing the number of plants per unit area due to shadingcan further reduce light for each plant and hence the yield will be reduced (Shafshak *et al.*, 1989). Analysis of variance of seed weight in table 1 showed that the treatment of genotype was significant at the probability levelof error 1% but the effect of plant density and interaction of genotype and the plant was not significant. Comparison of means in treatments (Table 2) shows that the highest seed weight and the lowest accounted for G_1 to G_4 to amount of 17.36 g and 15.49 g, respectively. The interaction of genotype and plant density in treatments G_1D_2 with 17.87 g and G_4D_4 with 14.42 grams had the highest and lowest of seed weigh, respectively. Due to this it can be concluded that an increase in seed weight also increases performance. It can be concluded that seed weight were influenced by genetic factors. By increasing the number of branches, number of pods and seeds per plant, seed weight due to increased competition within the plant is reduced.

Then by considering the results it can be concluded that an increase in seed weight also increases performance. Chu *et al.*, (2004) and Rahman (2005) reported that the increased density increased competition for light, nutrients and water, as a result of photosynthesis made less contribution was allocated to seed and finally seed weight was reduced (Ball *et al.*, 2001, Cho *et al.*, 2004). Analysis of variance in table 1 indicates that the number of pods per plant was significant at the probability of error of one percent by the impact of genotype, plant density and genotype interaction and plant density in the number of pods per plant. Comparison of means (Table 2) in treatments indicates that genotype G_2 and genotype G_3 had the highest number of pods per plant with 56.77 35.36 pods per plant.

Table 1: Analysis of variance for yield and yield components of soybean cultivars indifferent densities.

Average squares							
Sources of change	**Degree of freedom**	**Grain yield**	**Seed weight**	**Pods per plant**	**Seed per plant**	**Number of pods per square meter**	**Harvest index**
Replication	2	n1181664.583%	*2.184%	15.619%	0051%	8009.896%	3.6333%
figure	3	2789738.688%	8.716%**	925.278%	404%	1250910.135%	*65.655%
Plant density	3	133179.688%	1.289%	685395	*100%	1066370.576%	43.673%
Interaction	9	429613.280%	ns1.245%	11.588%	*34.%0	25109.743%	26.462%
effect	30	11912.09%	594%0	64.688%	008.0%	25109.743%	13.800%
Test error	---	9.77%	4.76%	7.28%	3.87%	21153.918%	12.19%
Change						8.46%	
coefficient							

In the plant density treatment, D_1 with a 65.57 and D_4 with 26.74 had the maximum and minimum number of pods per plant, respectively. In their interaction, G_3D_1 with 78.83 and G_2D_4 with 20.67 had the highest and lowest number of pods per plant, respectively.

It seems that in high densities, due to increased competition and nutrient absorption in plants the number of fertile flowers has decreased and also by increasing the number of plants per unit area, number of tributaries also declined and eventually the number of pods per plant was reduced, and generally the role of tributaries is more pronounced in the production of low density pods. Tavara *et al.* (1997) evaluated 46 soybean lines and reported that the number of pods per plant was the most direct effect on yield (Narne *et al.*, 2002).

Table 2: Comparison of the recorded quantitative and qualitative characteristics of a number, plant density and interactions impact.

Categorization of average quantitative and qualitative characteristics							
	Treatment	**Grain yield**	**Seed weight gr**	**pods per plant**	**Seed per plant**	**Number of pods per square meter**	**HI**
Figure	G_1	c2992	17.36	46.78b	B2.382	b1753	Ab30.2/
	G_2	bc3337	16.26b	35.36	2.175	c1330	28.54
	G_3	4117a	b15.62	A56.77	a2.68	2120a	33.79c
	G_4	b3690	b15.49	b47.68	b2.292	b1734	B29.40
Plant density	D_1	A3520	A16.39	A65.57	C2.250	c1311	Ab 30.18
	D_2	a3881	16.40a	55.72b	Bc2.333%	A1950	A32.75
	D_3	a3649	a16.32%	38.74 c	ab452	1937	B28.12
	D_4	b3086	15.71a	D2.450a	a**2/450**	B1738	Ab 30.19
Interaction of value in plant varieties	G_1D_1	Bcd3306	16.39abcde	63.00cd	De 30.300	i1260	abcd30.32
	G_1D_2	bcd3633	A17.87	de57.67	cd2.637	cd2018	A35.73
	G_1D_3	D2922**2**	ab17.48	Hij38.90	Bcd2.400	cde1944	d/ 23.29
	G_1D_4	e2105	abcd17.09	lm27.57	Abcd2.467	bef1791	Abc31.58
	G_2D_1	cd4530	Abcd17.09	fgh46.77	ef2.100	J935.7	bcd26.55
	G_2D_2	abc3933	Bcdef16.07	Gh46.77	F2.100	fgh1540	abcd30.19
	G_2D_3	bcd3273	Cdef15.98	Kl30.00	De2.300	ghi1500	abcd30.27
	G_2D_4	cd3095	Efg15.55	m20.67	De2.300	hi1343	Bcd26.79
	G_3D_1	bc3812	Fg15.13	a78.83	ab**6** 2.600	fgh1577	a34.61
	G_3D_2	ab4039	Fg15.45	Bc66.67	abc2.567	ab2333	a35.29
	G_3D_3	a4733	bcdef16.15	fg48.83	Ab2.677	A2442	ab33.48
	G_3D_4	Abc3884	defg15.77	Jkl3272	A2.667	bc2162	Abc31.79
	G_4D_1	abc3916	Bcdef16.03	Ab73.67	F2.000	ghi1437	abc13.75
	G_4D_2	abc3017	bcdef16.02	ef54.53	bcd2.400	cde1909	abcd29.78
	G_4D_3	bcd3667	fg15.31	ijk37.23**7**	bcd**2/400**	cde1862	Cd25.43
	G_4D_4	bcd3661	g14.42	lm26.00	cd2.367	efg1690	abc30.62

Ball *et al* (2001) reported that the plant density had inverse correlation with the number of pods per plant and in the figures studied; the number of fertile pods per node was different and decreased with increasing plant density (Asa *et al.,* 2010).

Analysis of variance in table 1 shows that genotype, plant density and also their interaction were significant in the probability level of error of one percent. Comparison of means (Table 2) showed that genotype G_3 with 2.608 and genotype G_2 with 2.175 had the highest and lowest number of seeds per pod respectively. Among the different densities, D_4 and D_1 with 2.450 and 2.250 had the highest and lowest number of seeds per pod. As well as in the interaction between genotype and density, G_3D_4 and G_2D_2 with 2.667 and 2.000 G_4D_1 had the highest and lowest number of seeds per pod. It can be concluded that between figures and also different densities, the number of seed per pod is variable, so that decreased number of seeds increases per pod density, and the more the plant density, the less the penetration of light into the canopy. It in turn will cause the block of assimilates for fetal development, resulting in a reduced number of seeds per pod and in a word, abortion will be observed. Chu *et al* (2004) reported that the number of seeds per plant is as the most important attribute to achieve superior performance. Anything that reduces this attribute, it effectively reduces grain yield.

The results of Table 1 show that the number of pods per square meter in the treatment of genotype and plant density was significantat the level of 1% error andinteraction between genotype and density was not significant.In the comparison of mean (Table 2) in the treatment, G_3 and G_4 with 1734 and 2120 had the highest and lowest number of pods per square meter. Increased density increased competition for resources between plants so the number of pods was reduced considerably per plant, but the increased number of plants per unit area, the decreased number of pods per plant was compensated. Khadem Hamza (2004) reported that by increasing the density, the number of pods per single plant was decreased, but increased per unit area.

HI represents the ratio of distribution of photosynthesis between economic performance and total yield. HI genotypewas significant at 1%, 5% at density level of error. And the interaction between genotype and plant density was not significant (Table 1). Comparison of mean (Table 2) shows that the G_3 with 79/33 and G_2 with 45/28 had the highest and the lowest harvest index, respectively. In thedensity treatment, D_2 and D_3 with a 75/32 percent and 12/28 are thehighest and lowest harvest index.Given that the interaction of genotype and density is not significant atvariance analysis table, by increasing plant density and harvest index shows a decreasing trend which is likely is due to increased plant density on grain yield.

CONCLUSION

Every soybean genotype that might have the highest light absorption in the most suitable plant density, might have higher dry matter and therefore have a greater yield. In the study, genotype (G_3: SG10-90064) with 50 plants per square meter and grain yield of 4733 kg per hectarehad thehighest yield.

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