IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS)
e-ISSN: 2319-2380, p-ISSN: 2319-2372. Volume 12, Issue 11 Ser. I (November 2019), PP 53-57
www.iosrjournals.org

Population of plants and its effect on the vegetative development and performance of sesame

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Abstract: *The research aimed to evaluate sesame production with different planting densities in the SH1El variety. The experiment was implemented in the district of Horqueta, Paraguay, from October 2016 to February 2017. The experimental design was randomized complete blocks, five treatments with four repetitions were used. The treatments consisted of different numbers of plants in planting T1: 10, T2: 15, T3: 20, T4: 25 and T5: 30 plants per linear meter. The variables evaluated were plant height, number of capsules, weight of 1000 seeds and yield. The data obtained from each variable studied were subjected to analysis of variance (ANAVA). The analysis of variance shows that significant differences were obtained at the statistical level for the height determination of plants 60 and 90 DDS, number of capsules, grain yield, and not significant for the determination of plant height 30 DDS, weight of 1000 seeds. It is concluded that the population of plants influenced sesame production, T2 is the one that obtained the best yield with 1054,75 kg ha with the number of 15 pl/m linear.*

Keywords: *Sesamun indicum* L.*, density, number.*

Date of Submission: 05-11-2019 Date of Acceptance: 20-11-2019

I. Introduction

Sesame (*Sesamum indicum* L.) is native to Asia and Tropical Africa, it is an annual, herbaceous, erect plant, with or without branches, whose cycle can be 80 to 130 days with good development (Robles 1991). In Paraguay it was introduced at the beginning of the 20th century and promoted as a crop of income for producers of small properties in the 1990s (Duarte 2008)

Sesame is an oleaginous grain, used for the extraction of oil and as an ingredient for the production of baked goods and other types of food. In Paraguay, 75% of the annual production is exported abroad, the rest is used as raw material for the manufacture of oil, with yield up to 52% (AFD, 2008).

Row crop sowing allows, among other things, the mechanization of work such as pesticide application and mechanical weed control, on the other hand, it seeks to achieve a distribution of plants in the field, so that competition between them for Water, nutrients and luminosity are minimized, allowing them to develop their maximum genetic potential. They recommend sowing in a row 0,50 to 0,60 m. It is also recommended to sow 20 to 25 seeds per linear meter for branched varieties and 25 to 30 seeds for unbranched varieties, these are general recommendations for all varieties, however, it is possible that when using varieties of different growth habits and vegetative cycle, both the adaptation of the plants, and the final sesame yield can be affected by sowing it at different densities (Ávila *et al*., 1992).

Colmán 2003, evaluating the yield of three sesame varieties, grown in four different densities 66,666; 88,888; 111,111 and 133,333 plants per hectare, resulting from 90 cm spacing. between rows and 6; 8, 10; 12 plants per linear meter, in the Department of Concepción, among the varieties studied, the most productive was the white broom, being, therefore, the one recommended for cultivation to farmers in relation to gold and black. Ávila *et al*., (1992), recommends the use of distances of 0.50 to 0.60 m between rows and 10 cm between plants or 200,000 $pl.ha^{-1}$. In a technical publication of Colombia, Varela (1991) recommends sowing with a separation of 60 cm, since this allows other tasks to be carried out.

The objective of this work was to evaluate the sesame production with different population densities of SH1E1 variety.

II. Materials And Methods

Location of the experiment

The research work was carried out in the district of Horqueta, Paraguay, circumscribed at 23º24'06.8 "South 57º07'41.8" West, elevated 160 meters above sea level. The period covered by the experiment was between October 2016 and February 2017.

Characteristics of the climate and soil of the place

The average annual rainfall varies between 1300 mm to 1700 mm in the Eastern Region, with seasonal rainfall variability. The highest rainfall occurs from October to March, July and August constituting the months of least rainfall, with a variability in the distribution of monthly rainfall in the different locations, being the continental climate (DMH - DINAC, 2017).

The soil of the region has the following characteristics, taxonomically belongs to the Alfisol Order of clay-loam texture (López *et al*., 1995), with a hill-shaped panorama of sandstone origin, with a flat relief of 0 to 3% slope and an approximate height of 200 meters above sea level, with good drainage and zero rockiness. This type of soil belongs to class III of the classification of capacity of use; Lands of this class have moderate limitations that reduce crop selection or require intensive moderate management and / or conservation practices or both. In the experimental area, before the implantation of the experiment, a soil sample was obtained, which was sent to the Soil Analysis Laboratory.

Table 1. Physical and chemical characteristics of the soil used in the experiment. Horqueta, Paraguay, 2016.

Depht	pH	O.M.	P	K^+	$Ca^{+2} + Mg^+$	Al^{+3}	Texture
cm		%	$mg.kg^{-1}$		$cmol.dm^{-3}$		
0-20	6,0	1,2	12	80	4,8	0	F.a

Fa.= sandy loam.

Experimental design used

The experiment performed had a randomized complete block design (DBCA), with 5 treatments and 4 repetitions. Each experimental unit (EU) had a dimension of (3 x 3 m) with 9 m2. Totaling an area of 285 m2. The treatments used were T1: 10 plants/m linear (111,000 $pl.ha^{-1}$); T2: 15 plants/linear meter (166,500 $pl.ha^{-1}$); T3: 20 plants/linear meter (222,000 $pl.ha^{-1}$); T4: 25 plants/m linear (277,500 $pl.ha^{-1}$) and T5: 30 plants/m linear (333,000 $pl.ha^{-1}$)

Process of experiment implementation and crop management

The soil preparation consisted of removal of soil with light dredge with two passes. Subsequently, the experimental area was delimited.

Sowing was done manually with the use of a manual seeder (ratchet), 0,90 meters between rows and plant densities mentioned in the treatments. The sesame variety used was SH1El.

The basic fertilization was performed at the time of sowing with 15-15-15 formulation, fully complying with the recommendation of the soil analysis, using manual seeder (rattle), parallel to the sowing lines with approximately 8-10 cm of depth.

Once the seedlings emerged in the different treatments used, thinning was carried out in order to enter the density established by linear meter, taking into account that at this time the plants already reached a height of approximately 10 cm.

The crop was free of weeds. The carpid was made 15 days after the emergency. The control of diseases and insects according to their appearance; the observations were made weekly throughout the crop cycle.

The harvest was done 90 days after the emergency. The plants were cut with a machetillo 50 cm flush with the ground and placed in mallets, the parvae were left in the field for 22 days for complete drying and subsequent threshing was carried out. The seeds were bagged and listed according to the treatments.

Only the central rows of each experimental unit were harvested, establishing a useful area of (1,5 x 1,5) ,eliminating the edges to avoid the effect, totaling a useful area of 2,25 m2 for the evaluation.

Once the grains were separated from the capsules, the cleaning and bagging was carried out; Then the weighing of the grains corresponding to the different treatments was performed using a digital scale.

Determinations and evaluation procedures

The variables evaluated were: **Plant height**: It was done manually at 30, 60 and 90 days after sowing (DDS) with the help of a measuring tape, where 5 plants were randomly chosen within each experimental plot. **Number of capsules**: It was done manually before cutting and embossing, 5 plants were randomly chosen within each experimental plot. **Weight of 1000 seeds**: 1000 seeds that were weighed on the digital scale, KERN

PLS, maximum 1200 gr with an accuracy of 0.001 gr, were extracted from each treatment, expressing their result in grams. **Yield**: the grains obtained by EU were weighed, using the digital scale used (KERN PLS, maximum 1200 gr with an accuracy of 0.001 gr), and the results were expressed in $kg.ha^{-1}$.

Analysis of the data

The data obtained from each variable studied were subjected to analysis of variance (ANAVA), to verify whether or not there was a significant difference between the treatments and the means that presented a significant difference were compared with the Tukey test at 5% of Probability to categorize the treatments under study.

III. Results and discussion

Sesame plants height

The data obtained for the variables of plant height at 60 DDS, 90 DDS, number of capsules and grain yield, according to the variance analysis, showed significant differences, in contrast, at 60 DDS and weight of 1000 seeds did not suffer significant effects Table 2 shows the height averages at 30, 60 and 90 DDS, which were measured in the different treatments compared by the 5% Tukey Test.

Table 2. Height measures of sesame plants influenced by different planting densities. Horqueta, Paraguay, 2017.

Treatments	30 DAS ($m.pl^{-1}$)		30 DAS ($m.pl^{-1}$)		30 DAS ($m.pl^{-1}$)	
		ns		*		**
T1	0,34		0,77	A	1,84	a
T2	0,34		0,73	A	1,73	ab
T3	0,31		0,58	B	1,54	ab
T4	0,28		0,54	B	1,53	ab
T5	0,27		0,54	B	1,47	b
General Mean	0,31		0,63		1,62	
C.V %	10,79		9,76		9,32	

Means followed by the same letter in the column do not differ from each other by the Tukey 5% test. C.V: Coefficient of variation. ns: not significant. (*) (**) significant at 5% and 1%.

The average height of the plants at 60 DAS (table 2) indicate that the T1 and T2 are statistically similar, differentiating with the T3, T4 and T5. The best values presented were the T1 and T2 with 0,77 and 0,73 m/pl, respectively; It is observed that as the number of plants per linear meter increased, their height decreased, which is where the competition of plants in vegetative growth is noted.

In relation to the height of plants at 90 DAS they reveal that the T1, T2, T3 and T4 are statistically similar to each other, however, the best result is observed in T1 with 1.84 m/pl. The T5 is the one that presented the lowest value in the height of the plants, it is denoted that the high density indisputably affects the vegettive growth of the plants and after the yield.

Noguera, (2013) working with early varieties, with the SH1 achieved an average height of 1,38 m/pl, result lower than what was obtained in this study, it should be noted that this work was not thinning. MAG, (2004), mentions that sesame is necessary to sow in rows spaced apart from 80 to 90 cm, So that they can develop vigorously in order to obtain high yield and good quality of seeds and the number must be 10 to 15 pl/m.

Number of capsules, weight of 1000 seeds and sesame yield

By analyzing the variable number of capsules in table 3, the results obtained show us that the T1, T2, T3 are statistically the same. The highest number of capsules obtained T2 and the lowest value presented T5; The number of capsules per plant is a component of sesame yield, so varieties with higher numbers show a better yield potential. Likewise, Mazzani (1999) indicates that the number of capsules per plant is one of the components that most affects the final yield. Similarly, Ayala (2005) mentions that it is the performance component that is most easily affected by environmental conditions and in conditions of extreme drought in the flowering stage and capsule formation, massive abortion of flowers can occur and consequently be affected The final number of capsules.

According to Centurión (2012), working with sesame of the Escoba variety with basic fertilization found the average of 87 capsules per plants with basic fertilization obtaining lower results compared with this study, in which the best value of 96.50 capsules was found by plants with T2.

Table 3. Average number of capsules, weight of 1000 seeds, sesame yield influenced by different planting densities. Horqueta, Paraguay, 2017.

Treatments	Number of capsules (Unit)		1000 seed weight (g)	Yield ($kg.ha^{-1}$)	
		**	ns		**
T1	93,50	a	2,61	996,25	a
T2	96,50	a	2,81	1054,75	a
T3	95,00	a	2,40	1016,75	a
T4	74,75	b	2,58	695,75	b
T5	72,00	b	2,52	689,00	b
General Mean	86,35		2,58	890,50	
C.V %	8,89		12,94	4,88	

Means followed by the same letter in the column do not differ from each other by the Tukey 5% test. C.V: Coefficient of variation. ns: not significant. (*) (**) significant at 5% and 1%.

In Table 3 shows, the average weight of one thousand seeds that were measured in the different treatments, in addition to the results of the 5% Tukey Test. It is observed that they presented a significant difference between the treatments.

According to Mazzani (1999) he mentions that the weight of 1000 sesame seeds ranges in general from 2.31 to 3.18 grams; similar values reported by Giménez (2008) evaluating the quality of sesame seeds originated in different types of deer mentions that the weight of 1000 seeds ranges from 2.5 to 2.75 grams value, results that agree with this experiment for being in The same reference range.

The results show in (Table 3) regarding the grain yield indicating that T1, T2 and T3 had similar behavior, there being no significant difference; the lowest values were found with the T4 and T5 that are similar to each other statistically. The T2 obtained a better result with 1054.75 kg ha^{-1} of sesame. These results show that the densities studied make a difference in the yield of grains, and comparing the lowest value obtained with the highest one has an increase of 365.75 kg ha^{-1}, when the density of plants per hectare increases the production decays .

These results are consistent with those presented by Moreno (2006), in an essay with sesame varieties, found that the Mbarete variety reaches a yield of 958 kg ha^{-1} on average in a trial planted in November. On the other hand, Cabral and Oviedo (2008), with a trial planted in December, indicates that sesame cultivation is affected by the sowing season and that the average yield in late sowing, for the Mbarete variety was 518 kg ha^{-1}.

IV. Conclusion

With the results obtained in this research and according to those proposed, it is concluded that the population density of sesame plant caused positive effects on the variables of plant height, number of capsules and grain yield. The T2 (15 plants/linear meter) is effective to obtain the best sesame yield.

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Edith Ruiz Díaz. " Population of plants and its effect on the vegetative development and performance of sesame. "IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS) 12.11 (2019): PP- 53-57.