



Influence of Plant Population and Seeds types on Yield of Groundnut (*Arachis hypogaea* L.) in New Halfa Scheme, Sudan

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Abstract

In order to study the effect of plant population on yield and its components of Groundnut, an experiment was conducted in complete randomized blocks design with four replications at Research Farm of New Halfa Research Station during summer seasons of 2016 and 2017. Experimental factors including: Type of seeds (shelled and unshelled), spacing (5, 10 and 15cm) and seed number (1, 2 and 3 Seeds or pods/hole) which combination to (285714, 571428, 857143, 142827, 428571, 95238 and 190476 plants/ha). The results revealed that, sowing groundnut at 285714-plant population (1seed at 15cm spacing) gave the highest number and weight of pods per plant but 285714-plant population (2 or 3seeds per hill in 10cm spacing) gave the higher 100-seed weight and shelling percentages for both seed types. Also, in the second season, the highest seed yield (4.2 and 4 ton ha⁻¹) produced at (285714 and 428571 plants/ha) when 3 seeds of Groundnut were planted at 10cm or 15cm for shelled and unshelled groundnut seeds. Hence, for achieving optimum results in groundnut variety Madni, the crop may be sown in plant spacing of 10 or 15cm with 3 seeds to achieve high plant population ha⁻¹ which significantly increased seed yield per unit area.

Keywords: Groundnut, yield, plant population, shelled and unshelled seeds.

Introduction

Groundnut (*Arachis hypogaea* L.) is a member of the family *Fabaceae* [Prasad, P. V. *et al.*, 2010]. The crop is currently distributed around the tropical, sub-tropical and warm temperate regions of the world, where it plays an important role as both food and cash crop, is the sixth and third most important source of vegetable oil and protein, respectively, and ranks thirteenth among the food crops [Maiti, R. K. *et al.*, 2002; Nautiyal, P.C. *et al.*, 2002; Singh, A.K. *et al.*, 2016]. The annual global mean production of unshelled groundnut over the past ten years is about 42.1 million tonnes (MT) and China is the major producer, with over 37.4% (15.76 MT) of the world production. Africa is the second major producing continent after Asia, with over

28.34% (11.93 MT) of the world production and a yield average of 0.9 t ha⁻¹, which is less than three-quarters of the world average of 1.64 t ha⁻¹ and cultivated area exceeds 1.5 million hectares in Sudan [FAOSTAT. 2018; Mohammed, Y. E. *et al.*, 2018]. The large gap between the realized and potential yield is due to several biotic, abiotic and socioeconomic constraints [FAOSTAT. 2018]. Several researches have been conducted to study the growth and yield of groundnut by modifying cultural practices worldwide including [Mohammed, Y. E. *et al.*, 2018] in Sudan who reported that, improper plant spacing and plant density affect the normal physiological activities of the crop. Also, they stated that, the highest and significant pod

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and hay yields, population and net benefit were obtained under the spacing of 30×20cm due to increased plant population. Also [Onat, B. et al., 2016] stated that when the plant density increases, the plants produce fewer pods and most of them are mature. Further (2007) [Ahmad, N. et al., 2007] reported that 100 seed weight decreased with increasing plant density in peanut. Also, [Laurence, R. C. N. et al., 1983] in Australia, studied the effect of several plant densities, namely, 4,7,16,28 and 44 plants/m² on pod yield and kernel weight of irrigated Virginia bunch peanut. He stated that pod yield and kernel yield, as well as, single kernel weight were increased with increasing plant population. Generally, yield of any crop is a complex phenomenon, a function of genetic factor as influenced by management practices. The crop must be given proper management so that better growth can take place. Regarding the management practices, spacing is the most important one for determining yield. It is important to accommodate the most appropriate number of plants per unit area of land to obtain better yield. Proper spacing in line sowing is to be recommended to maintain required number of plant population and to undertake intercultural operations for harvesting a better yield. Improper spacing and plant density affect the normal physiological activities of the crop. In densely populated crop, the inter-specific competition between the plants is high. Again, wider spacing leads to lower yield resulted from uneconomic utilization of space. Also, planting peanuts at certain plant populations, theoretically, can result in maximum yield of that population density if plants are uniformly arranged in the growing area. So, research on individual factors affecting peanut yield must be conducted. The most appropriate plant density and planting pattern to use for optimum growth and yield of groundnuts (*Arachis hypogaea* L.) in New Halfa area (eastern Sudan) among those currently used is not known, as the patterns are highly influenced by environmental conditions in specific regions. However, the simultaneous study of shelled and unshelled, hill spacings, within-row plant densities (hill

spacing), different number of seeds per hill and their interactions has been limited, particularly for New Halfa conditions. Therefore, the objective of this research was to investigate the influence of plant density in the hill, and population density on yield and its components of groundnut, to determine the optimum plant population(s) under irrigation in New Halfa area-eastern Sudan.

Materials and Methods

In order to study the effect of plant population on yield of groundnut (*Arachis hypogaea* L.), an experiment was conducted as factorial with complete randomized blocks design with four replications at Research Farm of New Halfa Research Station during two summer seasons of 2016 and 2017. Experimental factors including: Type of seeds (shelled and unshelled), plant population as spacing (5, 10 and 15cm) and number of seeds (Single, two and three Seeds or pods/hole). The different spacing and seeds/hill combination resulting in the following plant population in (table 1). Seeds of groundnut (variety Medani) were sown on first week of July during two seasons. The plot size was 6 rows and 6 m long ridges spaced 0.70 m apart. Seeds or pods per hill were sown at a depth of about 5cm for the both seasons. Plant holes were manually dug with a hoe. All recommended agronomic practices were followed throughout the season. At maturity: Ten plants of each plot randomly selected and tagged to measure the following attributes: Number of pods/plant, Weight of total pods/plant, Mean (100) seed weight, Shelling (%) and Total pod yield per hectare.

Statistical Analysis

Data collected subjected to statistical analysis as described by [Gomez, K. A. et al., 1984] using STATISTICS statistical package (version 10). The analysis of variance procedures for multifactor experiments were followed to determine whether differences existed among treatments. All treatments were compared using the Duncan Multiple Range Test (DMRT) at 5 % probability level.

Table 1: The different spacing and seeds/hill combination resulting in the following plant population

distances between hills	5cm	5cm	10cm	5cm	10cm	15cm	15cm	10cm	15cm
seeds/hill (no)	3	2	3	1	2	3	2	1	1
Plants/ha (no)	857143 (D1)	571428 (D2)	4285714 (D3)	285714 (D4)	285714 (D4)	285714 (D4)	190470 (D5)	142827 (D6)	95238 (D7)

Results and Discussion

Results that describe yield response to plant population alteration in different seed types were presented in the following paragraphs.

Generally, increasing plant population from 95238 until 285714 plants/ha significantly increased number and weight of pods per plants for both shelled and unshelled seeds (tables 2 and 3). However, sowing one seed in 15cm between hills gave higher number of pods and weight per plant as compared with other population treatments in both seasons while sowing two seed in 15cm resulted in higher pods weight per plants as compared to its related treatments. The increased in this yield component might be due to the beneficial effect of adequate space available in the above crop geometry for better development of pods and less competition for water and nutrients which had helped to increase the number of pods and weight per plant. These results were in agreement to findings reported by [Bakal, H. *et al.*, 2020] who stated that, pod number and weight per plant were decreased when the plant density was increased. On the other hand, 285714-plant population (2 or 3seeds per hill in 10cm spacing) gave the higher 100-seed weight and shelling percentages for both seed types

(tables 4 and 5). In this regard, sowing one or two seeds per hill in 10cm spacing and 5 seeds in 10cm (unshelled seeds in both seasons) increased 100-seed weight (table 4). This could be to the reason, decreasing the plant density significantly increased 100- seed weight per plant considerable. These could potentially be explained by decreasing plant density provides higher photosynthesis per plant which resulted in higher individual seed weight. On contrast, low 100-seed weight resulted from higher plant population could be due to the reason that, the close spacing (5cm) gave high number of plants per unit area. The assimilates which were translocated into the pods will be translocated to seeds; consequently seed size was inversely related to number of plants per unit area, but to a certain limit. Concerning shelling percentages, sowing peanuts at higher plant population (857143, 4285714 and 285714 plants/ha) resulted in increase of shelling percentages of both seed types in the two seasons (table 5). Supporting results were reported by [Bakal, H. *et al.*, 2020] who concluded that, when the plant density was increased shelling percentage values were increased.

Table 2: Mean Number of pods per plant as affected by shelled or unshelled, spacing and no. of seeds per hill and their interactions of ground nut during 2016 and 2017 seasons

	Spacing	Season 2016			Mean	Season 2017			Mean
		Seed Number/hill				Seed Number/hill			
		1	2	3		1	2	3	
Seed type Shelled)	5 cm	24.0	45.3	48.7	39.3	26.0	52.7	46.3	41.7
	10 cm	36.7	67.3	43.7	49.2	36.3	61.7	50.0	49.3
	1 5 cm	60.3	51.7	53.0	55.0	80.3	57.7	47.7	61.9
Mean		40.3	54.8	48.5	47.9	47.5	57.4	48.0	51.0
Seed type (Unshelled)	5 cm	23.7	25.7	41.3	30.2	40.3	43.0	43.7	42.3
	10 cm	30.7	41.3	28.7	33.6	45.7	83.3	52.7	60.6
	15 cm	58.0	36.3	32.7	42.3	52.7	36.3	42.3	43.8
Mean		37.5	34.4	34.2	35.4	46.2	54.2	46.2	48.9
Spacing	5 cm	23.8	35.5	45.0	34.8	33.2	47.8	45.0	42.0
	10 cm	33.7	54.3	36.2	41.4	41.0	72.5	51.3	54.9
	1 5 cm	59.2	44.0	42.8	48.7	66.5	47.0	45.0	52.8
Mean		38.9	44.6	41.3	41.6	46.9	55.8	47.1	49.9

Table 3: Mean pods weight/plant (g) as affected by shelled or unshelled, spacing and no. of seeds per hill and their interactions of ground nut during 2016 and 2017 seasons

Seed type	Spacing	Season 2016			Mean	Season 2017			Mean
		Seed Number				Seed Number			
		1	2	3		1	2	3	
Shelled	5 cm	20.0	47.7	47.3	38.3	24.3	46.7	48.3	39.8
	10 cm	34.3	74.3	46.7	51.8	33.7	76.3	45.3	51.8
	1 5 cm	59.7	53.0	53.0	55.2	85.7	59.7	48.7	64.7
Mean		38.0	58.3	49.0	48.4	47.9	60.9	47.4	52.1
Unshelled	5 cm	23.7	24.7	41.0	29.8	38.3	44.3	46.3	43.0
	10 cm	30.0	46.3	30.0	35.4	39.0	58.0	57.3	51.4
	15 cm	62.3	34.7	30.3	42.4	48.7	36.0	40.7	41.8
Mean		38.7	35.2	33.8	35.9	42.0	46.1	48.1	45.4
Spacing	5 cm	21.8	36.2	44.2	34.1	31.3	45.5	47.3	41.4
	10 cm	32.2	60.3	38.3	43.6	36.3	67.2	51.3	51.6
	1 5 cm	61.0	43.8	41.7	48.8	67.2	47.8	44.7	53.2
Mean		38.3	46.8	41.4	42.2	44.9	53.5	47.8	48.7

Table 4: Mean 100-seed weight (g) as affected by shelled or unshelled, spacing and no. of seeds per hill and their interactions of ground nut during 2016 and 2017 seasons

Seed type	Spacing	Season 2016			Mean	Season 2017			Mean
		Seed Number				Seed Number			
		1	2	3		1	2	3	
Shelled	5 cm	47.0	45.7	45.3	46.0	44.3	40.6	39.7	41.5
	10 cm	48.7	45.7	40.0	44.8	42.3	43.0	42.3	42.5
	15 cm	43.0	44.0	44.3	43.8	37.7	41.0	41.7	40.1
Mean		46.2	45.1	43.2	44.9	41.4	41.5	41.2	41.4
Unshelled	5 cm	45.3	44.7	49.7	46.6	42.7	40.0	42.0	41.6
	10 cm	47.0	44.0	48.7	46.6	40.0	39.3	39.7	39.7
	15 cm	44.7	42.7	47.7	45.0	38.0	40.7	42.7	40.5
Mean		45.7	43.8	48.7	46.1	40.2	40.0	41.5	40.6
Spacing	5 cm	46.2	45.2	47.5	46.3	43.0	40.3	40.8	41.4
	10 cm	47.8	44.8	44.3	45.6	41.2	41.2	40.0	40.8
	15 cm	43.8	43.3	46.0	44.4	37.8	40.8	42.2	40.3
Mean		45.9	44.4	45.9	45.4	40.7	40.8	41.0	40.8

Table 5: Mean Shelling percentage of interactions in experiment of shelled, unshelled, spacing and no. of seeds per hill on yield and yield components ground nut during 2016 and 2017 seasons at Halfa Elgadida

Seed type	Spacing	Season 2016			Mean	Season 2017			Mean
		Seed Number				Seed Number			
		1	2	3		1	2	3	
Shelled	5 cm	66.7	59.0	65.0	63.6	58.3	53.7	60.3	57.4
	10 cm	64.7	62.3	62.7	63.2	57.3	57.0	61.7	58.7
	15 cm	61.3	66.0	62.3	63.2	59.7	58.7	55.0	57.8
Mean		64.2	62.4	63.3	63.3	58.4	56.5	59.0	58.0
Unshelled	5 cm	64.3	64.3	66.7	65.1	60.0	50.0	60.7	56.9
	10 cm	62.7	61.0	67.3	63.7	56.7	53.0	57.3	55.7
	15 cm	63.7	62.3	66.0	64.0	55.0	56.0	55.0	55.3
Mean		63.6	62.5	66.7	64.3	57.2	53.0	57.7	56.0
Spacing	5 cm	65.5	61.7	65.8	64.3	59.2	51.8	60.5	57.2
	10 cm	63.7	61.7	65.5	63.5	57.0	55.0	59.5	57.2
	15 cm	62.5	64.2	64.2	63.6	57.3	57.3	55.0	56.5
Mean		63.9	62.5	65.0	63.8	57.8	54.7	58.3	57.0

Generally, increasing plant population resulting in increased pods yield of groundnut per unit area in the two seasons (table 6). The higher pods yield/ha (4.2 and 4 ton ha⁻¹) produced at (285714 and 428571 plants/ha) when 3 seeds of groundnut were planted at 10cm or 15cm for shelled and unshelled groundnut seeds in the second season while none significant differences between treatments on pods yield/ha were observed in the first season(table 6). The overall enhancement of the pods number and weight per plant due to aforementioned plant

populations possibly might explain the increase in pods yield per unit area in these plant population treatments. These results are in accord with the results reported by [Gardner, F. P. et al., 1989] who, pointed out that pod yield was the highest when plant population density ranged from 98.000-274.000 plants/ ha. The poor production of the close spacing arrangements might be due to competition between plants and higher removal of nutrients and water. Not only this, more plant population increased the effect of shading on one another, hence affecting the

process of photosynthesis which ultimately results in lower pods yield as reported n

by[Awal, M. A. et al., 2015].

Table 6: Mean pods yield (ton/ha) as affected by shelled or unshelled, spacing and no. of seeds per hill and their interactions of ground nut during 2016 and 2017 seasons

Seed type	Spacing	Season 2016			Mean	Season 2017			Mean
		Seed Number				Seed Number			
		1	2	3		1	2	3	
Shelled	5 cm	1.9	2.1	2.0	2.0	3.6	3.9	3.9	3.8
	10 cm	2.0	1.9	2.4	2.1	4.0	3.2	3.8	3.7
	15 cm	1.0	1.8	2.2	1.7	3.0	4.1	4.1	3.7
Mean		1.6	1.9	2.2	1.9	3.5	3.7	3.9	3.7
Unshelled	5 cm	2.1	2.3	2.2	2.2	3.3	4.0	4.0	3.8
	10 cm	2.2	2.0	2.2	2.1	3.8	3.3	4.0	3.7
	15 cm	2.0	1.9	2.2	2.0	3.5	3.6	4.2	3.8
Mean		2.1	2.1	2.2	2.1	3.5	3.6	4.1	3.7
Spacing	5 cm	2.0	2.2	2.1	2.1	3.4	3.9	4.0	3.8
	10 cm	2.1	2.0	2.3	2.1	3.9	3.3	3.9	3.7
	15 cm	1.5	1.8	2.2	1.8	3.3	3.8	4.1	3.7
Mean		1.9	2.0	2.2	2.0	3.5	3.7	4.0	3.7

Conclusion

Sowing either shelled or unshelled groundnut seeds at 285714 plant/ha (1 seed in 15cm, seeds in 10cm and 3 seeds in 15cm) resulted in increased of most of the yield components in this study.

Recommendation

Further experiments in optimum plant population by using different inter-row and intra-row spacing's to satisfy maximum productivity in groundnut seeds yield in different sites of the New Halfa area.

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