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GROWTH AND DEVELOPMENT OF THREE GROUNDNUT (*Arachis hypogaea* L.) VARIETIES AS AFFECTED BY BASIN SIZE AND PLANT POPULATION AT KADAWA, SUDAN SAVANNA NIGERIA

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ABSTRACT
Three irrigated trials were conducted during the dry season for three consecutive years at the Irrigation Research Station of the Institute for Agricultural Research, Ahmadu Bello University at Kadawa to study the growth and development of three groundnut (*Arachis hypogaea* L.) varieties as affected by plant population and basin size. The treatments, which consisted of three basin sizes (3m x 3m, 3m x 4m and 3m x 5m), three plant populations (50,000, 100,000 and 200,000 plants ha^{-1}) and three varieties (Samnut 23, Samnut 21 and Samnut 11) were laid out in a split plot design with plant population and variety assigned to the main plots and basin sizes in the sub plots. Significantly tallest groundnut plants were observed when the crop was planted at 200,000 plants ha^{-1} while canopy spread was widest at 50,000 plants ha^{-1}. Total dry matter was significantly highest at 100,000 plants ha^{-1}. Plant population did not significantly affect number of branches and number of leaves $plant^{-1}$. Flowering was delayed at 50,000 plants ha^{-}. Although Samnut 23 grew significantly taller than Samnut 21 and Samnut 11, Samnut 21 had wider canopy spread than Samnut 23 and Samnut 11. Plant height, canopy spread, number of leaves and branches, total dry matter (TDM) and days to 50% flowering were unaffected by basin sizes used.

KEY WORDS: Groundnut varieties; plant population; basin size; growth characters; development.

INTRODUCTION

Groundnut (*Arachis hypogaea.* L.) is one of the world's principal oilseed crops. It ranks fourth in oil production after soyabean (*Glycine max* L.), cottonseed (*Gossypium* sp.) and rapeseed (*Brassica napus* L.) (FAO 2007). Groundnut has contributed immensely to the development of Nigeria. Until 1969, Nigeria used to be the third largest exporter of groundnuts after India and China but now it is a net importer of vegetable oil due to decline in groundnut production. Conventionally, groundnut cultivation in Nigeria is carried out mostly by smallholder farmers during the wet season under rain fed conditions with limited inputs. Wright and Nageswara Rao (1994) report that more than 80% of world's peanut production comes from rainfed agriculture. Production of the crop in the Sudan savanna is declining due mainly to reduction in the amount and duration of rainfall caused by global changes in weather patterns attributed to global warming. Groundnut production with irrigation is a relatively new phenomenon to farmers in Nigeria generally and specifically in the Sudan savanna ecological zone. However this concept is not new in other parts of the world. Available production technology is meant for rain fed groundnut production thus technologies that would enable smallholder farmers produce more of the crop are required.

Together with other factors; use of low plant population density per unit area is responsible for low yields in groundnut Yayock, (1979) reported that as much as 150 – 250 % increase in pod yield can be expected by cropping at higher population densities and applying better management. Similarly other researchers (Giri and Saran, 1986; Tarimo, 1992 and Tanimu, 1998) have reported that it is possible to produce higher yields of groundnut by increasing plant population. The objective of plant population studies in crop plants is to determine the optimum plant population density for maximum productivity (Carangal, Rao and Siwi, 1987). Optimum plant population density in groundnut varies between environments, cultivars and plant arrangement (Jaaffar and Gardner, 1988). Amongst the various methods of irrigation, the basin method of irrigation is the most common and simplest to operate among all irrigation methods. In addition, it enables the manipulation of row spacing for the achievement of desired plant population. The size and shape of basins vary from small to medium unit areas for horticultural and other field crops to very large areas for paddy fields (James, 1988).

MATERIALS & METHODS

The experiment was conducted at the Irrigation Research Substation of the Institute for Agricultural Research, Ahmadu Bello University Kadawa (11° 39'N, 08" 27'E; 500m above sea level) during the 2004 dry season. The treatments consisted of three basin sizes (3m x 3m, 3m x 4m and 3m x 5m), three plant population densities (50,000, 100,000 and 200,000 plants ha^{-1}) and three varieties of groundnut Samnut 23, Samnut 21 and Samnut 11. The treatments were laid out in a split - plot design with a factorial combination of the three plant populations and three

varieties occupying the main plot while the three basin sizes were allocated to the subplots. The net plot size per basin was 1.5 x 3, 1.5 x 4 and 1.5 x 5 for the gross plots of 3m x 3m, 3m x 4m and 3m x 5m basin respectively. After harrowing and ridging at 0.75m width, the field was marked out into plots and thereafter leveled. Sowing was done on at a fixed inter-row spacing of 50cm. The intra-row spacing was however varied at 40, 20 and 10cm in order to give the predetermined plant density of 50,000, 100,000 and 200,000 plants ha^{-1} respectively. In this process 2 seeds per hole were sown at a depth of 3cm by hand. The first irrigation was applied immediately after seeding The crop was fertilized with 20kg N, 23.6kg P and 24.9 K/ha^{-1} as basal dose using urea, single super phosphate (SSP) and muriate of potash (MOP) Weed control was done by pre-emergence application of Metolachlor + Terbutryne (Igram Combi$^{(R)}$ 500EC) at the rate of 4 liters ha^{-1}. Hoe weeding at four (4) and eight (8) weeks after sowing was done in order to remove the weeds that emerged later.

The net plots were harvested by digging out the whole plant including the pods with a hoe and picking up the remaining pods from the soil. Thereafter the pods were detached from the haulms and allowed to dry for several days under the sun. Data collected on plant height, canopy spread, total dry matter, number of branches and number of leaves $plant^{-1}$ and days to 50% flowering were subjected to statistical analysis using SAS (SAS Institute Inc.) statistical software.

RESULTS

Stand count after emergence

The effect of plant population on stand count after emergence of groundnut which exhibited a similar trend across the years showed that significantly highest number of stands was observed at 200,000 plants ha^{-1} (Table 1). The varieties exhibited significant differences in their stand count after emergence. Samnut 11 had significantly higher number of stands in 2003/2004, 2005/2006 and even when combined. This was similar to Samnut 23 in 2005/2006 and Samnut 21 in 2004/2005. The least stands were observed for Samnut 21 in 2003/2004 and 2004/2005. The 3m x 5m basin had consistently the highest number of stands in three years; and was significantly higher than the other basins but was statistically at par with stand number observed in 3m x 4m in 2004/2005.

TABLE 1: Stand count at 3WAS and plant height as affected by plant population and basin sizes of groundnut varieties at Kadawa

Treatment	Stand count			Plant height		
	2004	2005	2006	2004	2005	2006
Plant Population ('000plants ha^{-1})						
50	21.0c	13.0c	10.0c	23.16c	34.39c	24.54
100	33.0b	29.0b	17.0b	24.96b	31.18b	24.42
200	56.0a	47.0a	26.0a	29.20a	41.33a	24.53
SE±	2.03	3.87	1.53	2.478	1.635	1.637
Variety						
Samnut 23	43.0b	30.0b	20.0a	29.84a	39.63a	28.03a
Samnut 21	11.0c	38.0a	12.0b	21.78c	35.43b	20.70c
Samnut 11	57.0a	21.0c	22.0a	25.70b	37.84ab	24.74b
SE±	2.03	3.87	1.53	2478	1.635	1.637
Basin size (m^2)						
3m x 3m	31.0c	25.0b	14.0b	25.50	37.03	24.15
3m x 4m	36.0b	30.0ab	16.0b	27.36	37.99	25.25
3m x 5m	43.0a	34.0a	23.0a	24.45	37.87	2407
SE±	1.68	1.76	0.99	1.141	0.875	0.725
Interaction						
P x V	NS	NS	NS	NS	NS	NS
P x B	NS	NS	NS	NS	NS	NS
V x B	NS	NS	NS	NS	NS	NS
P x V x B	NS	NS	NS	NS	NS	NS

*and** Significant at 5 and 1 percent levels respectively. NS- Not significant

Means followed by the same letter within the same treatment group and year are statistically the same.

Plant Height

Plant population significantly affected plant height of groundnut in 2004 and 2005 but in 2006, no significant differences were observed (Table 1). In 2003/2004, groundnuts planted at 200,000-plant ha^{-1} were significantly taller than those at 100,000 plants ha^{-1}. Significantly shorter plants were observed at 50,000 plants ha^{-1}. This trend was similar to that observed in 2004/2005. The varieties of groundnut used had significantly influenced plant height in 2003/2004, 2004/2005 and 2005/2006. In 2004/2005 Samnut 23 was taller than Samnut 21 but at par with Samnut 11. The different basin sizes did not have significant effect on plant height in all the years. There were no significant interactions among treatments.

Canopy spread

Populations had significant effect on canopy spread of groundnut at harvest only in 2005/2006 (Table 2). In 2005/2006 groundnuts planted at 50,000 plants ha^{-1} had wider canopies than those at 200,000 plants ha^{-1} but were statistically at par with those at 100,000 plants ha^{-1}. With the exception of 2005/2006, varieties used were observed to have a significant effect on canopy spread. Samnut 21 had significantly wider canopy than Samnut 23 and

Samnut 11 in 2003/2004. In 2004/2005, Samnut 11 had wider canopy than Samnut 21 and Samnut 23 in that order. Across the years there were no significant differences observed. Groundnuts planted in the 3m x 4m basin had the statistically wider canopies than those in the 3m x 5m basin but were statistically at par with those in the 3m x 3m basin. The interactions among the treatments were not significant in all the years

TABLE 2: Canopy spread and number of branches as affected by plant population and basin sizes of groundnut varieties at Kadawa

Treatment	Canopy spread			Number of branches		
	2004	2005	2006	2004	2005	2006
Plant Population ('000plants ha^{-1})						
50	52.8	67.48	61.24a	27.00	26.00b	57.00
100	51.7	66.00	59.14ab	29.00	28.00b	59.00
200	51.3	65.83	56.49b	31.00	33.00a	60,00
SE±	1.51	1.80	1.94	1.79	2.09	7.92
Variety						
Samnut 23	50.2b	62.64c	57.80	20.00b	21.00c	41.00c
Samnut 21	54.5a	65.77b	59.92	37.00a	30.00b	76.00a
Samnut 11	51.0b	70.89a	59.15	31.00a	35.00a	59.00b
SE±	1.51	1.80	1.94	1.79	2.09	7.92
Basin size (m^2)				31.00	27.00b	64.00a
3m x 3m	52.6	66.34	57.30	26.00	32.00a	63.00a
3m x 4m	52.1	67.16	61.54	30.00	27.00b	49.00b
3m x 5m	51.0	65.80	57.54	2.43	1.37	3.85
SE±	0.79	0.90	1.40			
Interaction						
P x V	NS	NS	NS	NS	NS	NS
P x B	NS	NS	NS	NS	NS	NS
V x B	NS	NS	NS	NS	NS	NS
P x V x B	NS	NS	NS	NS	NS	NS

* and ** Significant at 5 and 1 percent levels respectively. NS- Not significant
Means followed by the same letter within the same treatment group and year are statistically the same.

TABLE 3: Number of leaves and days to 50% flowering as affected by plant population and basin sizes of groundnut varieties at Kadawa

Treatment	Number of leaves			Days to 50% flowering		
Plant Population ('000plants ha^{-1})	2004	2005	2006	2004	2005	2006
50	200.00	160.00	247.00	40.0a	41.0a	41.0a
100	217.00	184.00	253.00	39.0b	40.0ab	39.0b
200	235.00	180.00	262.00	38.0b	40.0b	39.0b
SE±	18.107	11.96	27.64	0.436	0.443	0.348
Variety						
Samnut 23	140.00b	145.00b	200.00b	38.0c	38.0c	38.0c
Samnut 21	275.00a	160.00b	311.00a	41.0a	43.0a	42.0a
Samnut 11	238.00a	219.00a	252.00b	39.0b	41.0b	40.0b
SE±	18.10	11.96	27.64	0.436	0.443	0.348
Basin size (m^2)	224.00	178.00ab	274.00	39.0	41.0	40.0
3m x 3m	210.00	192.00a	248.00	39.0	41.0	40.0
3m x 4m	219.00	153.00b	241.00	40.0	41.0	40.0
3m x 5m	19.12	11.84	18.34	0.334	0.213	0.213
SE±						
Interaction						
P x V	NS	NS	NS	NS	NS	NS
P x B	NS	NS	NS	NS	NS	NS
V x B	NS	NS	NS	NS	NS	NS
P x V x B	NS	NS	NS	NS	NS	NS

*and ** Significant at 5 and 1 percent levels respectively. NS- Not significant
Means followed by the same letter within the same treatment group and year are statistically the same.

Number of branches $plant^{-1}$

The number of branches was not significantly affected by plant population in 2004 and 2006, however in 2004/2005 was observed that groundnut planted 200,000 plants ha^{-1} had more branches than at 100,000 and 50,000 plants ha^{-1} (Table 2).

There were significant differences among the varieties in their number of branches in the three years of the study. Samnut 21 had significantly more number of branches in 2003/2004 and 2005/2006 and was similar to Samnut 11 in 2003/2004. Samnut 11 had significantly higher number of branches than Samnut 21 and 23 in 2004/2005. Samnut 23

consistently had the least number of branches across the years of the study.

Number of leaves^{-1}

Plant populations did not significantly affect the number of leaves of the three groundnut varieties (Table 3). The differences between varieties in their number of leaves were significant. With the exception of 2004/2005, Samnut 21 produced significantly highest number of leaves in all the years and was similar to Samnut 11 in 2003/2004. Samnut 23 had the least number of leaves in all the years. It was only in 2004/2005 that significantly higher number of leaves was observed in the 3m x 4m basin than the 3m x 5m basin but which was statistically at par with that in the 3m x 3m basin. Number of leaves at harvest was not significantly affected by basin size in 2003/2004, 2005/2006.

Days to 50% flowering

Plant population significantly influenced days to 50% flowering in the three years. Significantly fewer days to 50% flowering were recorded for crops sown at 100,000 and 200,000 plants ha^{-1} than at lower population (Table 3). There were significant differences among the varieties in their days to 50% flowering. Samnut 23 attained days to 50% flowering earlier than the other varieties. The different basin sizes did not have any significant effect on days to 50% flowering. The interaction of treatments on days to 50% flowering was not significant.

DISCUSSION

The taller plants observed at 200,000plants ha^{-1} is attributed to competition by crops to intercept radiation. In addition, plants at high density tend to increase stem growth at the expense of assimilate partitioning to reproductive tissue. This conforms to the work reported by Chiezey (1989) who reported that plants grow taller at high density so that they can intercept enough sunshine. Similarly Mozingo and Steel (1987) in their study of 5 varieties of groundnut observed that plant height ranged from 32.9cm to 42.7cm at the higher plant population.

The widest canopies observed at 50,000 plants ha^{-1} indicate that the crop made adequate use of the narrower spacing to spread out in conformity with its growth habit. Although not statistically significant, the increase in number of branches and leaves from the lowest population (50,000) to the highest (200,000 plants hectare-^{1}) is attributed to competition by crops to intercept radiation. In addition, high plant population densities have a favourable effect on growth hormones such as auxins and their interaction with light. Gan *et al.*, (2003) have found increases in number of branches with increasing plant population density.

The crops flowered earlier when planted at 200,000 plants hectare-^{1} indicating that they attained certain level of development earlier than when planted at 100,000 plants or 50,000 plants hectare-^{1}. Flowering is a very important physiological process in the development of the groundnut crop and has a profound effect on the final yield that can be obtained. In their study on groundnut, Sastry *et al.*, (1985) reported that genotypes which flower early show greater synchrony and those which produce most of the flowers during 1st 2 weeks of flowering period produce greater numbers of pods.

CONCLUSION

When planted at 200,000 plants ha^{-1} groundnut plants grew taller than at other plant population. Flowering was delayed at 50,000 plants ha^{-1}. Plant population did not significantly affect number of branches and number of leaves. Samnut 21 produced more number of branches and leaves and had wider spread than Samnut 23 and Samnut 11.

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