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Intensifying Groundnut Production in the Sudan Savanna Zone of Nigeria: Including Groundnut in the Irrigated Cropping Systems

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Abstract: Inadequate and erratic rainfall pattern and extreme temperature variations induced by climate change being experienced in Sudan savanna areas have compromised the cropping systems of these areas. A change in the cropping patterns is required to maintain and improve upon crop output levels. The pod yield ha^{-1} and other growth and yield components of three varieties of groundnut grown under irrigated conditions were measured in a field experiment conducted at the Irrigation Research Station of the Institute for Agricultural Research, Zaria, from 2003 to 2006 dry seasons. Treatments consisted of three plant populations (50,000, 100,000 and 200,000 plants ha^{-1}), three varieties (Samnut 23, Samnut 21 and Samnut 11) and three basin sizes (3×3, 3×4 and 3×5 m) arranged in a split plot design with population and variety as main plot and basin size as sub plot. Treatments were randomly assigned and replicated three times. Plant populations significantly affected plant height and canopy spread but had no effect on number of branches plant. Plants grew significantly taller at 200,000 plants ha^{-1} while plant canopy spread was significantly widest at 50,000 plants ha^{-1}. Samnut 23 grew significantly taller than Samnut 21 and 11 although they exhibited wider canopies. Pod yield ha^{-1} and 100 seed weight were significantly highest at 200,000 plants ha^{-1}. Samnut 23 produced the significantly highest pod yield ha^{-1} and number of pods $plant^{-1}$. Samnut 11 produced significantly highest 100 seed weight. Samnut 23 planted at 200,000 plants ha^{-1} in 3×4 m basins is most promising for irrigated groundnut cultivation in the Sudan savanna of Nigeria.

Key words: Cropping pattern, climate change, rainfall pattern, yield components, groundnut

INTRODUCTION

In recent years the Sudan savanna areas in Nigeria have been experiencing erratic and inadequate rainfall in addition to high temperatures which have thus compromised their cropping systems. At Kadawa Kano which lies within the Sudan savanna ecological zone of Nigeria, the situation is no different. The cropping system which basically is made up of rice, wheat, horticultural crops and then maize, has an exhausting effect on soil resources and is detrimental in the long run. The inclusion of groundnut in the cropping system of this and similar areas could lead to several benefits which include, increase in out put of the crop per unit area, soil improvement, income generation as a cash crop, employment from on farm activities and off farm due to proliferation of small scale processing industries.

Groundnut is a critically important protein source for people, while oilseed, cake and haulms are important as animal feed. In developing countries it provides high quality cooking oil and is an important source of protein for both human and animal diet and also provides much needed foreign exchange by exporting kernels and cake (Nautiyal, 1999). Groundnuts are an important component of Nigerian diet and about 5% of the estimated 58.9 g of crude protein available per head per day, is contributed by groundnut (Abulu, 1978). As population continues to grow the demand for edible oil many developing countries such as Nigeria will also continue to grow. Groundnut will continue to be important in satisfying this growing demand because it is adaptable to a wide range of environments from sandy soils of the Sahel to favourable irrigated areas.

The Alexandratos (1988) estimated that almost two thirds of the increase in crop production that is needed in developing countries in the upcoming decades must come from an increased yield per unit of land area; one fifth must come from increased arable land area and remaining one-eighth from increased cropping intensity. The FAO attributes almost two-thirds of the increase in arable land to increased irrigated land. Rhoades (1997) similarly, concluded that the required increased food production in developing countries must come primarily from irrigated land.

Irrigated systems allow more scope for intensification and studies in Egypt, Africa show that yields of 2.8 t ha^{-1} were achieved under irrigation whereas those under rain fed conditions were much lower while in Saudi Arabia, yields of over 4 t ha^{-1} have been obtained by irrigating very small areas of desert (Anonymous, 2002). It was further reported by Anonymous (2002) that highest yields recorded under field conditions, at over 10 t ha^{-1} were achieved in Zimbabwe where Virginia varieties were used and the crop was irrigated until the onset of the rains, giving a greatly extended cropping season. Studies elsewhere, have shown the yield advantage to be obtained by cultivating groundnut with irrigation. In China, production increased by 4.69% from 1995 to 2004, (ICRISAT, 2005). In Pakistan 5% of the country's total groundnut crop is now produced under irrigation (Anonymous, 2002). This experiment was therefore, conducted to study the performance of groundnut under irrigation.

MATERIALS AND METHODS

Experimental site: An irrigated experiment was conducted at the Irrigation Research Substation of the Institute for Agricultural Research, Ahmadu Bello University Kadawa (11° 39'N, 08" 27'E; 500 m above sea level) during the 2005/2006 dry seasons. This substation is located in the Sudan Savanna ecological zone of Nigeria.

Treatment and experimental design: The treatments consisted of three basin sizes (3×3, 3×4 and 3×5 m) three plant population densities (50,000, 100,000 and 200,000 plants ha^{-1}) and three varieties of groundnut Samnut 23, (ICGV-IS-96894), Samnut 21 (UGA 2) and Samnut 11 (RMP 91). The treatments were laid out in a split-plot design with a factorial combination of the three plant population densities and three varieties occupying the main plot while the three basin sizes were allocated to the subplots. The experiment was replicated three times. The net plot size per basin was 1.5×3, 1.5×4 and 1.5×5 for the 3×3, 3 ×4 and 3×5 m^2 basins, respectively.

Cultural practices: The land was ploughed once, harrowed twice and ridged to obtain the desired tilth for proper germination and growth of crops. The field was then divided into irrigation basins as per the treatments. Each of the basins was thoroughly leveled manually and field channels constructed at appropriate distances. Seeds of groundnut varieties used for this experiment were obtained from the Institute for Agricultural Research Ahmadu Bello University, Zaria. Planting was done on the December, 2005. Planting was done at a spacing of 50×10, 50×20 and 50×40 cm. Fertilizer was applied by side placement the same day the seeds were planted using single super phosphate (SSP) (18% P_2O_5). Fertilizer application was carried out at the rate of 125 kg P ha^{-1}. Weed control was done by pre-emergence application of I g Combi at the rate of 4 L ha^{-1}. Hoe weeding at four and eight week after sowing in order to remove the weeds that emerges later followed this Harvesting was done when the crop reached physiological maturity i.e., when a few leaves turned brown and the inner ribs of the groundnut were a pronounced brown in colour. The net plots were harvested by digging out the whole plant including the pods with a hoe. Thereafter, the pods were picked from the main bunch and allowed to air and sundry for several days. The dried pods were then collected plot by plot and weighed. Growth characters assessed included plant height, canopy spread and number of branches plant. Yield characters assessed included pod yield, number of podsplant and 100 seed weight. The data collected was subjected to analysis of variance as described by Snedeccor and Cochran (1994) and significant differences among treatment means were determined using DMRT (Duncan, 1955).

RESULTS

Plant population has significantly affected plant height of groundnut and showed that the groundnut crop planted at 200,000 plants ha^{-1} were significantly taller than those at the 100,000 plants ha^{-1} and 50,000 plants ha^{-1}. Samnut 23 plants were significantly taller than the others (Table 1).

The different basin sizes however, did not have any significant effect on plant height.

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}. Samnut 21 and 11 had significantly wider canopies than Samnut 23. Groundnuts planted in the 3×4 m basin had the statistically wider canopies than those in the 3×5 m^2 basin but were statistically at par with those in the 3×3 m^2 basin. Plant population did not significantly affect the number of branches while Samnut 21 had significantly highest number of branches than the others. There was no significant effect of basin size on number of branches. The interactions of the treatments on plant height, canopy spread and number of branches was not significant.

Table 2 shows the effect of plant population and basin size on the yield and some yield components of three varieties of groundnut.

The highest pod yield was recorded at the 200,000 plants ha^{-1}. The result showed that Samnut 23 produced significantly the highest pod yield above others. Basin size did not have any significant effect on pod yield. Plant population did not significantly influence number of podsplant. Samnut 23 produced

Table 1: The effect of plant population, variety and basin size on the plant height, canopy spread and number of branches of three varieties of groundnut in 2004, 2005 and 2006 dry season at Kadawa, Sudan savanna, Nigeria

Parameters	Plant height	Canopy spread	No. of branches/plant
Plant population ('000 ha^{-1})			
50	31.69a	57.88b	36.66
100	28.85b	58.96ab	38.74
150	27.36b	60.52a	40.96
SE±	2.851	2.614	5.19
Variety			
Samnut 23	30.50a	56.92b	27.311c
Samnut 21	25.97c	60.08a	47.51a
Samnut 11	29.43b	60.36a	41.56b
SE±	2.851	2.614	5.19
Basin size (m^2)			
3×3	28.90	58.92ab	40.85
3×4	30.20	60.80a	40.12
3×5	28.80	58.14b	35.38
SE±	1.041	1.55	3.46
Interaction			
P×V	NS	NS	NS
P×B	NS	NS	NS
V×B	NS	NS	NS
P×V×B	NS	NS	NS

Means followed by the same letter (s) within the same row or columns are statistically significant at 5% level of significance. P: Plants, b: Bansinsize and v: Variety

Table 2: The effect of plant population and basin size on the pod yield ha^{-1}, number of pods plant^{-1} and 100 seed yield of three varieties of groundnut in 2004, 2005 and 2006 dry season at Kadawa, Sudan savanna, Nigeria

Parameters	Pod yield ha	No. of pods/plant	100 seed weight
Plant population ('000 ha^{-1})			
50	2483.0a	63.56	50.41a
100	1633.6b	61.60	47.81b
150	1413.8b	62.81	46.75b
SE±	336.32	9.567	1.69
Variety			
Samnut 23	2285.1a	72.02a	48.77a
Samnut 21	1315.1c	54.32b	45.92b
Samnut 11	1930.2b	61.64b	50.28a
SE±	336.32	9.567	1.69
Basin size (m^2)			
3×3	1924.9	64.27	47.62
3×4	1915.8	64.11	48.90
3×5	1689.8	59.60	48.44
SE±	177.29	5.6522	1.09
Interaction			
P×V	NS	NS	NS
P×B	NS	NS	NS
V×B	NS	NS	NS
P×V×B	NS	NS	NS

Means followed by the same letter (s) within the same row or columns are statistically significant at 5% level of significance. P: Plants, b: Bansinsize and v: Variety

significantly highest pod number. There were no statistical differences in the number of pods plant^{-1} due to basin size.

The result showed that 100 seed weight was significantly highest at 200,000 plants ha^{-1}. The varieties used have also significantly affected 100-seed weight. Samnut 23 and Samnut 11 had the significantly highest 100-seed weight. The basin size did not have any significant influence on 100-seed weight.

The interactions of the treatments on pod yield/hectare, number of pods/plant and 100 seed weight were not significant.

DISCUSSION

The growth of groundnut expressed as plant height and canopy spread were highest when planted at 200,000 plants hectare than at lower plant population. This 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 work by Chiezey (1989) who reported that plants grow taller at high density so that they can intercept enough sunshine. Also Mozingo and Steel (1987) in their study of 5 varieties of groundnut and observed that plant height ranged from 32.9 to 42.7 cm at the higher plant population. Generally increase in plant population leads to increase in yield for any given variety. Increase pod yield with increase in plant population density of groundnut up to the maximum; 200,000 plants ha^{-1} indicates that the crops therein made better use of available space and light. It also means that there are more reproductive units per unit area of land. In addition a highly populated plot confers better weed control than a less densely populated one. This finding conforms the results of other researchers like Tamimu *et al.* (1998) who reported that yield increased from 10.5 to 15.9% by increase in plant population; while Yayock (1978) also reported yield increases of 13, 9 and 6% of three varieties of groundnut achieved by raising the population density from 57,000 to 86,000 plants ha^{-1}. The varieties used in this experiment exhibited significant differences in their growth character such as plant height; canopy spread, number of branches. This is attributed to differences in their genetic composition and also the genotype and environment interaction. Optimum moisture availability provided by irrigation prolongs the vegetative growth phase of groundnut thus, enhancing plant height and canopy spread. Samnut 23 proved to be consistently taller than the other varieties and superior in pod yield hectare^{-1}. This is not surprising because flowering which occurred earlier in Samnut 23 is strongly related to pod formation thus positively influencing pod yield and other yield related characters. Generally the earlier the pods are formed; the more likely they are to reach maturity (Anonymous, 2002). The highest 100 seed weight obtained from Samnut 11 is not surprising and is in line with its genetic composition. The 100 seed weight observed in this experiment falls within the range reported by Misari *et al*. (1988), who in their work with 11 varieties of groundnut reported a range of 32.3-52.2 g weight / 100 seeds. There is an indication that there are differences in partitioning of dry matter to pod by the different varieties in response to environmental factors such as temperature and radiation.

CONCLUSION

A field experiment was conducted at the Irrigation Research Station of the Institute for Agricultural Research Zaria from 2003 to 2006 dry seasons to study the pod yield ha^{-1} and other growth and yield components of three varieties of groundnut grown under irrigated conditions. The results indicated that Samnut 23 produced the significantly highest pod yield ha^{-1} and number of podsplant. Samnut 11 produced significantly highest 100 seed weight. It is concluded that Samnut 23 planted at 200,000 plants ha^{-1} in 3×4 m basins is most promising for irrigated groundnut cultivation in the Sudan savanna of Nigeria.

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REFERENCES

Abulu, G.O., 1978. An economic analysis of groundnut production in Northen Nigeria. Proceedings of the National Seminar on Groundnut Production, September 7-9, 1978, Kano, Nigeria, pp: 83-90.

Alexandratos, N., 1988. World Agriculture: Toward 2000: An FAO Study. Belhaven, London, ISBN: 9781852930578, Pages: 338.

Anonymous, 2002. The Tropical Agriculturist. Macmillan Education Ltd., London and Oxford, pp: 146.

Chiezey, U.F., 1989. Effect of plant density and P fertilization on the yield and yield, component, groundnut. Ph.D. Thesis, Department of Agronomy, A.B.U. Zaria.

Duncan, D.B., 1955. Multiple range and multiple F test. Biometrics, 11: 1-42.

ICRISAT., 2005. ICRISAT annual report 2005. International Crop Research Institute for the Semi Arid Tropics, Patancheru Andhra Pradesh, India.

Misari, S.M., S. Boye-Goni and B.K. Kaigama, 1988. Groundnut improvement, production, management and utilization in Nigeria: Problems and prospects. Proceedings of the 1st ICRISAT Regional Groundnut Meeting for West Africa, September 13-16, 1988, ICRISAT Sahelian Center Niamey, Niger, pp: 61-64.

Mozingo, R.W. and J.L. Steel, 1987. Intra row seed spacing effect on five peanut cultivars. Proceedings of the American Peanut Research and Education Society, Inc. Meeting, July 14-17, 1987, Orlando, Florida.

Nautiyal, P.C., 1999. Groundnut: Post harvest operation. National Research Centre for Groundnut, pp: 46, http:// www.fao. org/fileadmin/user-upload/inpho/docs/Post-Harvest-Compendium-Groundnut.pdf

Rhoades, J.D., 1997. Sustainability of Irrigation: An Overview of Salinity Problems and Control Strategies. Proceedings of the Footprints of Humanity: Reflections on Fifty Years of Water Resource Developments Conference, June 3-6 1997, Canadian Water Resource Association, Lethbridge, Alberta, pp: 1-42.

Snedeccor, G.W. and W.G. Cochran, 1994. Statistical Methods. 8th Edn., Iowa State University Press, USA., ISBN-13: 978-0813815619, pp: 503.

Tanimu, B., B. Abdullahi, P.E. Olorunju and R. Ibrahim, 1998. Effect of inter and intra row spacings on growth and yield of groundnut in the northern guinea savanna of Nigeria. Plant Sci., 1: 69-82.

Yayock, J.Y., 1978. Yield and yield characters of certain varieties of groundnuts (*Arachis hypogaea* L.) as affected by plant population and fertilizer level, Nigeria. Ph.D. Thesis, Postgraduate School A.B.U. Zaria.