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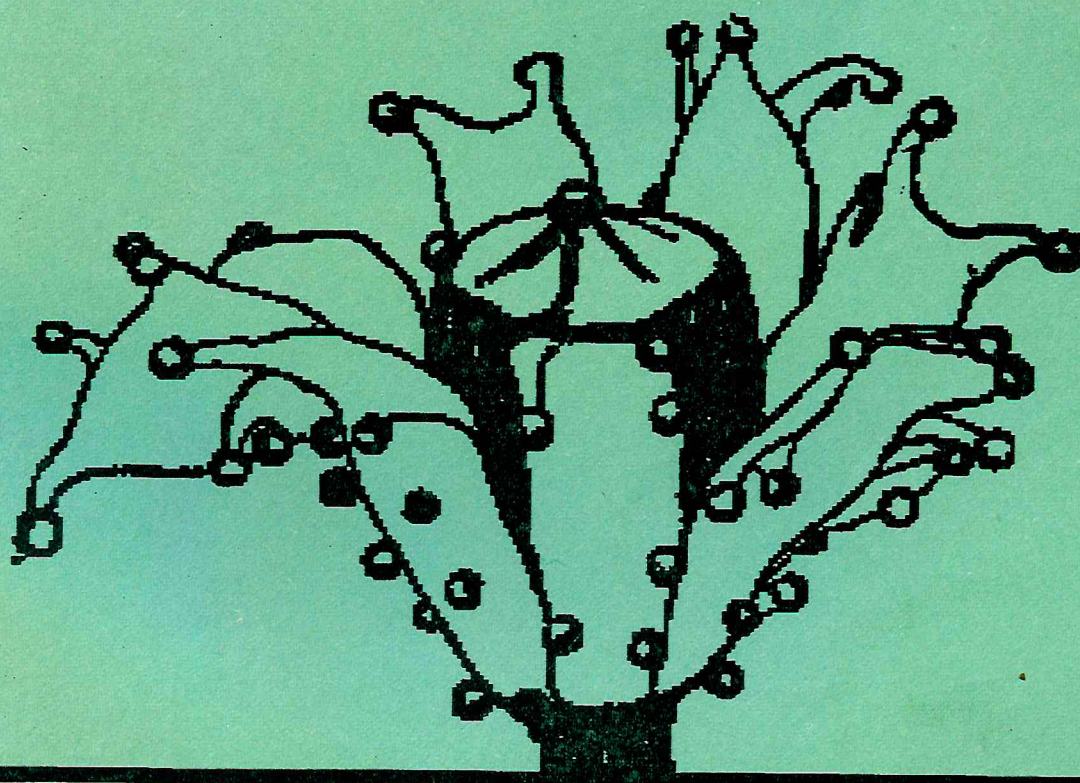
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Department of Crop Production, College of Agriculture, Kwara State University, Malete, Nigeria

Sorghum (*Sorghum bicolor* [L.] Moench) Growth and Yield As Influenced by Weed Infestation, Spacing and Number of Plants/Stand in the Southern Guinea Savanna of Nigeria

E. O. IMOLOAME

Department of Crop Production, College of Agriculture, Kwara State University,
Malete, P.M..B. 1530, Ilorin, Kwara State, Nigeria

With 4 tables and 13 references

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ABSTRACT

Field trials were conducted at the Teaching and Research Farm of the College of Agriculture, Kwara State University, Malete, Nigeria, during the 2012 and 2013 cropping seasons. The aim was to determine the effects of plant spacing and number of plants per stand on weed infestation and yield of sorghum in the southern Guinea savanna of Nigeria. The treatments consisted of three plant spacings at 90 × 60 cm, 75 × 50 cm and 75 × 25 cm, which were allocated to the main plot, while the number of plants per stand, namely: 1 plant, 2 plants 3 plants, 4 plants, 5 plants and 6 plants/stand were allocated to the sub-plots, making a total number of 18 treatments. These treatments were laid out in a split plot arrangement fitted into a randomized complete block design with three replicates. Parameters measured include weed cover scores, weed dry matter, plant height, 1000-seed weight and grain yield. Results showed that wider plant spacings supported weed infestation that were significantly higher than narrower spacings, though it produced significantly highest grain yield. Number of plants/stand had no significant effect on grain yield. Therefore, spacing at 90 × 60 cm and 1- 6 plants/stand are suitable for the production of higher yields of sorghum in the southern Guinea savanna of Nigeria.

Key words: Sorghum; spacing; number of plants/stand; yield; savanna

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Introduction

Sorghum (*Sorghum bicolor* (L.) Moench), locally called guinea corn, is the most extensively grown cereal in Nigeria. [Aba *et al.*, 2004]. The crop is environmentally friendly as it requires little or no fertilizer or pesticides and it is biodegradable [FAO, 1995]. About 50% of the total area devoted to cereal crops in Nigeria is occupied by sorghum. The area is estimated at 6.86 million hectares [Aba *et al.*, 2004]. Consequently, Nigeria is the highest producer of sorghum in the West African region, accounting for 71% of the regional total sorghum output. Globally also, the country leads in sorghum production and has risen from fifth position in 1995 [FAO,1995] to the third largest producer of sorghum in the world after United States of America and India where more than 90%of their sorghum harvest is used for animal feed [Obilana, 2005].

Sorghum plays an important role in our diet and is the staple food of millions in the dry parts of tropical Africa and Asia. The air-dried grain contains approximately 70 - 90% starch, 7 - 14% protein, 2 - 6% fat and 1 - 3% fiber. [Murty and Renard, 2001]. It is used as a stale food, for brewing beer, as livestock feed, for producing industrial goods such as wax, starch, alcohol, dextrose sugar, edible oil and gluten. Dried sorghum plants have many domestic uses such as in the making of baskets and mats, fencing or for thatching houses [Onwueme and Sinha, 1991]. Sorghum is high in energy and nutrition contents, and is, therefore, recommended for infants, pregnant and lactating mothers, the elderly and the convalescents [Obilana, 2005].

Among researches conducted on sorghum in recent years include the work of Miko and Manga, [2008] in which the closest intra-row spacing of 25 cm gave 35.06%, 38.58% increase in yield in 1999 and 2001 respectively, over the widest spacing of 75 cm in variety ICSV 400. Early season weed management is critical for maximizing yield potential of sorghum. Even light weed infestations early in sorghum development can significantly reduce yields. A heavy infestation at this time may cause up to 20% yield reduction [Anonymous, 2004].

In spite of its economic significance, its average grain yield in the small holder sector of northern Nigeria has not been too impressive and neither has its yield increased appreciably in recent times. [Kassam *et al.*, 1976]. It is on record that the yield of sorghum in Nigeria is about 1.16 tonnes/ha, which is very low compared to Jordan with 3.9 tonnes/ha [FOSTAT, 2007].

Sorghum, especially the local variety (Belegbeje), is one of the major cereal crops grown by farmers in Moro Local Government Area of Kwara State [Imoloame, 2013]. It is about 4 m tall, with a long and loose panicle and matures in about 5 months. Though it is very popular in this area, little or no research work has been carried out on it to find out how its productivity can be improved upon. Therefore, there was the need to carry out this study in order to provide the farmers with improved agronomic practices necessary for improving sorghum yield in the southern Guinea savanna agro-ecological zone. The present study was aimed at determining the right plant population that will reduce weed infestation and increase sorghum yield, and determining the correct spacing that will minimize weed infestation and give higher sorghum yield.

Materials and Methods

A field experiment was conducted during the 2012 and 2013 rainy seasons at the Teaching and Research Farm of the Kwara State University, Malete, Nigeria (Lat. 08°, 7'N; Long. 04°44'E). The experiment consisted of 18 treatments, namely, six plant populations (1 plant/stand, 2 plants/stand, 3 plants/stand, 4 plants/stand, 5 plants/stand and 6 plants/stand) and three plant spacing, *viz.*, 90 × 60 cm, 75 × 50 cm and 75 × 25 cm. These treatments were laid out in a split-plot arrangement and fitted into a randomized complete block design (RCBD), with plant spacing occupying the main plot, while the subplots were occupied by the number of plants/stand. The treatments were replicated 3 times. After ploughing and harrowing of the experimental field, it was leveled and marked out into plots of 4 m × 4 m each. A space of 0.5 m was left between plots, while a distance of 1 m was left between replicates. Nutrients at the rate of 60 kg N, 32 kg P₂O₅ and 32 kg K₂O were applied to each plot in two split doses, using 15:15:15 fertilizer. The first dose of fertilizer was applied before planting consisting of the full doses of phosphorus and potassium and half dose of nitrogen, while the second half dose of nitrogen using urea was applied as top dressing at 6 WAS. A local variety of sorghum (Belegbeje) which is popularly grown in Kwara State was sown on 3rd of July, 2012 and 28th June, 2013 and harvested on 7th and 20th of December, respectively. The gross plot was 4 × 4 m. During the harvesting, the two side rows were discarded while the two inner rows were harvested. The parameters measured were plant height, weed dry matter, weed cover score, 1000-seed weight and grain yield. Data collected were subjected to analysis of variance and means were separated using the Tukey's Honestly Significantly Difference (THSD) test at 5% level of probability.

Results

Effect of spacing and number of plants/stand on weed infestation

Table 1 presents the effects of spacing and plant population on weed dry matter. It shows that plant spacing and plant population affected weed dry matter significantly both at 6 WAS and at harvest ($p < 0.05$). Sorghum spaced at 90 × 60 cm supported significantly higher weed dry matter compared to narrower spacings in both years at 6 WAS and at harvest ($p < 0.05$). Also, the higher number of plants/stand, at 5 to 6 plants/stand significantly reduced weed dry matter at 6 WAS in 2012 and at harvest in both years of the study.

The effects of spacing and number of plants/stand on weed cover score is presented in Table 2. It shows that the narrow spacings of 75 × 50 cm and 75 × 25 cm resulted in significantly lower weed cover scores in both years at 6 WAS and at harvest. The wider spacing of 90 × 60 cm gave significantly higher weed cover score compared with the other treatments ($p < 0.05$). At harvest, similar observations were made with the wider spacing of 90 × 60 cm resulting in significantly higher weed cover scores.

The number of plants/stand significantly affected weed cover scores in 2012 at 6 WAS and in both years at harvest. At 6 WAS, the 5 plants/stand significantly reduced weed cover which was comparable to all the rest of the treatments, except the 1 plant/stand which gave a significantly higher weed cover. The same trend was observed at

harvest in both years with the higher plant population producing significantly lower weed cover compared to the wider spacing of 90 × 60 cm.

Table 1. Effect of spacing and number of plants/ stand on weed dry matter

Treatments	6 WAS ¹		Harvest	
	2012	2013	2012	2013
Spacing (S) (cm)				
90 × 60	20.5a ²	20.6a	10.7a	5.9a
70 × 50	10.9b	15.4ab	3.3c	1.0b
75 × 25	10.8b	12.0b	6.2b	0.2b
SE±	3.20	2.50	2.10	1.30
Number of plants (N)/stand				
1 plant/stand	17.1ab	20.8	11.2a	5.2a
2 plants/stand	13.3ab	13.9	6.9ab	1.8b
3 plants/stand	17.8a	17.9	9.2a	1.7b
4 plants/stand	15.6ab	15.9	6.8ab	0.6b
5 plants/stand	8.9b	11.1	3.4b	1.8b
6 plants/stand	11.6ab	16.3	3.9b	1.3b
SE±	1.40	1.40	1.30	0.70
Interaction (S × N)	NS ³	NS	NS	NS

¹WAS = weeks after sowing; ² = means followed by the same letters within the same column are not significantly different according to Tukey's Honestly significantly difference test at 5% level of probability; ³NS = not significant

Effect of spacing and number of plants/stand on plant height

Table 3, shows the effect of spacing and number of plants/stand on plant height. Plant spacing significantly affected plant height in 2012 and 2013 at 6 WAS and at harvest, respectively ($p < 0.05$). Spacing of 90 × 60 cm gave significantly taller plants which were comparable to those of the 75 × 50cm, but significantly taller than those of 75 × 25 cm. The same trend was observed in 2013 with crops spaced at 90 × 60 cm producing the tallest plants. The number of plants/stand had no significant effect on plant height of sorghum ($p > 0.05$).

Table 2. Effect of spacing and number of plants/ stand on weed cover score

Treatments	6 WAS ¹		Harvest	
	2012	2013	2012	2013
Spacing (S) (cm)				
90 × 60	6.9a	7.6a	3.6a	1.4a
70 × 50	5.8a	5.3b	2.4b	0.8b
75 × 25	4.1b	3.7c	2.3b	0.2c
SE±	0.82	1.10	0.40	0.40
Number of plants (N)/stand				
1 plant/stand	6.8a ²	6.7	4.5a	2.1a
2 plants/stand	6.4ab	5.3	2.8b	1.2b
3 plants/stand	5.3ab	5.9	2.7b	0.7b
4 plants/stand	5.1ab	4.9	2.1b	0.6b
5 plants/stand	4.8b	4.9	2.3b	0.0d
6 plants/stand	5.7ab	5.6	2.2b	0.0d
SE±	0.40	0.30	0.40	0.36
Interaction (S × N)	NS ³	NS	NS	NS

¹WAS = weeks after sowing; ² = means followed by the same letters within the same column are not significantly different according to Tukey's Honestly significantly difference test at 5% level of probability; ³NS = not significant

Table 3. Effect of spacing and number of plants/stand on plant height

Treatments	6 WAS ¹		Harvest	
	2012	2013	2012	2013
Spacing (S) (cm)				
90 × 60	46.4a	41.3	110.3	82.7a ²
70 × 50	46.3a	40.3	105.3	74.7ab
75 × 25	39.4b	39.0	103.0	67.9b
SE±	2.35	0.71	2.18	4.35
Number of plants (N)/stand				
1 plant/stand	40.9	40.1	95.0	75.7
2 plants/stand	43.5	38.3	103.3	77.7
3 plants/stand	44.2	38.6	104.8	75.1
4 plants/stand	45.8	42.3	114.3	71.1
5 plants/stand	47.2	42.5	115.0	69.8
6 plants/stand	42.5	39.4	106.6	77.4
SE±	1.05	0.81	3.41	1.50
Interaction (S × N)	NS	NS ³	NS	NS

¹WAS = weeks after sowing; ² = means followed by the same letters within the same column are not significantly different according to Tukey's Honestly significantly difference test at 5% level of probability; ³NS = not significant

Effect of spacing and number of plants/stand on 1000-seed weight and grain yield

Table 4, shows the effects of spacing and number of plants/stand on 1000- weight and grain yield. It shows that spacing had no significant effect on 1000-seed weight ($p > 0.05$), while the number of plants/stand had significant effect on 1000-seed weight. The 1 plant/stand produced significantly heavier seeds compared with the other treatments ($p < 0.05$). Similarly, plant spacing had significant effect on grain yield only in 2012 as the 90 × 60 cm spacing produced significantly higher grain yield compared to the narrower spacing ($p < 0.05$). The number of plants/stand did not affect the grain yield of sorghum significantly ($p > 0.05$).

Table 4. Effect of spacing and number of plants/stand on 1000-seed weight and grain yield

Treatments	1000-seed weight		Grain yield (kg/ha)	
	2012	2013	2012	2013
Spacing (S) (cm)				
90 × 60	27.6	22.5	3860.2a	857.4
70 × 50	27.5	22.9	3755.4b	786.3
75 × 25	27.1	22.3	3058.6b	886.3
SE±	0.15	0.18	256.29	30.29
Number of plants (N)/stand				
1 plant/stand	28.8a ¹	22.8	3186.2	853.6
2 plants/stand	28.4b	22.6	3446.1	902.4
3 plants/stand	27.0ab	22.7	3859.1	853.2
4 plants/stand	26.4b	22.7	3390.0	894.9
5 plants/stand	26.9ab	22.3	4057.0	898.6
6 plants/stand	26.8ab	22.3	3409.0	656.5
SE±	0.44	0.10	149.5	42.80
Interaction (S × N)	NS ²	NS	NS	NS

¹ = means followed by the same letters within the same column are not significantly different according to Tukey's Honestly significantly difference test at 5% level of probability; ²NS = not significant

Discussion

Wider spacing of observed further at the 1 plant narrower resulted in of the we closer Further narrow wider the narrow and weeds resources narrower at 90 × 60 Sorghum × 25 cm more nutrit significant significant present we has passed farmers ca

Conclusion

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- Onwueme CTA

Discussion

Wider spacing of sorghum at 90×60 cm produced weed dry matter that was significantly higher than narrower spacing of 75×50 cm and 75×25 cm in both years of the study at 6 WAS and at harvest. Similar trend was observed in relation to weed cover scores as this parameter was significantly reduced with narrower spacing. Furthermore, weeds were significantly reduced at the higher number of 5 plants/stand at 6WAS and at harvest than at the 1 plant/stand. The above results could be due to the ability of sorghum to achieve early canopy closure at narrower spacing with higher numbers of plants/stand than at wider spacing with lower number of plants/stand. This resulted in the shading of weeds growing beneath the crop from solar radiation leading to the smothering and death of the weeds. This is similar to the findings of Akobundu [1987] and Ndarubu [1997] in which it was reported that closer spacings resulted in less weed cover, while weed cover increased as the inter-row spacings increased. Furthermore, Dougherty [1969] reported that shading of weeds by quickly formed canopies of soybean planted in narrow rows account for more efficient weed control than the wider rows.

Wider spacing of 90×60 and 75×50 cm resulted in plant heights that were significantly taller than plants in the narrow spacing of 75×25 cm, at 6 WAS and at harvest. This could be due to less competition between the crop and weeds at wider spacings, which probably resulted in the uptake of more available nutrients and other growth resources for better performance. There was more intense competition between the crop and the weeds at the narrower spacing of 75×25 cm. The uptake of greater amounts of growth resources by widely spaced sorghum at 90×60 cm and 1 plant/stand could have resulted in the production of significantly higher 1000-seed weight. Sorghum grain yield was significantly higher at the wider spacing of 90×60 cm compared to closer spacing at 75×25 cm. This could have resulted from minimum competition between the sorghum crop and weeds which made more nutrients available to the crops that probably promoted the production of higher amounts of photosynthates, significantly taller plants, 1000-seed weight and better grain yield. Though sorghum spaced at 90×60 cm produced significantly higher weed dry matter, this treatment produced significantly higher yield. It is possible that the weeds present were not competing with the crops since they were present after the critical period of growth of sorghum has passed. The number of plants/stand had no significant effect on the grain yield of sorghum. Therefore, the farmers can leave between 1 - 6 plants/stand after thinning.

Conclusion

It can be concluded that for better growth and yield, sorghum should be grown at a spacing of 90×60 cm with the crop thinned to between 1 - 6 plants/stand.

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