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RESPONSE OF COTTON CULTIVARS TO SOIL AND FOLIAR APPLIED FERTILIZER IN KABBA, KOGI STATE, NIGERIA

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ABSTRACT

The experiment was carried out at Kabba College of Agriculture experimental field in 2020 and 2021 cropping seasons to evaluate response of cotton cultivars to soil and foliar applied fertilizer. The experiment was performed in a randomized complete block design with two factors arranged in split plot arrangement in three replications. The first experimental factor was a cultivar, include two cotton varieties Hybrid and Lokoja local (abbreviated as C1 and C2) were used. The second experimental factor was the different nitrogen sources applied at five levels, NS1 = No Nitrogen source (control), NS2 = NPK (20:10:10 plus boron) fertilizer applied into soil alone = 80kg NPK & B, NS3 = NPK & B at 50% (40kg N) + Agric Zyme 50% (40 kg N), NS4 = NPK & B at 75% (60kg N) + Agric Zyme at 25% (20kg N) and NS5 = NPK & B at 25% (20kg N) + Agric Zyme at (60kg N). Data were collected on growth characters such as plant height, stem girth, number of leaves and leaf area fresh and dry weight of cotton. Yield characters observed were number of flowers per plant, cotton ball per plant, cotton yield per plant and cotton lint yield. All plots with NPK&B and Agric Zyme produce better growth and yield characters than the control. All plots with NPK&B alone or in combination with Agric Zyme at reduced level produced similar growth characters. Cotton with fertilizer application either singly or combined produced higher number of flowers and cotton balls compared to the control. Cotton grows through hybrid seeds gave more flowers and cotton balls more than Lokoja local seeds used. Cotton with fertilizer application were susceptible to pest attacked compared to cotton grow in the control plots. Cotton grows with the use of hybrid seed gave higher number of aborted flowers than the Lokoja local seed used. Though, cotton plant grows with NPK&B at 80 kg /ha gave the highest yield of cotton. All other plots with combined application of NPK&B and Agric Zyme produced yield comparable to plots with NPK&B at 80 kg /ha. Among cotton with combined application of NPK&B and Agric Zyme, plots treated with NPK & B at 25% (20kg N) + Agric Zyme at 75% (60kg N) gave the greatest yield. Cotton with hybrid seed produced cotton yield higher than the Lokoja local seed. The increment in hybrid cotton yield over Lokoja local seed is 58.52%. Cotton farmers in the study area should grow hybrid cotton using any of the treatment combinations especially NPK & B at 25% (20kg N) + Agric Zyme at 75% (60kg N).

Key words: Lokoja local seed, Hybrid, Agric Zyme, Lint yield, Cotton

INTRODUCTION

Cotton (*Gossypium species*) is one of the most important commercial crops in Nigeria, being the principal fibre for growing Nigerian textile industry. Cotton belongs to the family of Malvaceae, a plant of the genus *gossipier* which is widely grown in warm climates areas. The average cotton plant is an herbaceous shrub having a normal height of 1.2 to l.8m. Globally, cotton is planted in more than 75 countries occupying more than 30 million hectares (Bednarz *et al.,* 1999). Cotton is reported to tolerate wide range of soils but highest yields of cotton are usually obtained on alluvial soils. High yield of cotton is dependent on favorable air and moisture regime, good soil structure and texture and also good soil depth. Cotton is usually cultivated on sandy loam to loam soils (Ayissa and Kebede, 2011).Low level of soil fertility and inappropriate nutrient management are the most important factors affecting the production of cotton (Yayock, 2002). Optimum nutrient applications determine the plant size, boll size and fruiting intensity (Sing *et al*., 1998).

Cotton response to fertilizer is more critical than other crops (Nasim *et al.*, 2011). Haphazard fertilization may results in increasing the amount of nutrients not needed by the plant and increases the fertilizer costs of the farmer unnecessarily (Bisson *et al.,* 1994). Incorrect fertilization leads to environmental hazard (Bisson *et al.,* 1994). Excessive usage of nitrogenous fertilizer prolong maturity time of the crop (Steenkamp and Jansen, 1998), it also lower the resistance of the plant against diseases and greater attractiveness to insect pests (Constable and Rochester, 1988; Hearn, 1981).

Foliar Fertilizer has the advantages of low cost and a quick plant response, and it is particularly important when soil problems occur and root growth is inadequate. On the other hand, it has disadvantages of possible foliar burn, solubility problems, and only a small amount of the nutrient can be applied at a time. Cotton requires balance nutrients for cotton optimal productivity. In cotton production, this can be achieved by combining soil application of fertilizer with foliar applications. These may be appropriate

after canopy closure or when a specific nutrient is urgently required. Furthermore, foliar fertilization may lead to less concern about groundwater and surface water contamination, with nitrates in particular. Foliar application of specific nutrients is a method used to improve the efficiency of fertilizer use and increase yields. The increased use of foliar fertilizers in cotton production is due to changes in production philosophy. The objective of the study is to evaluate the response of cotton cultivars to soil and foliar applied fertilizer in Kabba, Kogi State, Nigeria.

MATERIALS AND METHODS

Experimental Site

The experiment was carried out in 2020 and 2021 seasons. The site is located within the Kabba College of Agriculture under the Division of Agricultural Colleges, Ahmadu Bello University, Kabba, Kogi State, Nigeria. It lies between latitude 7° 52'N and 7° 34'N longitude 6° 02'E and 7°42'E in the Guinea Savannah Agro-ecological zone of Nigeria. The area experiences a tropical climate with marked wet and dry seasons, high temperature joined with high humidity. Rainy season spans over seven months from mid-March or early April to October. The mean annual rainfall is 1329mm per annum. Dry season spans from November to early March. Average means annual temperature of the area ranges between 30°C and 32°C. The topography of the site is gentle slope. The geology of the area is dominated by crystalline rocks while the soils are mostly of granitic parent material. The vegetation of the area is dominated by tall grasses and shrubs, also human activities have influenced the vegetation of the area.

Experimental Design

The experiment was performed in a randomized complete block design with two factors arranged in split plot arrangement in three replications. The main plot factor included two cotton varieties (Hybrid C1 and Lokoja local C2). The sub plot treatment involved different nitrogen sources applied at five levels (NS1 = No Nitrogen source (control), NS2 = NPK (20:10:10 plus boron) fertilizer applied into soil alone = 80kg NPK & B, NS3 = NPK & B at 50% (40kg N) + Agric Zyme 50% (40 kg N), NS4 = NPK & B at 75% (60kg N) + Agric Zyme at 25% (20kg N) and NS5 = NPK & B at 25% (20kg N) + Agric Zyme at 60kg N).

The seeds were sown on 1st of June, 2020 and 2021 in 30 plots with each plot of 20 m^2 (5.0 m by 4.0 m). The N was applied twice at the equal rate after seed sowing and at an initial flowering stage. Insect were control at peak-flowering and boll-setting period with the use karate at 10 ml per 15 litres sprayer. Major weeds observed in the plots like Euphobia species, *Cyprus* species and Panicum species and other weed species were controlled manually at three weeks' interval at the same time for all treatments. Thinning of seedlings was done three weeks after sowing to have 20 cm spacing between plants as recommended and practiced in the area to obtain the recommended plants per stand. Thrips and Africa boll worm were controlled by spraying Thiodan at the rate of 2.5 l ha-1 while Aphids were controlled by using Marshal at the rate of 2 liter ha^{-1} in all plots in the same manner. All other typical agronomic practices of the area were performed uniformly to all plots. Data were collected on growth characters such as plant height, stem girth, number of leaves, and leaf area fresh and dry weight of cotton. Yield characters observed were number of flowers per plant, cotton ball per plant, cotton yield per plant and cotton lint yield.

Yield Harvest

Cotton yield was determined 2 weeks after chemical defoliation by picking the entire length of the center two rows in each plot. Cotton from each plot was collected in bags and fresh weight measured. A subsample (approximated 1 kg) from each plot was ginned with a bench-top gin with lint, seed, and trash separated. Ginning percentage, calculated as (100 × lint weight)/(weight of lint +seed + trash), was used to convert seed cotton yield to lint yield (Watts *et al*., 2014).

Data analysis

All growth and yield data were subjected to analysis of variance test (ANOVA) according to Obi (1986) for split plot experiment in a randomized complete blocks design. Fisher's least significant difference (F-LSD) at 5% probability level (Gomez and Gomez, 1984) was employed for the mean separation.

RESULTS AND DISCUSSION

Results

The effect of different nitrogen sources on plant height of cotton is presented in Table 1. Similar mean plant height was observed in all plots with nutrient sources. However, the tallest plant occurred in plots with NPK Fertilizer applied into the soil alone (80kg NPK & B), followed by NPK & B at 50% (40kg N) + Agric Zyme 50% (40 kg N) and then NPK & B at 75% (60kg N) + Agric Zyme at 25% (20kg N) while the shortest plant among the plots with nutrient sources was recorded in plots with NPK & B at 25% (20kg N) + Agric Zyme at 60kg N.

Significant difference was observed in plant height of cotton due to the different cultivar used. Cotton grows with hybrid seed recorded significant higher plant height compared to Lokoja cultivar seed used.

Effects of nutrient sources and cultivar on stem girth of cotton were similar. No significant difference observed in the thickness of cotton due to different

nutrient sources used and sources of seeds whether hybrid or local seed used. All the cotton plants produced similar thickness.

Number of leaves and leaf area of cotton were significantly affected by the different nutrient sources used. Plots with nutrient sources produce similar number of leaves and leaf area, though, all these were better than the control plots. Control plot recorded the least values of all the growth parameter checked in this experiment. Cotton raised with hybrid seed recorded significant higher number of leaves and leaf area compared with cotton grow with Lokoja local seed (Table 1).

Effect of combined application of agric enzyme and NPK on fresh and dry weight of cotton plant is presented in Table 2. In 2020, fresh weight and dry weight of cotton were highest in when Fertilizer was applied into soil alone (80kg NPK & B), followed by NPK & B at 75% (60kg N) + Agric Zyme at 25% (20kg N), thenNPK & B at 25% (20kg N) + Agric Zyme at (60kg N) while the least fresh weight occurred in plots withNPK & B at 50% (40kg N) + Agric Zyme 50% (40 kg N). However, in 2021, no significant difference observed in both the fresh and dry weight of the plots treated with combined application of agro enzyme and NPK&B. Also, mean of fresh and dry weight of cotton plant calculated indicated that plot with nutrient sources produced similar fresh and dry weight and all these were significantly better than the control. Cotton with fertilizer applied into soil alone (80kg NPK & B) as amendment recorded the heaviest plant(fresh and dry weight), followed by cotton amend with NPK & B at 50% (40kg N) + Agric Zyme 50% (40 kg N), NPK & B at 75% (60kg N) + Agric Zyme at 25% (20kg N) while the least weights (fresh and dry) was observed in cotton grow with NPK & B at 25% (20kg N) + Agric Zyme at (60kg N). Weight of control plots was significantly inferior to cotton treated with agric zyme and NPK&B irrespective of their combinations.In 2020 and 2021, cotton grow with hybrid seed recorded significant higher fresh and dry weight when compared with plots raisedthrough Lokoja local seed.

Effect of combined application of agric enzyme and NPK&B on flower characters of cotton plant is presented in Table 3. Number of flowers was highest in plot with fertilizer applied into soil alone (80kg NPK & B), followed by NPK & B at 50% (40kg N) + Agric Zyme 50% (40 kg N), NPK & B at 75% (60kg N) + Agric Zyme at 25% (20kg N) and NPK & B at 25% (20kg N) + Agric Zyme at (60kg N). The least number of flowers occurred in control plot (NS1). Cotton balls per plant and % aborted flowers was highest whenfertilizer was applied directly into soil alone (80kg NPK & B). Number of cotton ball per plant of NPK & B at 50% (40kg N) + Agric Zyme 50% (40 kg N), NPK & B at 75% (60kg N) + Agric Zyme at 25% (20kg N) andNPK & B at 25% (20kg N) + Agric Zyme at (60kg N). The least number of flowers occurred in control plot(NS1). Cotton balls per plant and % aborted flower was highest in plot where fertilizer was applied into soil alone (80kg NPK & B). Numbers of cotton ball per plant of NPK & B at 50% (40kg N) + Agric Zyme 50% (40 kg N), NPK & B at 75% (60kg N) + Agric Zyme at 25% (20kg N) and NPK & B at 25% (20kg N) + Agric Zyme at (60kg N) were similar. The least cotton ball per plant occurred in the control (NS1). % aborted flowers was highest in plots with NPK & B at 50% (40kg N) + Agric Zyme 50% (40 kg N), followed by plots with fertilizer applied into soil alone (80kg NPK & B), then NPK & B at 75% (60kg N) + Agric Zyme at 25% (20kg N) and the least among the treated plots was recorded in plot with NPK & B at 25% (20kg N) + Agric Zyme at (60kg N).Among the cultivar used, number of flower, cotton ball per plant and % aborted flower were higher in hybrid cultivar when compared with Lokoja local.

Effect of combined application of agric zyme and NPK& B on yield of cotton is presented in Table 4. Plot with fertilizer applied into soil alone (80kg NPK & B) recorded the highest cotton yield per plot and cotton yield per hectarein 2020 and 2021. This was followed by NPK & B at 25% (20kg N) + Agric Zyme at (60kg N) (0.42 kg), 5.04 kg/ha respectively. Among the treated plots, cotton with NPK & B at 50% (40kg N) + Agric Zyme 50% (40 kg N) recorded the least yield per plot and yield per hectare. The control plots yield was significantly inferior to all the treated plots. Cotton lint yield was significantly better in hybrid than the local variety used in this experiment. The mean yield of hybrid and local cultivar were 0.55 and 0.33; 0.72 and 0.36 respectively.

Table 1: Effect of combined application of agric enzyme and NPK on growth characters of cotton

Treatment	Plant height (cm)			Stem girth (cm)			Number of leaves			Leaf area (m2)		
	2020	2021	mean	2020	2021	mean	2020	2021	mean	2020	2021	mean
NS1	59.6	53.2	56.4	0.5	0.7	0.6	19.3	22.7	21.0	26.2	30.4	28.3
NS2	91.0	91.0	89.7	0.6	1.0	0.8	27.5	34.5	31.0	36.9	41.3	39.1
NS3	86.0	90.6	88.3	0.5	1.1	0.8	25.4	32.6	29.0	39.0	36.2	37.6
NS4	72.7	100.1	86.4	0.5	0.9	0.7	29.1	26.9	28.0	38.3	35.3	36.8
NS5	77.8	88.8	83.3	0.5	0.9	0.8	20.0	38.0	29.0	31.9	42.9	37.4
LSD (0.05)	21.6	23.4	19.4	Ns	0.27	Ns	4.63	10.5	4.16	5.68	5.31	4.88
Cultivar												
Hybrid	88.1	91.1	89.6	0.8	0.8	0.8	29.6	36.4	33.0	38.2	41.4	39.8
Lokoja	61.1	73.3	67.2	0.4	1.2	0.8	24.4	23.6	24.0	22.2	25.2	23.7
LSD (0.05)	21.6	23.4	12.4	0.21	0.14	Ns	2.31	9.68	5.14	8.44	10.4	9.86
Interaction NS VS Cult	ns	ns	ns	ns	Ns	Ns	Ns	ns	ns	ns	ns	ns

KEY: NS1 = No Nitrogen source (control), NS2 = NPK Fertilizer applied into soil alone = 80kg NPK & B, NS3 = NPK & B at 50% (40kg N) + Agric Zyme 50% (40 kg N), NS4 = NPK & B at 75% (60kg N) + Agric Zyme at 25% (20kg N) and NS5 = NPK & B at 25% (20kg N) + Agric Zyme at (60kg N). NS=Nutrient sources, Cult= cultivar and ns = non-significant.

Table 2: Effect of combined application of agric enzyme and NPK on fresh and dry weight of cotton plant

Nutrient Sources	Fresh weight			Dry weight		
	2020	**2021**	**Mean**	**2020**	**2021**	**Mean**
NS_1	4.03	3.75	3.80	1.22	1.10	1.16
NS_2	5.88	6.16	6.02	1.68	1.82	1.75
NS_3	4.89	5.93	5.41	1.47	1.65	1.56
NS_4	5.10	5.68	5.39	1.18	2.00	1.59
NS_5	4.96	5.60	5.28	1.55	1.61	1.58
LSD (0.05)	0.94	1.26	1.46	0.36	0.43	0.33
Cultivar						
Hybrid	5.11	6.57	5.84	2.75	2.91	2.83
Lokoja	3.61	3.65	3.63	1.59	2.03	1.81
LSD (0.05)	0.84	2.31	0.96	0.46	0.46	0.21
Interaction NS VS Cult	Ns	ns	Ns	Ns	ns	ns

NS1 = No Nitrogen source (control), NS2 = NPK Fertilizer applied into soil alone = 80kg NPK & B, NS3 = NPK & B at 50% (40kg N) + Agric Zyme 50% (40 kg N), NS4 = NPK & B at 75% (60kg N) + Agric Zyme at 25% (20kg N) and NS5 = NPK & B at 25% (20kg N) + Agric Zyme at (60kg N). NS=Nutrient sources, Cult= cultivar and ns = non-significant.

Table 3: Effect of combined application of agric zyme and NPK&B on flower characters of cotton plant

Nutrient Source	Number of flowers			Cotton balls per plant			% Aborted		
	2020	2021	Mean	2020	2021	mean	2020	2021	Mean
NS_1	21.1	24.9	23	18.4	23.6	21.0	1.8	2.2	2 (8.7)
NS_2	40.8	51.2	46	35.9	42.1	39.0	5.7	8.3	7 (15.2)
NS_3	38.2	43.8	41	30.2	35.8	33.0	7.5	8.5	8 (19.31)
NS_4	35.6	42.4	39	31.6	34.4	33.0	5.4	6.6	6 (15.4)
NS_5	37.2	38.8	38	29.3	39.5	34.0	3.3	4.7	4 (10.52)
LSD (0.05)	6.21	10.46	9.63	3.68	4.11	3.21	1.4	2.1	2.66
Cultivar									
Hybrid	46.4	49.6	48	38.5	45.5	42.0	4.7	7.3	6 (12.5)
Lokoja local	18.6	23.4	21	17.1	20.9	19.0	2.2	1.8	2 (9.5)
LSD (0.05)	9.63	6.81	12.46	6.43	6.81	4.89	1.36	3.21	2.11
Interaction NS VS Cult	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS1 = No Nitrogen source (control), NS2 = NPK Fertilizer applied into soil alone = 80kg NPK & B, NS3 = NPK & B at 50% (40kg N) + Agric Zyme 50% (40 kg N), NS4 = NPK & B at 75% (60kg N) + Agric Zyme at 25% (20kg N) and NS5 = NPK & B at 25% (20kg N) + Agric Zyme at (60kg N). NS=Nutrient sources, Cult= cultivar and ns = non-significant.

Table 4: Effect of combined application of agric zyme and NPK&B on yield of cotton

Treatment	Cotton yield per plant (kg)			Cotton lintyield (t/ha)		
	2020	2021	Mean	2020	2021	Mean
Nutrient Source						
NS_1	0.24	0.28	0.26	2.90	3.34	3.12
NS_2	0.47	0.51	0.49	5.81	5.95	5.88
NS_3	0.38	0.40	0.38	4.32	4.80	4.56
NS_4	0.34	0.44	0.39	4.56	4.80	4.68
NS_5	0.40	0.44	0.42	3.99	6.09	5.04
LSD (0.05)	0.09	0.13	0.10	1.13	1.75	1.74
Cultivar						
Hybrid	0.51	0.55	0.53	0.68	0.76	0.72
Lokoja	0.29	0.33	0.31	0.36	0.56	0.46
LSD (0.05)	0.12	0.16	0.14	0.20	0.14	0.21
Interaction NS VS Cult	NS	NS	NS	NS	NS	NS

NS1 = No Nitrogen source (control), NS2 = NPK Fertilizer applied into soil alone = 80kg NPK & B, NS3 = NPK & B at 50% (40kg N) + Agric Zyme 50% (40 kg N), NS4 = NPK & B at 75% (60kg N) + Agric Zyme at 25% (20kg N) and NS5 = NPK & B at 25% (20kg N) + Agric Zyme at (60kg N). NS=Nutrient sources, Cult= cultivar and ns = non-significant.

Discussion

All plots with NPK&B and agric zyme produced better growth and yield characters than the control. The work was in line with Karion and Venugopalan (1999) who attributed the better performance of the treated plots to balanced application of nutrients (NPK). This could responsible for the better growth and yield recorded in the plots with NPK&B either applied solely or

combined with agric zyme. Cotton grows with hybrid seeds recorded better growth characters than the Lokoja local seeds used. Afe *et al.* (2020) worked on growth and Yield of Sesame as Influenced by combinations of varying levels of nitrogen and foliar fertilizers; they concluded that the performance of any seed is directly related to the genetic composition of the cultivar used. The difference in growth and yield characters observed among the cultivar used could be attributed to the differences in genetic makeup of the cultivar used.

All plots with amendment either NPK&B alone or in combinations with agric zyme produce similar growth characters. These indicated that half of soil applied NPK fertilizer such as NPK 15:15:15 could be applied into the soil and consequently augment the remaining nutrient with foliar fertilizer. This would go a long way in reducing the high cost of buy soil applied fertilizer, since small quantity of foliar fertilizer contain high concentration of the needed N,P and K.

Cotton with fertilizer application either singly or combined produced higher number of flowers and cotton ball compared to the control. This is expected, because there was adequate nutrient supply due to the fertilizer applied. The result suggested that cotton plants respond to applied fertilizer. This result is in line with the work of Ahmad *et al.* (2019). They reported that adequate diverse nutrients are necessary for ensuring reasonable cotton plant growth and development. Nasim *et al.* (2011) opined that nitrogen (N), phosphorus (P) and potassium (K) are considered the three main nutrients to improve cotton production. Both soil applied NPK&B and agric zyme supplied this major nutrients. Hence, better performance of the treated plots.

Cotton grows through hybrid seeds gave more flowers and cotton balls more than Lokoja local seeds used. The observed situation could be due to differences in their nutrient use efficiency. Nutrient use efficiency of hybrid seeds was greater and better than the Lokoja local seed used.

Cotton with fertilizer application were susceptible to pest attacked compared to cotton grow in the control plots. The susceptibility of plots with amendment could be due to high nitrogen content of the applied fertilizer. Steenkamp and Jansen (1998) reported that high level of nitrogen leads to succulence in plants, making it vulnerable and susceptible to insect pest.

Cotton grows with the use of hybrid seed gave higher number of aborted flowers than the Lokoja local seed used. This could be due to low adaptability of hybrid seed to the environment which resulted in low resistance of hybrid seeds to insect attack in the new environment. Lokoja local seed is well adapted to experimental area since farmer grows every year and seem to develop resistance to insect pest attack common in the area. This could be the reason why Lokoja local seeds recorded less percentage in abortion of it flowers and cotton ball.

CONCLUSION

It is concluded that the nutrients applied had significant influence on the growth and lint yield of cotton. Though, cotton plant grown with NPK&B at 80 kg /ha gave the highest yield of cotton. All other plots with combined application of NPK&B and Agric Zyme irrespective of rate of combinations produced yield comparable to plots with NPK&B at 80 kg /ha. Among cotton with combined application of NPK&B and Agric Zyme, cotton treated with NPK & B at 25% (20kg N) + Agric Zyme at 75% (60kg N) gave the greatest cotton lint yield.

Cotton with hybrid seed produced cotton lint higher than the Lokoja local seed. The increment in hybrid cotton yield over Lokoja local seed is 58.52%. Cotton farmers in the study area should grow hybrid cotton using any of the treatment combination especially NPK & B at 25% (20kg N) + Agric Zyme at 75% (60kg N).

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