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(Research Article)

Effect of nitrogen and weeding regimes on yield and yield components of maize (*Zea mays L.)* in the derived guinea savanna Agro-ecological zone of Nigeria

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Abstract

In the 2017 and 2018 wet seasons, field trials were conducted at the Teaching and Research Farm of the Faculty of Agriculture, Kogi State University, Anyigba to determine the effect of nitrogen and weeding regime (period of weed interference) on the yield and yield components of maize. The experimental design used was a split-plot in a randomized complete block design replicated three times. The main plot was assigned to four different levels of nitrogen 0, 40, 80 and 120 kg N/ha while the sub-plot was assigned to different frequencies or regimes of weed control. The results obtained from the study revealed that the application of 120 kg N/ha produced the highest cob weight, 100-seed weight and grain yield per hectare in both years. The study also showed that all the rates of nitrogen application resulted into increased grain yield in comparison to where there was no nitrogen application. Maize plant kept weed-free for 9 and 12 weeks after planting (WAP) and those weed infested for 3 WAP produced cob dry weight, 100-seed weight and grain yield (kg/ha) comparable to those kept weed-free throughout. From the two-year study conducted, it was found out that keeping the field weed-free for only 3WAP did not provide a satisfactory weed control situation for optimum crop performance owing to imminent re-infestation. Conversely, plants weed infested for 3WAP could ward off whatever damage that might have been inflicted initially through subsequent re-growth which could translate into impressive yield as observed in this study.

Keywords: Nitrogen; Weeding-regime; Yield; Agro-ecological; Tasseling

1. Introduction

Maize (*Zea mays L.*) is a staple food and source of raw material for industries and is fast replacing other cereals such as millet, guinea corn and rice in Nigeria. It is a major cereal crop third in world production after wheat and rice (1). Maize is grown extensively in the northern guinea savanna that offers greater yield potentials than the forest agro-ecological zone owing to availability of abundance sunshine, low incidence of pest and disease invasion and dry weather conditions at the end of the crops growth life cycle [1]. Among the factors constraining the production of maize in the tropics are inadequate supply of nutrients in the soil most especially nitrogen and intense competition with weeds. At the early stage of crop growth and development, the weed and rice plant requirements for nutrients are met but as growth advances for the two plant species, the nutrient supply normally falls short of the combining demands leading to competition [2]. In Nigeria weed losses of up to 80% in the potential growth yield in maize have been attributed to unchecked weed growth throughout the crop's life cycle (3). Maize is highly susceptible to weed competition particularly at the early stage of growth. In Nigeria, yield losses as high as 51 to 100% have been recorded in maize due to weed competition [4]. According to Rao and Kang [5], high cost of inputs such as fertilizer, improved seeds were of no use if not accompanied with efficient weed control. Therefore, the study was conducted to examine the influence of nitrogen and period of weed interference in the production of maize in the derived guinea savanna zone.

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2. Material and methods

The experiments were carried out during the rainy seasons of 2017 and 2018 at the Students' Teaching and Research Farm, Faculty of Agriculture, Kogi State University, Anyigba.

In each year, the experimental field was ploughed and harrowed after which it was marked out. Each plot size measured 3m x 4m and was separated from the other by a 0.5m pathway. The experiment was arranged as a split-plot using a randomized complete block design (RCBD) replicated three times. The main treatment consisted of four levels of nitrogen, 0. 40, 80, and 120 kg N/ha and the sub-plot treatments comprised ten periods of weed interference treatments. In each of the years, the weed interference treatments consisted of weed free for 3, 6, 9, 12 and till harvest on one hand and weed infested for the same periods and till harvest on the other.

Appropriate nitrogen fertilizer was applied using urea at four rates of 0, 40, 80 and 120 kg N/ha two weeks after planting (WAP). This was mixed with 30kg/ha each of K_2O and P_2O_5 using muriate of potash and single superphosphate to supply the needed potassium and phosphorus respectively. Maize variety used in this study was TZE composite 3C, which is late maturing. The maize variety used planted at an intra and inter spacing s of 25cm and 75cm respectively giving a total population of 53,333 plants per hectare. Data collected on days to 50% tasseling, stem girth, cob diameter, cob length, number of cobs/plant, 100- seed weight and grain yield/ha were subjected to analysis of variance (ANOVA) as described by Snedecor and Cochran [6]. Significant differences between treatment means were compared by the use of Fisher's Least significant difference (F-LSD) at 5% level of probability.

3. Results

Table 1 Common weeds at the experimental site before the trial in 2017 cropping season in Anyigba, Nigeria

Type of weed	Species	Relative abundance
Grasses	*Panicum maximum*	xxx
	Axonoopuscompressus	xx
	Eragrostistremula	x
	Andropogongayanus	xxx
	Brachariadeflexa	xx
	Cenchrus biflorus	xx
	Chlorispilosa	xxx
	Digitariahorozontalis	x
	Eleucineindica	xxx
	Heterepogoncontortus	x
Broadleaf	*Ageratum conyzoides*	xxx
	Euphorbia hirta	xx
	Sidaacuta	xxx
	Boehaviadiffusa	xx
	Mitrocarpusvillosus	x
	Urena lobata	x
Sedges	*Cyperus esculentus*	xx
	Cyperusrotundus	xx
	Mariscusalternifolius	xxx

x = low density; xx = medium density; xxx= high density

As shown in Table 1, the dominant weed species of the experimental site were grasses. Following this were broadleaf weeds with sedges being the least. The soil of the experimental site was loamy (Table 2).

Table 2 Physical and chemical properties of soil at the experimental site at a depth of (0-15cm) Anyigba, 2017 cropping season

Components	
Sand (%)	52
Silt (%)	32
Clay (%)	16
Textural class	Loam
PH (H20)	6.62
Total N (%)	0.13
Available P (mg/kg)	46.54
Organic carbon (%)	1.13
Exchangeable cation meq/100 g) of soil	
Calcium	0.52
Potassium	1.05
Sodium	0.16

Table 3 Effect of nitrogen and weeding regime on number of days to 50% tasselling and stem girth at Anyigba during 2017 and 2018 cropping seasons

Treatments	**Number of days to 50% tasselling**			**Stem girth (cm)**		
	2017	**2018**	**Mean**	**2017**	**2018**	**Mean**
Nitrogen (kg N/ha)						
0	93	92	92.5	2.5	2.3	2.4
40	93	91	92.0	4.8	4.4	4.6
80	93	92	92.5	9.0	8.2	8.6
120	93	90	91.5	9.6	9.5	9.6
F-LSD0.05	NS	NS		0.03	0.01	
Weeding regimes (W)						
Weed infested for 3WAP	91	90	90.5	8.8	9.1	8.9
Weed infested for 6 WAP	91	90	90.5	5.2	5.0	5.1
Weed infested for 9 WAP	92	90	91.0	3.7	4.0	3.9
Weed infested for 12 WAP	92	91	91.5	2.3	2.4	2.4
Weed infested till harvest	92	92	92.0	2.0	1.9	1.9
Weed free for 3 WAP	92	93	92.5	3.6	2.8	3.2
Weed free for 6 WAP	93	93	93.0	6.5	6,8	6.7
Weed free for 9 WAP	93	92	92.5	7.9	7.0	7.5
Weed free for 12 WAP	93	91	92.0	8.2	9.3	8.8
Weed free till harvest	93	92	92.5	9.3	8.9	9.1

WAP = Weeks after planting; F-LSD0.05

The treatments applied had no significant (P>0.05) effect on the number of days to 50% tasseling. In both years, it took the plants 90-93 days to attain 50% tasseling irrespective of the weeding regimes and level of nitrogen application (Table 3). Stem girth of maize plant increased with increase in nitrogen application indicating that there was a significant effect of nitrogen on stem girth in comparison with no nitrogen control in the two years of study. Maize plant kept weed infested for 3 WAP and those kept weed free for 9 and 12 WAP had higher stem girth comparable to the maximum obtained from those kept weed till harvest. Maize plant kept weed free for 6 WAP produced similar stem girth which was significantly higher than weed infested till harvest.

Table 4 Effect of nitrogen and weeding regimes on number of cobs/plant, cob length and cob diameter at Anyigba during 2017 and 2018 cropping seasons

Treatments	**Number of Cobs/plant**			**Cob length (cm)**			**Cob diameter (mm)**		
	2017	**2018**	**Mean**	**2017**	**2018**	**Mean**	**2017**	**2018**	**Mean**
Nitrogen (kg N/ha)									
0	1	0	0.5	6.7	7.0	6.9	21.4	19.8	20.6
40	1	1	1	13.6	13.2	13.4	32.8	30.7	31.8
80	2	1	1.5	26.0	25.4	25.7	61.5	63.2	62.4
120	3	3	3	26.0	25,1	25.6	68.2	65.8	67.0
F-LSD 0.05	0.03	0.02		0.11	0.13		0.20	0.23	0.23
Weeding regimes (W)									
Weed infested for 3 WAP	3	3	3	25.8	25.3	25.6	67.3	65.6	66.5
Weed infested for 6 WAP	2	1	1.5	18.3	19.7	19.0	51.6	50.0	50.8
Weed infested for 9 WAP	1	1	1	10,2	8.9	9.6	40.4	38.6	39.5
Weed infested for 12 WAP	1	1	1	6.5	5.3	5.9	25.0	19.4	22.2
Weed infested till harvest	1	0	0.5	4.7	5.3	5.0	23.2	19.6	21.4
Weed free for 3 WAP	1	0	0.5	7.1	5.8	6.5	22.5	20.1	21.3
Weed free for 6 WAP	2	1	1.5	14.8	12.5	13.6	24.4	20.0	22.2
Weed free for 9 WAP	3	2	2.5	25.2	25.3	25.3	29.7	32.5	31.1
Weed free for 12 WAP	3	3	3	25.9	25.6	25.8	67.4	66.0	66.7
Weed free till harvest	3	3	3	25.8	25.4	25.6	66.9	65.4	66.2
F- LSD 0.05	0.02	0.04		0.33	0.42		0.43	0.46	

WAP = Weeks after planting

Number of cobs produced per plant was significantly affected by the application of nitrogen and period of weed interference (weeding regime) in all the years of study (Table 4). In the two years of study, it was observed that application of higher level of nitrogen resulted in significantly higher number of cobs per plant. The application of 120kg N/ha produced the highest number of cobs per plant. Similarly, maize plant kept weed infested initially for 3 WAP and those kept weed free for 9 and 12 WAP and till harvest produced the highest number of cobsper plant (Table 4). In both years of study, number of cobs per plant, cob length and cob diameter were significantly (P< 0.05) increased by the application of 120kg N/ha compared with no nitrogen treatment.

Application of 80kg N/ha compared favourably with nitrogen application at 120kg/ha in these parameters. Less number of cobs/ plant, shorter cob length and smaller cob diameter were obtained in plants to which 40kg N/ha was applied with the least in plots without nitrogen treatment. Plants kept weed free for 9 WAP and more and those initially weed infested for 3 WAP produced the highest number of cobs per plant. Similarly, maximum cob length was produced by plants kept weed free for 9 WAP and more as well as by those weed infested initially for 3 WAP. Plants in plots weed infested for 3 WAP and those kept weed free for 12 WAP and till harvest produced the largest cob diameter.

There were significant effects of nitrogen application on cob dry weight, 100-seed weight and grain yield per hectare of maize in the two years of study (Table 5). Application of all levels of nitrogen in 2017 and 2018 cropping seasons resulted in significantly ($P < 0.05$) higher cob weight, 100 - seed weight and grain yield than 0 kg N/ha. Highest cob weight, 100 –seed weight and grain yield were all obtained from maize plants that received 120kg N/ha in both years. In a similar vein, maize plants kept weed free for 9 and 12 WAP and those weed infested for 3 WAP produced cob dry weight, 100- seed weight and grain yield comparable to those plants in plots kept weed free throughout the entire life cycle of the plants. Plants kept weed infested all through their life cycle and those that did not receive fertilizer treatments recorded the least of all the parameters measured. Leaving the crop plants unweeded throughout the duration on the field reduced maize grain yield by 90% and 95% in 2017 and 2018 respectively compared with those of the crops kept weed free throughout their life cycle. There was significant interaction of nitrogen fertilizer application and period of weed interference (weeding regime) on maize grain yield. Maximum grain yield was obtained in plots to which crops were kept weed free till harvest and supplied 120kg N/ha (Table 6).

In the two years of study, it was realized that crops infested with weeds initially for 3 WAP and those kept weed free initially for 6, 9 and 12 WAP and given 120kg N/ha as well as those kept weed free till harvest and given 80kg N/ha produced comparable grain yield to the maximum which was obtained from crops subjected to weed free treatment till harvest and supplied with 120kg N/ha. The application of 120kg N/ha brought about a significant increase in grain yield in comparison to the lower levels and treatments with no nitrogen application as well as in plots weed infested for 9 and 12 WAP and till harvest.

Table 5 Effect of nitrogen and weeding regimes on cob dry weight, 100-seed weight and grain yield at Anyigba during 2017 and 2018 cropping seasons

Treatments	**Cob dry weight (g)**			**100 seed weight (g)**			**Grain yield (kg/ha)**		
	2017	**2018**	**Mean**	**2017**	**2018**	**Mean**	**2017**	**2018**	**Mean**
Nitrogen (kg N/ha)									
0	18.9	20.2	19.6	5.3	5.1	5.2	634.8	591.2	613.0
40	37.8	40.0	38.9	11.5	10.2	10.9	1028.3	995.3	1011.8
80	89.6	87.8	88.7	18.7	18.0	18.4	1793.5	1862.9	1828.2
120	98.2	97.5	97.9	23.4	21.8	22.6	2346.3	2321.6	2333.9
F-LSD 0.05	0.53	0.51		0.10	0.13		108.8	106.5	
Weeding regimes (W)									
Weed infested for 3 WAP	96.2	95.4	95.8	22.6	21.0	21.8	2281.0	2194.3	2237.7
Weed infested for 6 WAP	80.5	78.3	79.4	17.3	18.6	17.9	1139.7	1118.9	1129.3
Weed infested for 9 WAP	57.3	55.7	56.5	10.1	12.4	11.3	528.3	502.9	515.6
Weed infested for 12 WAP	29.1	25.7	27.4	5.6	5.0	5.3	270.6	280.3	275.5
Weed infested till harvest	21.4	21.1	21.3	5.4	5.2	5.3	272.2	280.5	276.4
Weed free for 3 WAP	19.4	19.2	19.3	6.3	5.5	5.9	297.5	283.5	290.5
Weed free for 6 WAP	49.7	47.5	48.6	11.0	11.9	11.5	1601.3	1328.3	1464.8
Weed free for 9 WAP	86.9	89.7	88.3	19.3	17.7	18.5	2098.5	1996.8	2047.7
Weed free for 12 WAP	99.2	98.6	98.9	22.2	23.0	22.6	2365.6	2286.4	2326.0
Weed free till harvest	98.6	98.3	98.5	22.2	22.5	22.4	2371.4	2290.7	2331.1
F-LSD 0.05	2.3	2.5		0.23	0.19		116.5	115.9	

WAP =Weeks after planting

Table 6 Interaction of nitrogen fertilizer and weeding regimes on grain yield of maize at Anyigba in 2017 cropping season.

Weeding regimes	**Grain yield (kg/ha)**			
	0	**40**	**80**	**120**
Weed infested for 3 WAP	672	930	1608	2021
Weed infested for 6 WAP	584	806	1376	1906
Weed infested for 9 WAP	379	623	1053	1735
Weed infested for 12 WAP	280	458	979	1013
Weed infested till harvest	217	309	720	819
Weed free for 3 WAP	214	420	856	1472
Weed free for 6 WAP	252	698	1371	1864
Weed free for 9 WAP	557	993	1493	1983
Weed free for 12 WAP	681	1187	1778	2418
Weed free till harvest	678	1204	1929	2436
F-LSD (0.05)	61.4	93.2	116.9	118.2

WAP =Weeks after planting

4. Discussion

The two years of study revealed that the application of nitrogen and period of weed interference (weeding regime) had no significant effect on number of days to 50%. tasseling. This could be attributed to the use of a as single variety with the same genetic constitution. This corroborates the findings of Maduka [7] who observed a non-significant difference in number of days to 50% flowering and height of soybean (var TGX 1440-IE) on the basis of the same genetic make-up. It was also observed in this study that the application of nitrogen significantly increased stem girth, number of cobs/plants, cob length and cob diameter. In both years, number of cobs/plants, cob length and cob diameter increased significantly ($p<0.05$) with nitrogen application especially at 80 and 120kg N/ha. This shows the responsiveness of maize to nitrogen application especially when present at low rate as well as under conditions of adequate weed control situations. Fagade [8] reported similar incidence in rice production. Cob dry weight and 100- seed weight were increased by nitrogen application throughout the two years of study. This is due to the fact that nitrogen enhances the photosynthetic capacity of plants as earlier reported by Arbon [9]. The consistent increase in grain yield of maize following the application of nitrogen clearly demonstrated the vital role played by nitrogen in enhancing good yield as observed in the two years of study. It was observed that the grain yield of maize increased significantly ($p<0.05$) with increase in nitrogen application. This affirms the earlier reports by Adejo [10] who attributed the impressive grain yield to profound influence of nitrogen on the yield components such as stem girth, cob length, cob weight and 100-seed weight. Infestation of weeds throughout the crop life cycle resulted into a severely depressed grain yield of maize by 92 and 95% respectively in 2017 and 2018. Yield reduction of similar proportion was also reported in maize [11]. As observed in this study, weed interference for initial 3 WAS had no significant effect on stem girth, number of cobs/plants, cob length, cob diameter and grain yield. It was shown in the two years of study that the grain yield of plants in plots weed infested for 3 WAP did not differ significantly as it compared favorably with the maximum obtained from plants kept weed free for 12WAP and till harvest. This could be attributed to the fact that weed interference for the first three weeks of plant life could not exert adverse effect on crop growth and development. This result corroborates the earlier finding of Adebayo [12] who reported that weed infestation for 21 days after sprouting of maize did not affect maize grain yield adversely.

In this study maximum grain yield of maize was obtained from plants in plots kept weed free for 12 weeks as well as those in weed free plots till harvest. However, those kept weed free for 9 WAP produced grain yield comparable to the maximum. This shows that the critical period of weed interference in maize is between 3 and 6 weeks of growth. This result affirms the earlier report of Lawson [13] who reported that maize plant requires weed free periods of 45 days after emergence for optimum grain yield. As observed in most crop plants, weed infestation at the initial stage of crop growth and development leaves a most devastating effect on the overall yield output of that crop. This is the period referred to as the critical period of weed interference by Nieto *et al.* [14]. This is the period during which uncontrolled weeds cause the greatest yield depression as the damage inflicted at this period cannot be reversed. From this study, it was revealed that the highest grain yield was obtained from maize plants supplied with 120kgN/ha and kept weed free till harvest. The least grain yield came from maize plants in plots without nitrogen treatment in addition to those weeds infested till harvest. In fact, the grain yield decreased sharply with plants initially weed infested for 6 WAP and correspondingly decreased further with the least arising from plants subjected to weed infestation all through the life cycle of the plant. This is in agreement with the finding of Fadumila [15] who stated that nitrogen utilization in maize was 22% where weed was present and 95.8% in a weed free situation.

5. Conclusion

Since grain yield is in most cases the ultimate in maize production, particular attention should be paid to the use of 120 kg/ha of nitrogen as optimum grain yield was obtained therefrom in this study. In addition, weeding of maize farm should not be delayed beyond three (3) months for impressive grain yield.

Compliance with ethical standards

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Disclosure of conflict of interest

This trial is completely devoid of conflict of interest.

References

[1] Kowal J, Kassan AH, Dagg M, Harrison MN. Maize in West Africa and its potential in savanna areas-World Crops.1975; 27(2): 73 – 78.

[2] Musa BJ and Timbale FT (2013). Crop – weed competition in maize. International Maize Research Newsletters.2013; 8(2): 24.

[3] Lagoke STO. Methods of control of speargrass (*Imperatacylindrica* L. Beaux) in maize unpublished Ph. D Thesis. Department of Agronomy, University of Ibadan. 1978; 410p

[4] Akobundu IO and Ekeleme F. Effect of method of *Imperatacylindrica* management on maize grain yield in the derived savanna of south western Nigeria. Journal of Weed Science, 2000; 13:22-28.

[5] Rao FB and Kang CS (2010). Weed and weed management in maize. Adv. Agronomy 22.2010; 108-116

[6] Snedecor GW and Cochran WG. Statistical Methods 6th Edition, Iowa State University Press, Ames, USA.2010; 456.

[7] Maduka LB. Weed control in soybean in the Tropics. In: Singh SR, Rachie KO and Dashiell KE (eds). Soybean for the tropics. Research production and utilization. John Wiley and Sons. 2014; 70-78.

[8] Fagade SO. Effects of nitrogen application and weeding on the yield of upland rice. Int. Rice Comm. Newsletter 1976; 25: 15-16.

[9] Arbon SK. The discovery of photosynthetic phosphorylation: Trends in Biochemical Sciences.2009; 7:251-265.

[10] Adejo FB. Effect of nitrogen and potassic fertilizers on the yield and yield components of maize. In: Proceedings of Yield Research.1994; 48-66.

[11] Drapper LS. Manual of weed control Research Publications on Cereals. Dohal.2007; 302.

[12] Adebayo CS. Critical period of weed interference in maize intercropped with egusi melon (*Colocynthiscitrullus*). Weed Research.1999; 14: 28-36

[13] Lawson JK. Weeds in Tropical Crops: Review of Abstracts on constraints in production caused by weeds in maize, rice, sorghum, millet, groundnut and cassava. FAO. Plant production and protection. Paper 2000; 31 (1):100-121.

[14] Nieto AJ, Borondo MA and Gonzalez TJ. Critical periods of the crop growth cycle for competition from weeds PANS © 1968; 14: 159 -166.

[15] Fadumila MS. Effects of period of weed interference and season long weed control in maize (*Zea mays* L). Field Crops Research, 1972; 36: 400-430.