

NITROGEN AND WEED STRESS DYNAMICS ON YIELD OF MAIZE (*Zea mays* L.) IN SUDAN SAVANNA REGION OF NIGERIA

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ABSTRACT

Field trials were conducted during 2018 to 2020 rainy seasons at Audu Bako College of Agriculture Dambatta (ABCOAD) Teaching and Research Farm (12.8°–12.15° N, 8.12°–8.20° E) in Kano State, Nigeria. The study aimed to determine the effects of nitrogen (N) fertilizer rates, periods of weed interference, and timing of N application on maize yield using the improved EV99DT-W STR maize variety. The experiment involved 96 treatments arranged in a randomized split-split plot design with three replications. Four nitrogen levels (0, 60, 120, and 180 kg N ha⁻¹ rates), six periods of weed interference (weed-free at 6 WAS, weed-free at 8 WAS, weed-free at harvest), (weed-infested up to 6 WAS, weed-infested up to 8 WAS, weed-infested up to harvest) and four (T₁–T₄) N application schedules (T₁= 0 rate at Sowing + full rate at 4 WAS, T₂= 1/4 rate at 2 WAS + 3/4 rates at 6 WAS, T₃= 0 rate at Sowing + full rate at 6 WAS, T₄= 1/4 N rate at 2 WAS + 2/4 N rates at 6 WAS + 1/4 N rate at 8 WAS) were tested. Data were collected on yield indices such as grains weight cob⁻¹ (g) plant⁻¹ and grain yield kg ha⁻¹. Major weed species observed included *Cynodon dactylon*, *Digitaria marginata*, *Dinebra retroflexa*, *Cyperus rotundus*, *Ageratum conyzoides*, and *Digera arvensis*. Results showed that, the highest maize yield and favorable weed control were achieved with (T₄) - N applied in three splits: 1/4 rate at 2 WAS, 1/2 rate at 6 WAS, and 1/4 rate at 8 WAS. The interaction between weed-free conditions at harvest or at 8 WAS and T₄N application significantly improved maize yield indices across all the seasons followed by 120 kg N ha⁻¹ in three split doses. According to this finding, 180 kg N ha⁻¹ rate is recommended based on the most efficient and cost-effective nitrogen management strategy for sustainable maize production in the study area.

Keywords: *Periods of weed interference, main plot, split-split-plot, weed infested plot, sub-sub-plots, grain yield.*

INTRODUCTION

Maize (*Zea mays*) is one of the main and popular cereal crops due to its high value as stable food as well as its Stover demand for animal feed, fuel and even for construction purposes (Abebe, Dabala and Birhanu, 2016). FAO, (2020) stated that, maize has experienced an increase in output and yield overtime due to extension of cultivated land but this increased in production from 1720 metric tons to 11000 metric tons within 1980 to 2019 was inadequate, the increase in production output in Nigeria is still below average world requirement of 4.3 tons / ha.

Nitrogen is a vital element for plant growth, essential to the development and productivity of maize (Dobermann *et al.*, 2022). Abbas *et al.*, (2020) reported that, for the best possible growth of maize, there must be an adequate supply of nitrogen available during the whole growing season. Hammad *et al.*, (2022) reported that, timely nitrogen application improves nitrogen uptake and maintains soil health.

Weed stress on maize crop has focused on the phenomenon of competition (i.e., the existence of the competition in various conditions). Weed management plays a critical role in ensuring sustainable agriculture by effectively addressing resource competition and enhancing crop nutrition and yield quality (Ahmad *et al.*, 2020). Conversely, inadequate weed management strategies coupled with nutrient insufficiency have been shown to result in substantial annual yield losses, with potentially long-term impact on agricultural productivity (Wang *et al.*, 2019).

PROBLEM STATEMENT

Maize production is ascending in the savanna ecology of Nigeria and gradually replacing sorghum in many areas of the ecology due to its high yielding ability in contrast to the lower yield of sorghum per unit area. In spite of the increase in land area under maize production, yield is still low. Some of the major causes of low maize yields are: - maize susceptibility to weed interference and inadequate nitrogen supply among others (Olson *et al.*, 2004).

JUSTIFICATION OF THE STUDY

It has been reported that, effective and timely weed control is one of the major critical components of successful maize production (Lucier and Plummer, 2003). Tobert *et al.* (2001) reported that, timely N application to coincide with the need of the crop during its growth cycle is inevitable. This study was therefore, designed to evaluate the maize reactions to nitrogen rates, periods of N applications and weed stress in the Sudan Savanna region of Nigeria.

OBJECTIVES

The specific objectives of this study were to:-

1. Determine the effect of nitrogen rates on yield of maize in the study area.
2. Determine the effect of nitrogen application periods on yield of maize in the study area.
3. Determine the effect of weed stress on yield of maize in the study area.

MATERIALS AND METHODS

Field trials were conducted during 2018 - 2020 rainy seasons at Audu Bako College of Agriculture, Dambatta (ABCOAD) Teaching and Research Farm (12.8 and 12.15 N of latitude and longitude 8.12 and 8.20 E) and 460 m above sea level in the northern part of Kano city in Makoda Local Government Area, Kano within the Sudan savanna zone of Nigeria.

Climatic and Edaphic Records of the Experimental Sites

The average mean annual rainfall of the sites during 2018, 2019 and 2020 rainy seasons were (722.0 mm, 1033.0 mm, 1186.0 mm), mean daily minimum and maximum temperature were [(25.25, 34.58°C), (24.60, 32.02°C) and (24.17, 31.45°C)]. Soil textural classes were sandy loam of pH (5.43, 6.00 and 6.00), organic matter and total nitrogen contents (2.80, 2.93, 2.96 g kg⁻¹) and (0.98, 1.10, 1.20).

TREATMENTS AND EXPERIMENTAL DESIGN

The field trials consisted of 96 treatments from the factorial combinations of 4 nitrogen rates{(N₁= application of 0 kg N ha⁻¹, N₂= 60 kg N ha⁻¹, N₃= 120 kg N ha⁻¹ and N₄= 180 kg N ha⁻¹), periods of weed interference (W₁=weed free at 6 WAS, W₂=weed free at 8 WAS, W₃= weed free at harvest, W₄= weed infested up to 6 WAS, W₅= weed infested up to 8 WAS, W₆= weed infested up to harvest and periods for N application (PNA₁ - PNA₄) on a variety of maize. Factorial combinations of these treatments were laid out in a randomized split-split-plot design with three replications. The main plots consisted of N fertilizer at four rates (0, 60, 120 and 180 rates kg ha⁻¹), sub-plots were six periods of weed interference (weed free at 6 WAS, at 8 WAS and weed free at harvest, weed infested up to 6 WAS, up to 8 WAS, Weed infested up to harvest) and sub-sub-plots were four times for N application (T₁= Application of (0 rate) at Sowing + (full rate) at 4 WAS, T₂= Application of (1/4 rate) at 2 WAS + (3/4 rates) at 6 WAS, T₃= Application of (0 rate) at Sowing + (full rate) at 6 WAS and T₄= Application of (1/4 rate) at 2 WAS + (2/4 rates) at 6 + (1/4 rate) at 8 WAS). Each sub-sub-plot consisted of 6 ridges × 0.75 m × 3 m long. Alleys of 0.5 m were left within the sub-sub plots, 1 m between main plots, sub-plots and replications. Net plot was made up of 2 innermost ridges × 0.75 m × 3 m.

DATA COLLECTION

Data were collected on grains weight cob⁻¹ (g) plant⁻¹ and grain yield kg ha⁻¹.

STATISTICAL ANALYSIS OF DATA

The data collected on yield characters were subjected to analysis of variance (ANOVA) with the help of GenStat 17th edition for split-split-plot design to test the significance effects of the treatments and SNK (Student-Newman-Keuls Test) was used to separate treatments means where 'F' test showed significance difference between the treatments as described by Snedecor and Cochran (1967).

RESULTS AND DISCUSSIONS

Grains weight cob⁻¹ (g) plant⁻¹.

Effect of nitrogen rates (kg ha⁻¹) was found to recorded significant differences on grains weight cob⁻¹ (g) plant⁻¹ on maize crop during all the seasons. The highest significant effect at $P \leq 0.001$ levels were observed with means values (122.1, 199.5 and 151.0) on grains weight cob⁻¹(g) with the application of 180 kg N ha⁻¹ among rest of the treatments in all the seasons. Simultaneously, the lowest significant means values of (88.70, 85.1 and 110.2) on grains weight cob⁻¹ (g) was recorded with the application 0 kg N ha⁻¹ during 2018 - 2020 rainyseasons respectively. This is similar to Abebe *et al.*, (2016) findings who reported that, nitrogen fertilizer is one of the most important nutrients that determine maize yield per hectare. It is also in agreement with Ibrahim, *et al.*, (2022) who stated that, cob length increased with increasing rates of N fertilizer applied, the longest cobs were observed with 120 kg N ha⁻¹ while the least (9.30 cm) was with control treatment, They further said that, application rate of 120 kg N ha⁻¹ significantly enhanced grain yield, number of grains per cob, weight of grains per cob, and grain yield per hectare.

Periods of weed interference had significantly affected grains weight cob^{-1} (g) of maize crop at $P \leq 0.001$ levels. The highest significantly recorded means values of (141.5, 145.5 and 175.9) on grains weight cob^{-1} (g) were observed from WF @ harvest in all the seasons. Nevertheless, WIF up to harvest significantly recorded the lowest means values (65.7, 69.7 and 83.3) on grain weight cob^{-1} (g) in all the seasons respectively.

Significant differences were observed by periods of N applications on grains weight cob^{-1} (g) at $P \leq 0.001$ levels. The effect of N applications revealed that, $T_4 = \text{PNA (2 WAS + 6 WAS + 8 WAS)}$ and $T_2 = \text{PNA (2 WAS + 6 WAS)}$ treatments were statistically at par and significantly obtained the highest means values of (105.1, 110.1, 135.1) and (104.9, 109.9, 135.9) compared to $T_3 = \text{PNA (0 WAS + 6 WAS)}$ and $T_1 = \text{PNA (0 WAS + 4 WAS)}$ being statistically at par and significantly obtained the lowest means values of (98.3, 103.3, 126.8) and (99.1, 104.1, 127.7) respectively. This is supported by De Datta and Baltazar, (1996) who reported that, weeds usually grow faster than the crop plants and absorb added nutrient more rapidly and in larger quantities than by crops and thus deprive the supply of nutrients in time to the crop plants. Also Chauhan and Johnson (2010) stated that when maize crop grown together with either *Cyperus rotundus* or *Digitaria* spp, shoot competition reduced the growth and yield of maize more than root competition and maize grain yield was highly correlated with above and below ground biomass of the weeds (Table 1).

Effects of interaction were found to be significant on grains weight cob^{-1} (g) with PWI
* PNA in only 2019 and 2020 seasons respectively (Table 2).

Table 1: Grains weight cob^{-1} (g) plant^{-1} of maize crop as influenced by nitrogen rates (kg ha^{-1}), periods of weed interference and periods of N applications during 2018, 2019 and 2020 rainy seasons at ABCOAT Teaching and Research Farm

Treatments	Grains weight cob^{-1}		
	2018	2019	2020
<u>Nitrogen rates (Kg ha^{-1})</u>			
0 kg ha^{-1}	88.70d	85.1d	110.2d
60 kg N ha^{-1}	100.60c	97.70c	124.8c
120 kg N ha^{-1}	111.9b	99.30b	138.6b
180 kg N ha^{-1}	122.1a	199.5a	151.0a
S.E.±	0.615	0.615	0.751
Significance	<.001	<.001	<.001
<u>Periods of Weed interference (PWI)</u>			
$W_1 = \text{WF @ 6 WAS}$	118.5c	122.5c	147.8c
$W_2 = \text{WF @ 8 WAS}$	129.7b	133.7b	161.4b
$W_3 = \text{WF @ harvest}$	141.5a	145.5a	175.9a
$W_4 = \text{WIF up to 6 WAS}$	88.0d	92.0d	110.6d
$W_5 = \text{WIF up to 8 WAS}$	85.8d	89.8d	107.9d
$W_6 = \text{WIF up to harvest}$	65.7e	69.7e	83.3e
S.E.±	1.038	1.038	1.267
Significance	<.001	<.001	<.001
<u>Periods of N applications</u>			
$T_1 = \text{PNA (0 WAS + 4 WAS)}$	99.1b	104.1b	127.7b
$T_2 = \text{PNA (2 WAS + 6 WAS)}$	104.9a	109.9a	135.9a
$T_3 = \text{PNA (0 WAS + 6 WAS)}$	98.3b	103.3b	126.8b
$T_4 = \text{PNA (2 WAS + 6 WAS + 8 WAS)}$	105.1a	110.1a	135.1a
S.E.±	0.527	0.613	0.841
Significance	<.001	<.001	<.001
<u>Interactions</u>			
NR * PNA	0.293	0.241	0.232
PWI * PNA	0.041	<.002	<.001
NR * PWI * PNA	0.461	0.532	0.481

Means in a column of any set of treatments followed by same letter (s) are not significantly different at $P \leq 0.05$ using Student Newman Keuls test, WF = weed free, WIF = weed infested plot, WAS = weeks after sowing, PNA = periods of nitrogen applications, NR = nitrogen rate, WIF = weed infested plot, $T_4 = (\frac{1}{4} \text{ N rate})$ at 2 WAS + ($\frac{2}{4} \text{ N rates}$) at 6 + ($\frac{1}{4} \text{ N rate}$) at 8 WAS, ABCOAD = Audu Bako Col. Of Agric. Dambatta

Interaction effects between periods of weed interference and periods of nitrogen applications on grains weight cob^{-1} (g) per plant during 2019 and 2020 rainyseasons

According to table 3, significant interaction effects between periods of weed interference and periods of nitrogen applications on grains weight cob^{-1} (g) per plant during 2019 rainyseason recorded the highest significant mean value of (181.3) between WF @ harvest combined with PNA_4 period of nitrogen application though being statistically similar with mean value of (183.7) between WF @ harvest combined with PNA_2 period of nitrogen application followed by PNA_1 and PNA_3 periods of N applications being statistically at par to each other treatments whereas the lowest significant interaction means values were statistically similar to each other (86.5, 77.5, 79.4, 79.4) on grains weight cob^{-1} (g) per plant between WIF up to harvest combined across PNA_1 to PNA_4 periods of N applications respectively, the data recorded in table 2 during 2020 rainyseason have followed the same trend with that of 2019 rainyseason accordingly.

Table 2: Interaction effects between periods of weed interference and periods of nitrogen applications on grains weight cob^{-1} (g) per plant during 2019 and 2020 rainy seasons at ABCOAD Teaching and Research farm

Treatments		Periods of nitrogen applications (PNA)			
	Periods of weed interference (PWI)	$T_1 = \text{PNA}_1$	$T_2 = \text{PNA}_2$	$T_3 = \text{PNA}_3$	$T_4 = \text{PNA}_4$
<u>Experimental seasons</u>					
Year 2019	$W_1 = \text{WF @ 6 WAS}$	141.0e	147.9d	141.0e	148.3d
	$W_2 = \text{WF @ 8 WAS}$	153.7cd	160.7b	154.9c	163.3b
	$W_3 = \text{WF @ harvest}$	161.8b	183.7a	163.0b	181.3a
	$W_4 = \text{WIF up to 6 WAS}$	103.4gh	111.5f	104.2gh	111.6f
	$W_5 = \text{WIF up to 8 WAS}$	101.9h	107.5fgh	102.2h	108.4fg
	$W_6 = \text{WIF up to harvest}$	86.5i	79.4j	77.5j	79.4j
S.E.±			3.091		
Year 2020	$W_1 = \text{WF @ 6 WAS}$	142.2e	149.2d	142.2e	149.6d
	$W_2 = \text{WF @ 8 WAS}$	154.9cd	162.0b	156.2c	164.6b
	$W_3 = \text{WF @ harvest}$	163.1b	185.2a	164.3b	182.8a
	$W_4 = \text{WIF up to 6 WAS}$	104.2gh	112.5f	105.0gh	112.5f
	$W_5 = \text{WIF up to 8 WAS}$	102.8h	108.4fgh	103.0h	109.3fg
	$W_6 = \text{WIF up to harvest}$	87.2i	80.0j	78.1j	80.0j
S.E.±			3.117		

Means in a column of any set of treatments followed by same letter (s) are not significantly different at $P \leq 0.05$ using Student Newman Keuls test, WF = weed free, WIF = weed infested plot, WAS = weeks after sowing, PNA = periods of nitrogen applications, NR = nitrogen rate, WIF = weed infested plot, $T_4 = (\frac{1}{4} \text{ N rate})$ at 2 WAS + ($\frac{2}{4} \text{ N rates}$) at 6 + ($\frac{1}{4} \text{ N rate}$) at 8 WAS, ABCOAD = Audu Bako Col. Of Agric. Dambatta

Grain yield kg ha^{-1} of maize crop

Table 3: Grain yields kg ha^{-1} recorded significantly lowest means values from 0 kgN ha^{-1} with means values of (1637, 1658 and 1819) but the highest significant treatment among the rest was 180 kgN ha^{-1} rate with means values of (2259, 2280 and 2511) during all the rainyseasons respectively. This agreed with Gul *et al.*, (2021) findings who reported that grain yield per hectare have all increased in response to increases in nitrogen levels. Tis result agreed with Phoo, *et al.*, (2024) who stated that, $T_5 = (180 \text{ N kg ha}^{-1})$ recorded significant the highest mean hybrid maize grain yield value of (7696.6 kg ha^{-1}) in post monsoon season at $P \leq 0.01\%$ levels followed significantly by $T_4 = (150 \text{ N kg ha}^{-1})$, $T_3 = (120 \text{ N kg ha}^{-1})$ and $T_2 =$

(90 N kg ha⁻¹) while T₁ = (0 N kg ha⁻¹) observed to recorded the lowest mean hybrid maize grain yield of (4747.9 kg ha⁻¹).

Effect of periods of weed interference on grain yield kg ha⁻¹ showed that, the best treatment with significantly the highest means values of (2708, 2729 and 3009) was recorded from WF @ harvest and the lowest significantly means values of (1177, 1198 and 1307) was recorded from WIF up to harvest respectively. This could be due to weed competition according to Farooq, *et al.* (2020) weeds compete with crop plants either through competing for moisture, sunlight, nutrients, and space or through secreting allelo-chemicals, which adversely impact seed germination growth and yield of the crop plants. This is also similar with Khaliq *et al.*, (2012) who reported that, maize grain yield decreased with prolonged delays in weed removal; conversely, grain yield increased with the increasing length of weed-free period.

Periods of N applications indicated significant effect among the results on grain yield kg ha⁻¹ across all the rainy seasons. It is also in agreement with Azizullah, *et al.*, (2018) who stated that, grain yield per hectare of cultivated maize was significantly influenced by nitrogen levels and application schedules as maximum grain yield was recorded with the 240 N kg ha⁻¹ application which significantly recorded the highest mean value compared to 180 N kg ha⁻¹ dose followed by 120 N kg ha⁻¹ with the control treatment being the least respectively.

Interactions effect were found to be significantly different with PWI * PNA on grain yield kg ha⁻¹ across all the rainy seasons respectively (Table 4).

Table 3: Grain yield kg ha⁻¹ of maize crop as influenced by nitrogen rates (kg ha⁻¹), periods of weed interference and periods of N applications during 2018, 2019 and 2020 rainy seasons at ABCOAD Teaching and Research Farm

Treatments	Grain yield (kg ha ⁻¹)		
	2018	2019	2020
<u>Nitrogen rates (kg ha⁻¹)</u>			
0 kg ha ⁻¹	1637d	1658d	1819d
60 kg N ha ⁻¹	1845c	1866c	2050c
120 kg N ha ⁻¹	2064b	2085b	2294b
180 kg N ha ⁻¹	2259a	2280a	2511a
S.E.±	16.31	16.48	17.88
Significance	<.001	<.001	<.001
<u>Periods of weed interference (PWI)</u>			
W ₁ =WF @ 6 WAS	2041c	2062c	2268c
W ₂ = WF @ 8 WAS	2621b	2642b	2913b
W ₃ = WF @ harvest	2708a	2729a	3009a
W ₄ = WIF up to 6 WAS	1707d	1728d	1896d
W ₅ = WIF up to 8 WAS	1455e	1476e	1617e
W ₆ = WIF up to harvest	1177f	1198f	1307f
S.E.±	8.37	8.94	9.71
Significance	<.001	<.001	<.001
<u>Periods of N applications</u>			
T ₁ = PNA(0 WAS + 4 WAS)	1806d	1827d	2007d
T ₂ = PNA (2 WAS + 6 WAS)	2004b	2025b	2226b
T ₃ = PNA (0 WAS + 6 WAS)	1867c	1888c	2075c
T ₄ = PNA (2 WAS + 6 WAS + 8 WAS)	2129a	2150a	2366a
S.E.±	9.07	9.26	10.29
Significance	<.001	<.001	<.001
<u>Interactions</u>			

NR * PNA	0.152	0.198	0.201
PWI * PNA	<.001	<.001	<.004
NR * PWI *PNA	0.971	0.824	0.917

Means in a column of any set of treatments followed by same letter (s) are not significantly different at $P \leq 0.05$ using Student Newman Keuls test, WF = weed free, WIF = weed infested plot, WAS = weeks after sowing, PNA = periods of nitrogen applications, NR = nitrogen rate, WIF = weed infested plot, $T_4 = \frac{1}{4}$ N rate at 2 WAS + $\frac{2}{4}$ N rates at 6 + $\frac{1}{4}$ N rate at 8 WAS, ABCOAD = Audu Bako Col. Of Agric. Dambatta

Significant interaction effect between periods of weed interference and periods of nitrogen application on grain yield kg ha^{-1} during 2018 rainyseason recorded the highest mean value of (3340) from WF @ harvest combined with PNA_4 treatmentwhile the lowest significant interaction mean value of (1277, 1281, 1334, 1338) were recorded from WIF up to harvest combined across PNA_1 to PNA_4 periods of N application. At 2019 and 2020 rainy seasons, the recorded data had followed similar trend with that of 2018 rainyseason on grain yield kg ha^{-1} accordingly (Table 4)

Table 4: Interaction effect between periods of weed interference and periods of nitrogen applications on grain yield kg ha^{-1} of maize during 2018, 2019 and 2020 rainy seasons at ABCOAD Teaching and Research farm

Treatments		Periods of Nitrogen Applications			
	Periods of Weed interference (PWI)	$T_1 = \text{PNA}_1$	$T_2 = \text{PNA}_2$	$T_3 = \text{PNA}_3$	$T_4 = \text{PNA}_4$
<u>Experimental seasons</u>					
Year 2018	$W_1 = \text{WF @ 6 WAS}$	1852i	1925h	1867hi	2519f
	$W_2 = \text{WF @ 8 WAS}$	2545ef	2650d	2572ef	2719c
	$W_3 = \text{WF @ harvest}$	2287g	2940b	2597de	3006a
	$W_4 = \text{WIF up to 6 WAS}$	1671l	1735jk	1678kl	1743j
	$W_5 = \text{WIF up to 8 WAS}$	1332n	1570m	1339n	1581m
	$W_6 = \text{WIF up to harvest}$	1149o	1201o	1153o	1204o
S.E.±				30.40	
Year 2019	$W_1 = \text{WF @ 6 WAS}$	2008i	2087h	2024hi	2731f
	$W_2 = \text{WF @ 8 WAS}$	2759ef	2872d	2788ef	2948c
	$W_3 = \text{WF @ harvest}$	2480g	3187b	2815de	3259a
	$W_4 = \text{WIF up to 6 WAS}$	1811l	1881jk	1819kl	1890j
	$W_5 = \text{WIF up to 8 WAS}$	1444n	1702m	1451n	1714m
	$W_6 = \text{WIF up to harvest}$	1245o	1302o	1249o	1305o
S.E.±				32.96	
Year 2020	$W_1 = \text{WF @ 6 WAS}$	2058i	2139h	2074hi	2799f
	$W_2 = \text{WF @ 8 WAS}$	2828ef	2944d	2858ef	3021c
	$W_3 = \text{WF @ harvest}$	2542g	3267b	2885de	3340a
	$W_4 = \text{WIF up to 6 WAS}$	1856l	1928jk	1865kl	1937j
	$W_5 = \text{WIF up to 8 WAS}$	1480n	1744m	1488n	1757m
	$W_6 = \text{WIF up to harvest}$	1277o	1334o	1281o	1338o
S.E.±				33.78	

Means in a column of any set of treatments followed by same letter (s) are not significantly different at $P \leq 0.05$ using Student Newman Keuls test, WF = weed free, WIF = weed infested plot, WAS = weeks after sowing, PNA = periods of nitrogen applications, NR = nitrogen rate, WIF = weed infested plot, $T_4 = \frac{1}{4}$ N rate at 2 WAS + $\frac{2}{4}$ N rates at 6 + $\frac{1}{4}$ N rate at 8 WAS, ABCOAD = Audu Bako Col. Of Agric. Dambatta

SUMMARY

The N rates, timing of N fertilizer applications and sufficient weed control have a major impact on maize yield. The use of fertilizer in weed infested environment and at the incorrect time may cause nutrient loss, hasten weeds competition with cultivated maize crop resulting in fertilizer wastage and crop damages. However, using the right timing of fertilizer application coupled with sufficient weed control to maize crop increases nitrogen use efficiency and lowers nutrient loss which also saves environmental harmful effect caused by leaching. The differences on rates of fertilizer applications to these maize trials have

indicated marginal increase of maize yield indices and final yield. The higher values of all yield indices studied in the experimental rainy season of 2020 compared with 2018 and 2019 rainy seasons may be attributed to the optimum rain that fell in the latter season and as well maintenance of same experimental trial site. In 2020 season, sufficient and adequate amount of extended rainfall was recorded, which may have resulted in the efficient utilization of applied fertilizer and as well led to increase of the maize crop growth and ultimately yield. This is in agreement with the finding of Albayrak (2021) who reported that, maize needs minimum of 700 –750 mm of water and above during its production season. Supporting this postulation, Lu *et al.* (2021) also stated that heavy rains during the early part of the main cropping season (June–July) caused substantial soil nutrient losses because of intensive leaching and erosion, which affect the growth and development of maize crops. Applying N fertilizer in three split applications resulted in superior values of the yield components. This implies that the timing of applying N fertilizer results in the synchrony of N availability in the soil in the amount demanded by the crop plant for optimum uptake by the roots according to the growth stages. This agreed with Meng *et al.* (2016) findings who reported that, the uptake of N fertilizer was more efficient when the supply matched the N demand of the maize crop. Also correspond with Du *et al.* (2022) who reported that poor synchronization between the N supply and the demand of crops mainly is due to a large amount of N fertilizer applied in the early stages of growth, which generates a high level of inorganic N in the soil long before the crop absorbs it rapidly thereby resulting in the loss of N in the form of leaching and volatilization.

CONCLUSION – Despite the fact that maize productivity is relatively better than other major cereal crops, its current productivity is still far below its potential productivity. N rate and time of N application coupled with weed infestations are among the major biotic and abiotic factors limiting the production and productivity of the crop. Amount and distribution of rainfall across the seasons considerably influenced the responses of maize to N rate and time of N application including effectiveness of weed control. Application of 180 kg N ha⁻¹ combined with PNA₄ (¼ N rate at 2 WAS + ¾ N rates at 6 + ¼ N rate at 8 WAS) significantly recorded the highest means grains values followed significantly by application of 120 kg N ha⁻¹ combined with PNA₂ (¼ rate) at 2 WAS + (¾ rates) at 6 WAS when weeded at the right time while the lowest maize yield was recorded from 0 kg N ha⁻¹ rate combined with T₁ = PNA(0 WAS + 4 WAS) coupled with weeds infestations .

RECOMMENDATIONS

The results of this study recommended that: -

- Application of 180 kg N ha⁻¹ in three split applications (¼ N rate at 2 WAS + ¾ N rates at 6 + ¼ N rate at 8 WAS) or two split applications (¼ N rate at 2 WAS + ¾ N rates at 6 WAS) combined with W₃ = WF @ harvest / W₂ = WF @ 8 WAS could be adopted in the study area.

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