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Nitrogen Application Studies as it Influences the Performance of Sunflower *(Helianthus annuus L.)* in Southern Borno, Nigeria

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ABSTRACT
Field trial was conducted during 2010 and 2011 rainy seasons at Wamdeo (10^0 30 'N, 13^0 09 'E), 523 m above sea level in Borno State, North-East, Nigeria, aimed at studying growth and yield performances of sunflower under deferring N rates. The treatments were 0, 30, 60, 90 and 120 kg N ha^{-1}, which were arranged in randomized complete block design (RCBD) and replicated three times. Results from the two years average indicated that the application of 120 kg N ha^{-1} produced leaves with wider surfaces during all sampling periods (4, 6, 8 and 10 weeks after sowing (WAS)). The application of 90 – 120 kg N ha^{-1} recorded significantly higher average values for dry matter across all the sampling periods (4 – 10 WAS). However, higher values for crop growth rates (CGR) were also recorded at 8 WAS than other sampling periods, and 60 – 120 kg N ha^{-1} accelerated growth with statistically similar values in the two years average. Days to 50% flowering was not significantly influenced by N rates in both years and their average, as well as 1000-grain weight during 2010 rainy season. The application of 60 - 120 kg N ha^{-1} however increased 1000 – grain weight and out-weighed those of all other N rates in the two years mean. Values for head dry weight increased statistically with increasing N rates up to 60 kg ha^{-1} during both years, with their average value recorded as 106.95 g per head. The application of N at 60 kg ha^{-1} yielded the highest grain with the two years average recorded as 2159.90 kg ha^{-1}. From this study therefore, this rate could be recommended as optimum for adaptive farm trails in this agro-ecological zone. Fodder yield also increased statistically as N rates increased up to 120 kg ha^{-1} in both years, and at this rate, the highest average yield value (4098.60 kg ha^{-1}) was also recorded.

Key words: N-application, grain and fodder yields, sunflower, Southern Borno, sampling periods

INTRODUCTION

Sunflower *(Helianthus annuus L.)* may soon be a substitute to Nigeria's traditional vegetable oil source (groundnuts, sesame and Palm oil) because it is gaining wider acceptability among Nigerian farmers. Unfortunately nitrogen deficiency has always imposed limits on crop yields in the Nigerian savanna (Kiri, 2010). This is because most savanna soils are under continuous cropping and bush burning which lowers soil organic matter.

Nitrogen application therefore markedly enhanced growth and yield, and if applied at the rate of 60 kg N ha^{-1}, would increase seed and oil yield in sunflower (Osman and Awed, 2010). Investigation into sunflower N fertilization by Muhammad (2006) revealed that split application of 100 kg N ha^{-1} to vegetative and flowering phases increased crop performances, and Dangari *et al.* (2011) was of the same opinion when he reported that N if split-applied, its early dose appears to have more pronounced effects on crop yield. Reports on yield and yield components also indicated that higher N rate of 180 kg ha^{-1} delayed days to 50% flowering and increased yield performances (Ali *et al.*, 2000). Similarly, Allam and Gallal (1996) reported that application of 180 kg N ha^{-1} increased 100-grain yield, grain yield per head and per hectare, and increased N application up to 200 kg ha^{-1} increased grain and fodder yield as reported

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by Akhtar (2004). Farooq (1996) however recommended that application of lower N rate of 50 kg ha^{-1} is ideal for 1000-grain weight, grain yield per head and per hectare.
In spite of the increase in number of sunflower growers in this study region, no research has been conducted in recent times to determine its nutrient requirements. Since artificial application of nitrogen however remains the most important measure to correct deficiencies and optimize crop yield in the affected regions, there is the need to conduct this experiment in order to make N recommendation to the increasing number of sunflower growers in the region.

MATERIALS AND METHODS

Field experiment was conducted during 2010 and 2011 rainy seasons at Wamdeo (10^0 30 ′N, 13^0 09 ′E), 523 m above sea level. This study area is geographically located south of Borno state in North-Eastern Nigeria and forms part of the fringes of Sudan-Northern Guinea Savanna agro-ecological zone. To study the performance of sunflower under nitrogen fertilization, five N rates (0, 30, 60, 90 and 120 kg ha^{-1}) were arranged in randomized complete block design (RCBD), fitted in three replications. Seeds (Var., *Funtua*) was sourced from the Institute for Agricultural Research Ahmadu Bello University, Zaria and sown at 75cm x 25cm inter and intra row spacings respectively, on seed beds measuring 4.5m x 4.0m during early July in both years. Over-seeded holes were later thinned to one stand per hole during first weeding at 2 weeks after sowing (WAS). Nitrogen fertilizer in the form of urea (46%) was split-applied of equal amounts at first weeding (2WAS) and at floret initiations. Subsequent weed management were carried out at 5 and 8 WAS using hoe and diseases and pests incidences were timely managed.

Recording of data on growth parameters started at 4 WAS and continued fortnightly up to 10 WAS as the crops cease further vegetative growth. Days to 50% flowering was evaluated by recording the number of days from sowing to the attainment of full flowering by 50% plant population in each plot, while 1000-grain weight, head dry weight; and grain and fodder yields were all evaluated from net plots after harvest. Data collected were analyzed by analysis of variance (ANOVA) using the "Statistix" version 8.0 analytical software and means were separated by Duncan's Multiple Range Test (Duncan, 1955) at 5% confidence level.

RESULTS

Table 1 shows that application of higher N rate of 120 kg ha^{-1} recorded statistical increase in leave area per plant and produced leaves with widest surfaces in both years and combined analysis during all sampling periods. Table 2 shows that dry matter production increased with increasing N rates and the application of 90 to 120 kg N ha^{-1} recorded higher and similar average values for the two years during all the sampling periods (4-10 WAS).

Table 1: Effects of nitrogen fertilizer rates on leaf area per plant of sunflower in Wamdeo during 2010 and 2011 rainy season and their combined means

Treatment N/Kg ha^{-1}	Leaf area (cm2)/plant											
	4 WAS[1]			6 WAS			8 WAS			10 WAS		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
0	5.08^{c3}	3.65^{c}	4.37^{c}	11.80^{d}	10.83^{d}	11.31^{d}	17.71^{e}	14.60^{d}	16.16^{e}	19.18^{e}	16.95^{e}	18.03^{e}
30	5.25^{bc}	4.04^{c}	4.64^{c}	12.56^{d}	11.75^{cd}	12.16^{d}	20.16^{d}	16.64^{c}	18.40^{d}	21.25^{d}	19.69^{d}	20.47^{d}
60	5.99^{b}	5.16^{b}	5.58^{b}	14.62^{c}	12.65^{c}	13.63^{c}	23.31^{c}	19.31^{b}	21.31^{c}	25.00^{c}	22.37^{c}	23.68^{c}
90	6.09^{b}	5.74^{ab}	5.92^{b}	16.12^{b}	15.50^{b}	15.81^{b}	26.96^{b}	20.94^{b}	23.95^{b}	29.72^{b}	25.36^{b}	27.54^{b}
120	7.89^{a}	6.50^{a}	7.20^{a}	19.23^{a}	18.24^{a}	18.73^{a}	30.66^{a}	26.18^{a}	28.42^{a}	35.96^{a}	30.38^{a}	33.17^{a}
SE(±)	0.432	0.430	0.331	0.691	0.645	0.512	0.976	0.882	0.889	0.979	0.639	0.763

1. Week after sowing
2. Mean value of the combined analysis for 2010 and 2011 data

3. Means in a column followed by the same letter(s) are not significantly different at 5% level of probability according to DMRT

Table 2: Effects of nitrogen fertilizer rates on plant dry weight of sunflower in Wamdeo during 2010 and 2011 rainy season and their combined means

Treatment N/Kg ha^{-1}	Plant dry weight (g)											
	4 WAS[1]			6 WAS			8 WAS			10 WAS		
	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean	2010	2011	Mean
0	9.04^{c3}	5.76^{c}	7.40^{d}	57.07^{d}	26.74^{d}	41.40^{c}	113.50^{d}	73.19^{d}	93.34^{d}	180.76^{d}	101.14^{d}	140.95^{d}
30	14.16^{b}	6.43^{c}	10.29^{c}	60.60^{cd}	36.24^{c}	48.42^{c}	144.81^{c}	90.09^{c}	117.45^{c}	190.65^{d}	119.31^{c}	154.98^{cd}
60	18.63^{a}	9.53^{b}	14.08^{b}	69.92^{bc}	45.55^{b}	57.74^{b}	154.71^{bc}	111.22^{b}	132.97^{b}	205.94^{c}	145.16^{b}	175.55^{bc}
90	20.79^{a}	11.76^{b}	16.28^{ab}	77.57^{ab}	62.60^{a}	70.08^{a}	160.22^{b}	121.19^{ab}	140.70^{ab}	225.36^{b}	160.09^{a}	192.73^{a}
120	20.63^{a}	15.08^{a}	17.86^{a}	81.43^{a}	65.09^{a}	73.26^{a}	173.45^{a}	128.65^{a}	151.05^{a}	249.02^{a}	164.87^{a}	206.94^{a}
SE (±)	1.224	1.124	1.320	4.742	4.319	4.367	5.188	7.255	7.639	6.185	7.291	11.326

1. Week after sowing
2. Mean value of the combined analysis for 2010 and 2011 data
3. Means in a column followed by the same letter(s) are not significantly different at 5% level of probability according to DMRT

Crop growth rate was also statistically influenced by N rates as the application of 90 kg N ha^{-1} accelerated crop growth at 6 WAS during both years and combined analysis (Table 3). Results evaluated from the two years average indicates that application of 60-120 kg N ha^{-1} recorded higher and similar growth rates at 8 WAS; and at 10 WAS, average crop growth rate increased statistically with increased N rates up to 120 kg ha^{-1}.

Table 3: Effects of nitrogen fertilizer rates on crop growth rates of sunflower in Wamdeo during 2010 and 2011 rainy season and their combined means

Treatment N/Kg ha^{-1}	Crop growth rate (g dm^{2} day^{-1})								
	6 WAS[1]			8 WAS			10 WAS		
	2010	2011	Mean[2]	2010	2011	Mean	2010	2011	Mean
0	2.39^{d3}	1.48^{c}	1.93^{d}	4.71^{c}	3.33^{c}	4.02^{b}	2.78^{d}	1.99^{c}	2.39^{d}
30	3.44^{c}	2.14^{b}	2.79^{c}	5.08^{c}	3.85^{bc}	4.46^{b}	3.10^{d}	2.09^{bc}	2.59^{cd}
60	4.84^{b}	2.53^{b}	3.68^{b}	6.81^{b}	4.70^{a}	5.76^{a}	4.50^{c}	2.42^{a-c}	3.46^{bc}
90	6.42^{a}	3.63^{a}	5.03^{a}	7.59^{b}	4.18^{ab}	5.89^{a}	5.79^{b}	2.78^{a}	4.29^{b}
120	6.99^{a}	3.57^{a}	5.28^{a}	8.70^{a}	4.50^{a}	6.62^{a}	7.85^{a}	2.59^{ab}	5.22^{a}
SE(±)	0.316	0.285	0.386	0.501	0.282	0.478	0.323	0.250	0.465

1. Week after sowing
2. Mean value of the combined analysis for 2010 and 2011 data
3. Means in a column followed by the same letter (s) are not significantly different at 5% level of probability according to DMRT

Results from Table 4 also shows that the effects of N rates on days to 50% flowering in both years and combined analysis, and 1000-grain weight during 2010 rainy seasons were not significant. During 2011 rainy season however, 1000-grain weight increased significantly as N rates increased up to 120 kg N ha^{-1}, and 60-120 kg N ha^{-1} recorded higher and similar values in the two years average. The application of 90 kg N ha^{-1} recorded statistical increased in head dry weight in 2010 and combined analysis, but in 2011 wet season results were higher and statistically similar among 60-120 kg N ha^{-1} (Table 4).

Table 4: Effects of nitrogen fertilizer rates on days to first and 50% flowering, 1000-grain weight and head dry weight of sunflower in Wamdeo during 2010 and 2011 rainy season and their combined means

Treatment N/Kg ha^{-1}	Days to 50% Flowering			1000-grain weight (g)			Head dry weight (g)		
	2010	2011	Mean[1]	2010	2011	Mean	2010	2011	Mean
0	79.27	79.93	79.60	59.87	31.00[c2]	45.43[c]	56.79[d]	28.71[c]	42.75[d]
30	77.20	79.27	78.24	65.27	35.27[c]	50.27[bc]	89.68[c]	69.43[b]	79.56[c]
60	79.33	77.27	78.30	63.60	44.80[b]	54.20[ab]	93.18[bc]	98.17[a]	95.68[b]
90	79.13	74.00	79.07	65.87	47.27[b]	56.57[ab]	108.98[a]	104.92[a]	106.95[a]
120	77.07	79.13	78.10	62.40	55.53[a]	58.97[a]	106.28[ab]	101.47[a]	103.88[ab]
SE(±)	1.475	2.342	1.558	3.164	2.356	3.779	7.661	5.045	5.066

1. Mean value of the combined analysis for 2010 and 2011 data
2. Means in a column followed by the same letter(s) are not significantly different at 5% level of probability according to DMRT

The effect of N rates on the yield parameters is presented on Table 5. Application of 90 kg N ha^{-1} produced significantly higher grain yield in 2010 rainy season (2692.50 kg ha^{-1}) and average grain yield of 2159.90 kg ha^{-1} was recorded at 60 kg N ha^{-1} in two years mean. In 2011 wet season, yield also increased statistically (2210.70 kg ha^{-1}) with 60 kg ha^{-1}. The application of 120 kg N ha^{-1} increased fodder production to 4545.90 kg ha^{-1} in 2010, 3651.20 kg ha^{-1} in 2011 and 4098.60 kg ha^{-1} in two years mean from lower values recorded in control treatment.

Table 5: Effects of nitrogen fertilizer rates on grain and fodder yields of sunflower in Wamdeo during 2010 and 2011 rainy seasons and their combined means

Treatment N/Kg ha^{-1}	Grain yield (kg ha^{-1})			Fodder yield (kg ha^{-1})		
	2010	2011	Mean[1]	2010	2011	Mean
0	1396.0[c2]	395.2[d]	882.1[c]	1119.6[e]	643.0[e]	881.3[e]
30	2112.7[b]	1560.0[bc]	1836.3[b]	2048.4[d]	909.1[d]	1478.7[d]
60	2109.1[b]	2210.7[a]	2159.9[ab]	3045.3.[c]	1411.8[c]	2228.6[c]
90	2692.5[a]	1760.7[b]	2226.6[a]	3659.9[b]	2509.9[b]	3084.9[b]
120	2129.1[b]	1523.2[c]	1826.2[b]	4545.9[a]	3651.2[a]	4098.6[a]
SE(±)	207.20	107.14	154.57	167.54	75.666	189.33

1. Mean value of the combined analysis for 2010 and 2011 data
2. Mean in a column followed by the same letter(s) are not significantly different at 5% level of probability according to DMRT

DISCUSSION

Leaf area per plant, crop growth rates and dry matter production were all influenced by higher N rates because its increasing application at early, active growth phase would increase the above measurable physiological growth parameters. As increasing N rates influenced increase in leaf area, this increased photosynthetic efficiency and dry matter production later used for further growth and yield. Dangari *et al.* (2011) earlier reported that N applied at early growth phase appears to have more pronounced effects on crop performance than the later applications. The declining values in crop growth rates after 8 WAS sampling was presumably due to the fact that peak growth phase has been attained and further growth in plant was at declining rate, since there was possible diversion in photosynthates towards the commencement of the reproductive phase.

N application did not significantly influence days to 50% flowering herein and these contradicts the report of Ali *et al.* (2000). This is most probably due to the fact that the climatic and soil conditions under which the studies were carried out differ, or better still due to wider gap in N treatments applied.

The highest grain yield recorded at 60 kg N ha^{-1} in this study confirms the earlier finding of Osman and Awed (2010). Later N application might also have influenced the increases recorded in yield components and yield parameters because its application fulfills the plants N demand at reproductive phase. The above finding is in conformity with the report of Muhammad (2006). Dry matter produced might have been partitioned for grain filling which reduced the incidences of hollow-seediness and increased 1000-grain weight, grain yield and head dry weights. Besides, nitrogen stored at growth phase would obviously be later remobilized up for head and grain dry matter production and contributed to yield (Moll *et al.*, 1994). The overall effects of higher N rates on leaf and head dry matter production exerted higher and significant influence on fodder production as in the report of Aktar (2004).

CONCLUSION AND RECOMMENDATIONS

Since the application of 60 kg N ha^{-1} and 120 kg N ha^{-1} increased the performances of grain and fodder yields, respectively. It can be concluded that these rates of applications increases grain and fodder yields. Hence, these rates could be recommended for farmers adaptive farm trails.

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