The Effects of Nitrogen Mineral on Yield Performance of Sunflower *(Helianthus Annuus L.)* in Bauchi State, Nigeria

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ABSTRACT

Result of field trial reported herein was conducted during 2010 and 2011 wet season at Wamdeo (10^0 30 'N, 13^0 09 'E), 345m above sea level, geographically located south of Borno state in Northern Guinea savanna of Nigeria. The treatments were 0, 30, 60, 90 and 120kg N ha^{-1}, arranged in randomized complete block design (RCBD) and replicated three times. Results indicated among others that growth parameters (leaf area, plant dry weight and crop growth rates) all increased with increasing Nitrogen (N) rates as the application of 120kg N ha^{-1} produced leaves with wider surfaces and increased dry matter production during all sampling periods (4, 6, 8 and 10 WAS) in both years and combined analysis. Also, the application of 90kg N ha^{-1} accelerated crop growth in 2011 wet season without statistical comparison to other N rates, as 120kg N ha^{-1} in 2010 at 8 and 10 WAS and in combined analysis at 10 WAS influenced higher crop vigour which out-grew other N rates. Conclusively, the study stressed that Nitrogen application markedly enhanced growth and yield if applied in the right quantity and time. Consequently, farmers are hereby encouraged to apply the mineral in the right proportion of at least 120kg to 200kg to their plants for improved growth and yield.

Keywords: *Mineralization, nitrogen, sunflower, yield*

INTRODUCTION

Nitrogen has been described by Fageria and Baligar (2005) as quantitatively, the most important nutrient element required for plant growth and is the most essential in determining yield potentials of crops. Sunflower *(Helianthus annuus L.)* has also been identified by Ogunremi (2000) as potential substitute to Nigeria's traditional vegetable oil source (groundnuts and Palm oil). The crops are gaining wider acceptability across Nigerian savanna agro-ecological zones but unfortunately nitrogen availability has always imposed limits on production prospects of crops in the region as reported by Kiri (2010). This is because most savanna soils are becoming depleted of inherent fertility arising from continuous cropping and bush burning which lowers soil organic matter. In spite of the increase in the number of sunflower growers in this study region, no research has ever been conducted there to determine its nutrient requirements. However, since artificial application of nitrogen still 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 this study area in order to make Nitrogen *(N)* recommendation to the increasing number of sunflower growers in the region. Nitrogen application therefore markedly enhanced growth and yield, and if applied at the rate of 60kg *N* ha^{-1} would produce the highest seed and oil yield in sunflower (Osman and Awed, 2010). Wabekwa *et al.* (2011) however reported that growth parameters increased with increase *N* rates up to 120 kg ha^{-1}, and in another study, Wabekwa, Odion and Idem (2010) reported that N inorganically applied at higher rate of 120-180kg ha^{-1} interfered with kernel formation and grain filling. Investigation into sunflower N fertilization by Gutierrez *et al.* (2000) also reveal that higher N rate of 200kg ha^{-1} significantly increased fodder and biomas production, and Khaliq (2004) reported same *N* rate as ideal for leaf area and crop growth rate performances.

In contrast, Saifullah (1996) reports significant increase in crop growth, biomas, dry matter production and biological yield with lower N rate of 100kg ha^{-1}. Furthermore, Muhammed (2006) was of the opinion that split application of 100kg N ha^{-1} to vegetative and flowering phases increased crop performances and Dangari, Tenebe and Wabekwa (2011b) 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, Khalil and Nawab, 2000). Similarly, Allam and Gallal (1996) report that application of 180kg N ha^{-1} increased 100-grain yield, grain yield per head and per hectare, and increased N application up to 200kg ha^{-1} increased grain and fodder yield as reported by Akhtar (2004). In his studies however, Farooq (1996) 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.

MATERIALS AND METHOD

Field experiment was conducted during 2010 and 2011 cropping seasons under rainfed condition at Wamdeo (10^0 30 ′N, 13^0 09 ′E), 345m above sea level. This study area is geographically located south of Borno state in North-Eastern Nigeria and forms part of the fringes of Northern Guinea savanna agro-ecological zone. To study the performance of sunflower under nitrogen fertilization, five *N* rates at 0, 30, 60, 90 and 120kg ha^{-1} were selected as treatments and experimentally designed 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, following heavy rainfall in first week of July during both years. Over-seeded holes were later thinned to one plant stand per hole during first weeding at 2 weeks after sowing (WAS), and fertilizer N (urea, 46%) was split-applied in their appropriate rates, first at 2 WAS after first weeding and the second application at floret initiations. Subsequent weed management and all other agronomic practices were timely carried out. Data on growth parameters were recorded fortnightly and terminated at 10 WAS as the crops cease vegetative growth and developments. Day to 50% flowering was however evaluated by recording the number of days from sowing to the attainment of full flowering by half of plant population (50%) in each plot, while 1000-grain weight, head dry weight and grain, fodder and biological yields respectively were all evaluated from net plots at harvest. Data collected were also analyzed 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 AND DISCUSSION

Table 1 shows that application of higher N rate of 120 kg ha^{-1} produced leaves with wider surfaces in both years and combined analysis during all sampling periods, but this result was statistically comparable with that of 90kg *N* ha^{-1} in 2011 wet season at 4 WAS. Furthermore, at 4 and 6 WAS in both years and combined analysis, difference in mean leaf area among 0 and 30kg N ha^{-1} were not statistically significant. Similarly, table 2 shows that dry matter production increased with increasing *N* rates up to 120kg ha^{-1} across all sampling periods in both years and combined analysis, except at 4 WAS in 2010. However, the difference in mean dry weight between 120 and 90kg *N* ha^{-1} was not statistically significant in the combined analysis and in the individual years except at 4 WAS in 2011 and at 8 and 10 WAS in 2010 wet seasons respectively.

Crop growth rate was also statistically influenced by N rates as the application of 90 kg N ha^{-1} accelerated crop growth statistically at 6 WAS during both years and combined analysis. Additional N rate (120 kg ha^{-1}) however favoured crop growth than all other rates at 8 and 10 WAS in 2010 and at 10 WAS in combined analysis. Furthermore, application of 60kg N ha^{-1} increased crop growth statistically in 2011 at 8 and 10 WAS and in combined analysis at 8 WAS only (Table 3). Result on table 4 also shows that the effects of N rates on yield components such as days to 50% flowering in both years and combined analysis, and mean 1000-grain weight during 2010 wet seasons were not significant. During 2011 and combined analysis however, 1000-grain weight increased as N rates increased and at 120kg N ha^{-1}, grain weight statistically exceeded those of all other rates in 2011 wet seasons and increasing N rates from 30-90kg ha^{-1} in combined analysis did not statistically increase 1000-grains weight. Similarly, application of 90kg N ha^{-1} produced head dry weight which statistically out-weighed all lower N rates in 2010 and combined analysis, but in 2011 wet season, results were not statistically significant among 60-120kg N ha^{-1}.

The effect of N rates on the yield parameters (grain, fodder and biological yields) were also significantly influenced as presented on table 5. Application of 90kg N ha^{-1} produced significantly higher grain yield with means value of 2692.50kg ha^{-1} in 2010 and 2226.60kg ha^{-1} in combined analysis. In 2011 wet season, yield increased statistically with increased N rates up to 120 kg ha^{-1}. Similarly, application of 120 kg N ha^{-1} increased fodder production to 4545.90kg ha^{-1} in 2010, 3651.20kg ha^{-1} in 2011 and 4098.60kg ha^{-1} in combined analysis from lower values recorded in control experiments. Biological yields also increased to 5552.20kg ha^{-1} at 60kg N ha^{-1} from lower values recorded at lower N rates in 2010 wet season, but in 2011 increasing N rates up to 120kg ha^{-1} increased biological yield statistically to 5147.70kg ha^{-1}. Results from combined analysis however indicated that biological yield statistically increased (5426.70kg ha^{-1}) with increasing N rates up to 90kg ha^{-1}. Leaf area per plant, crop growth rates and dry matter production were all influenced by higher N rates as reported by Wabekwa, Odion and Idem (2011) and this is because it is obvious that nitrogen plays significant role in plant growth, and its increasing application at early active growth phase would increase the above physiological parameters. As increasing N rates influenced increase in leaf area, dry matter production might also have increased due to increased photosynthetic efficiency arising from increased canopy production which was used for further growth and for later yield determination as Fageria and Baligar report in 2006; and as opined by Dangari, Tenebe and Wabekwa (2011b) that N applied at early growth phase appears to have more pronounced effects on crop performance than the later applications. Later N application might also have influenced the increases in yield components and yield parameters and the above is in conformity with the report of Muhammad (2006). Dry matter produced might have been remobilized and partitioned for grain filling thereby reduced the incidences of hollow-seededness (contrary to report of Wabekwa *et al.*, 2010), and this increased 1000-grain weight, grain yield and head dry weights. Besides, nitrogen stored at growth phase was reported to later remobilize for grain production and contributed to yield (Moll, Jackson and Mokkelsen, 1994).

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 Leaf area (cm^2)/plant

	4 WAS[1]			**6 WAS**			**8 WAS**			**10 WAS**		
N rates (kg ha^{-1})	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($\pm$)	**0.432**	**0.430**	**0.331**	**0.691**	**0.645**	**0.512**	**0.976**	**0.882**	**0.889**	**0.979**	**0.639**	**0.763**

Source: Experimentation, 2010/2011

1. *Week after sowing*
2. *Mean value of the combined analysis for 2010 and 2011 data*
3. *Mean 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 Plant dry weight (g)

	4 WAS[1]			**6 WAS**			**8 WAS**			**10 WAS**		
N rates (kgha^{-1})	2010	2011	Mean[2]	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 ($\pm$)	1.224	1.124	1.320	4.742	4.319	4.367	5.188	7.255	7.639	6.185	7.291	**11.326**

Source: Experimentation, 2010/2011

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

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 crop growth rate (g dm^{2} day^{-1})

N rates (kg ha^{-1})	6 WAS 2010	6 WAS 2011	6 WAS Mean^{2}	8 WAS 2010	8 WAS 2011	8 WAS Mean	10 WAS 2010	10 WAS 2011	10 WAS 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**

Source: Experimentation, 2010/2011

1. Week after sowing

2. Mean value of the combined analysis for 2010 and 2011 data

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

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

N rates (kg ha^{-1})	Days to 50% Flowering 2010	Days to 50% Flowering 2011	Days to 50% Flowering Mean^{1}	1000-grain weight (g) 2010	1000-grain weight (g) 2011	1000-grain weight (g) Mean	Head dry weight (g) 2010	Head dry weight (g) 2011	Head dry weight (g) 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

Source: Experimentation, 2010/2011

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.

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

N rates (kg ha^{-1})	GY 2010	GY 2011	GY Mean^{1}	FY 2010	FY 2011	FY Mean	BY 2010	BY 2011	BY Mean
0	1396.0^{c2}	395.2^{d}	882.1^{c}	1119.6^{e}	643.0^{e}	881.3^{e}	3022.2^{b}	1057.6^{e}	2039.9^{d}
30	2112.7^{b}	1560.0^{bc}	1836.3^{b}	2048.4^{d}	909.1^{d}	1478.7^{d}	4254.8^{b}	2614.1^{d}	3434.5^{c}
60	2129.1^{b}	1523.2^{c}	1826.2^{b}	3045.3.^{c}	1411.8^{c}	2228.6^{c}	5552.2^{ab}	3674.7^{c}	4613.5^{b}
90	2692.5^{a}	1760.7^{b}	2226.6^{a}	3659.9^{b}	2509.9^{b}	3084.9^{b}	9382.5^{a}	4806.3^{b}	5426.7^{a}
120	2109.1^{b}	2210.7^{a}	2159.9^{ab}	4545.9^{a}	3651.2^{a}	4098.6^{a}	6034.6^{ab}	5147.7^{a}	5591.1^{a}
SE(±)	207.20	107.14	154.57	167.54	75.666	189.33	2132.2	165.31	270.17

Source: Experimentation, 2010/2011

GY = Grain yield (kg ha^{-1}); FY =Fodder yield (kg ha^{-1}), BY = Biological yield (kg ha^{-1})

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.

CONCLUDING REMARKS

This experiment investigated The Effects of Nitrogen Mineral in Yield Performance of Sunflower (Helianthus Annuus L.) in Bauchi State, Nigeria. The study revealed that the overall effects of higher N rates on dry matter production, yield and yield components also exerted higher influence on biological yield performance (Saifullah, 1996) and as well as fodder production as in the report of Aktar (2004). Hence, the study conclusively, the study stressed that Nitrogen application markedly enhanced growth and yield if applied in the right quantity and time. Consequently, farmers are hereby encouraged to apply the mineral in the right proportion of at least 120kg to 200kg to their plants for improved growth and yield.

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