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Effect of rate and time of nitrogen application on the performance of cowpea *Vigna unguiculata* (L) Walp in the northern guinea savannah zone of Nigeria

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ABSTRACT: Fields trials were conducted (on bi-location) at Maiduguri (Latitude 11°51') and longitude 13°15') during 1997 cropping season. The objective was to determine the amount and time of application of nitrogen that would boost the performance of cowpea. The two experiments were laid in a spilt-plot design. In each of the experiments, cowpea varieties (95K-596, 93K-597 and TVU2027) were assigned to the main plots, while the subplots were assigned to nitrogen (at 0, 10, 20, 30 and 40Kg/ha) in the first experiment and the second experiment, nitrogen application at (0, 1, 2, 3 and 4) weeks after sowing were assigned to the subplots. It was observed that variety significantly ($p \leq 0.05$) affected striga infestation on cowpea. TVU 2027 (local) recorded the lowest striga population.Variety 93K-597 recorded the significantly highest ($p \leq 0.05$) dry matter yield (DMY) and nodulation. Nitrogen at 40Kg/ha significantly ($p \leq 0.05$) increased cowpeas' DMY, nodulation and effected a reduction in striga infestation. Time of application of nitrogen did not significantly ($p \leq 0.05$) increase DMY at the two locations. Nitrogen significantly ($p \leq 0.05$) affected striga count and nodulation at location 1 where application at 0, 3 and 4 weeks after sowing significantly reduced striga infestation. Similarly, at location 1 nitrogen application at 0, 1, 2 and 4 weeks after sowing, were significantly ($p \leq 0.05$) highest. Nitrogen however did not significantly increase nodulation at location 2. However, variety TVU 2027, is recommended for its resistance to striga while 95K-597 is recommended for high nodulation and high DMY and basal application of 40N/Kg is recommended for cowpea.

Key Words: Nitrogen application; Cowpea varieties; *Vigna unguiculata*; Guinea savannah; Nigeria.

Introduction

The yield of grain legumes (specifically cowpea) are low and generally more variable than those of many other crops Jeuffroy and Ney (1997); BOSADP (1990) in developed countries grain yield of cowpea have not as rapidly as those of cereal crops. (Health and Hebblethwaite, 1985a). The yield of cowpea in developing countries was estimated to be 45% of that of developed countries (Oram and Agraoil: 1992)

The major problem responsible for the low yield of legumes/cowpea ranges from the unfavourable climate (rainfall), biotic (pest and diseases) to edaphic (soil physiochemical-characteristics) Several successes had been re corded in attempts made to alleviate the pest diseases and drought related stress. This is evident from the breeding and release of several multiple resistant/tolerant varieties. Despite these efforts and successes recorded, the sub-sahara sub region is still faced with challances in the likes of how to increase food production to keep pace with the teaming population and how to avoid degrading soil and the related resources in that effort (Brader 1990), FAO (1986) earlier that the high rate at which the soil fertility is getting degraded is alarming and should be considered an environmental treat.

From the foregoing, attempts /efforts to improve food production should be approached via a good understanding and manipulation of crops environment (Willey 1996b) may be achieved by a compatible management of agronomic/cultural practices such as mineral nitrogen fertilizer management strategies.

To actualize the present study, the following aim and objectives are the focus (i). to determine the nitrogen rate to boost the field performance of cowpea (ii) to determine the appropriate time to apply the nitrogen that will boost the field (iii). to test the varietal responses of cowpea to the rate and time of application and (iv). field situation at Maiduguri. (Semi arid zone).

Materials and Methods

Two experiments were simultaneously conducted in this study during 1997 cropping season. They were established bi-location (Research and teaching farm of (i) University of Maiduguri (ii) Ramat polytechnic Maiduguri) The two site fall within the same AgroEcological zone (Northern guinea savannah of Nigeria, latitude 11°51' and longitude 13°15').

For the first experiment, the trials were laid out in a split plot design with cowpea cultivars (95K-596, 93K-597 and TVU 2027) as the main plots and nitrogen (0, 10, 20, 30 and 40KgN/ha) as the sub-plot factors. Each plot was $16m^2$ with a border of 75cm apart. The fields on the two experimental sites were harrowed once to produce a well pulverized tilt-leveling was manually done with hoe before the seed beds were raised.

A basal application of phosphorus was done at the rate of 50Kg/ha (P_20_5). Seeds were sown on July 16, 1997 and July 23 1997 at location 1 and 2 respectively. The seeds were sown at 30cm by 60cm intra and inter row spacing. The crops were sprayed once at flowering sites with Karate (2, 2 dichloromethyl-di ethylphosphate). One manual two weeding were done to control weeds at the two locations.

In the design of the second experiment, (using split-plot), cowpea cultivars (95K-596, 93K-597 and TVU2027) were maintained as the main plot factors. For the sub-plot treatments, 30KgN/ha (based on bavery and Jarrel 1978) was applied at five different period of time (Basal 1, 2, 3 and 4 weeks after sowing). All other agronomic/cultural practices were same with what was done and reported for experiment 1.

Data Collection

Soil Sampling and Analysis.

Soil samples were collected at the top soil and 10cm soil depts. at 20 randomly selected points on the two sites. The samples for each location were composited on location basis. The soil samples were analyses for physiochemical characteristics using the standard procedure according to A. O. A. C (1970).

Striga count: The total no of striga per individual plots were counted at 7 weeks after sowing.

Dry matter yield (Kg/ha): The vegetative parts of 10 plants per plots were uprooted and dried under the shade for five (5) days and in the laboratory oven for 24hours. the weight were measured on weighing scales when the samples were crispy to touch. the dry matter weight per plot were converted to hectare.

Nodule count: Fresh nodules were counted on the roots of the samples uprooted for dry matter determination. A magnifying glass (hand lens) was used as eye aid to achieve a precision in numerical enumeration of the nodules on the roots.

Data Analysis: Data collected were subjected to analysis of variance (ANOVA) using Statistix 8.0 version programme. The difference between treatments means were pair wise compared using least significant difference LSD at 5% level of probability where F values were significant.

Results

The effect of variety on striga infestation significantly ($p \leq 0.05$) on cowpea at the two locations. (Table 1). Although a slight inconsistency was recorded in the result from the two locations. The result consistently shows that the highest striga infestation was recorded from variety 93K-597, at the two locations while 93K-596 recorded the lowest at L_1 and TVU 2027 recorded the lowest at L_2. The mean striga count for the two locations was 15.5, 16.2 and 20.5 striga population per plot respectively for varieties and TVU2027, 93K-597 and 93K-596. The result shows further that striga nitrogen significantly ($p \leq 0.05$) reduced striga population on cowpea plots. The lowest striga infestation was recorded on the application of 40KgN/ha while the check (0KgN/ha) recorded the highest striga count at the two locations. Cowpea variety × nitrogen significantly ($p \leq 0.05$) affected striga infestation on cowpea plots at location one only (Figure 1). The three varieties generally recorded the lowest/least striga population with the application of 40KgN/ha with cultivar 93K-596 recording the least striga count.

Table 1 Effect of rate of Nitrogen (Kg/ha) on the performance of cowpea at Maiduguri in the year 1997.

Treatment	Striga count			Dry matter yield(Kg/ha)			Noduleount/plot		
	L_1	L_2	Mean	L_1	L_2		Mean	L_1	L_2 mean
A. Cowpea variety									
93K-596	14.7^c	17.6^b	**16.2**	580.3^b	583.5^b	**581.9**	21.5^b	17.6^b	**19.6**
93K-597	18.6^a	22.3^a	**20.5**	584.3^a	587.4^a	**585.9**	25.6^a	22.3^a	**24.0**
TVU 2027 (local)	15.3^b	15.6^c	**15.5**	578.1^c	581.0^c	**579.6**	19.3^c	16.6^c	**18.0**
SE ±	0.2	0.5		0.1	9.8×10^{-15}		0.1	0.5	
LSD ($p \leq 0.05$)	0.6	1.5		0.3	2.7×10^{-15}		0.3	1.5	
B. NKg/ha									
0	20.6^a	23.3^a	**22.0**	578.6^{bc}	581.5^{bc}	**580.1**	15.8^d	13.3^d	**14.6**
10	16.8^b	19.4^b	**18.1**	571.2^c	574.8^c	**573.0**	19.3^c	19.4^b	**19.4**
20	16.5^b	19.2^b	**17.9**	582.8^{ab}	586.4^{ab}	**584.6**	22.8^b	19.2^b	**21.0**
30	14.8^c	16.7^c	**15.8**	582.5^{ab}	585.6^{ab}	**584.1**	23.5^b	16.7^c	**20.1**
40	12.2^d	13.9^d	**13.1**	589.3^a	592.3^a	**590.8**	29.4^a	23.9^a	**26.7**
SE ±	0.6	0.6		3.6	3.6		1.2	0.7	
LSD ($p \leq 0.05$)	1.2	1.4		7.4	7.4		2.2	1.4	
C. A×B	*	NS		NS	NS		NS	NS	

L_1= University of Maiduguri L_2= Ramat polytechnic Maiduguri *=Significant at P=0.05 NS=Not significant at P=0.05. Means followed by same letter do not significantly differ at 5% level of probability using LSD

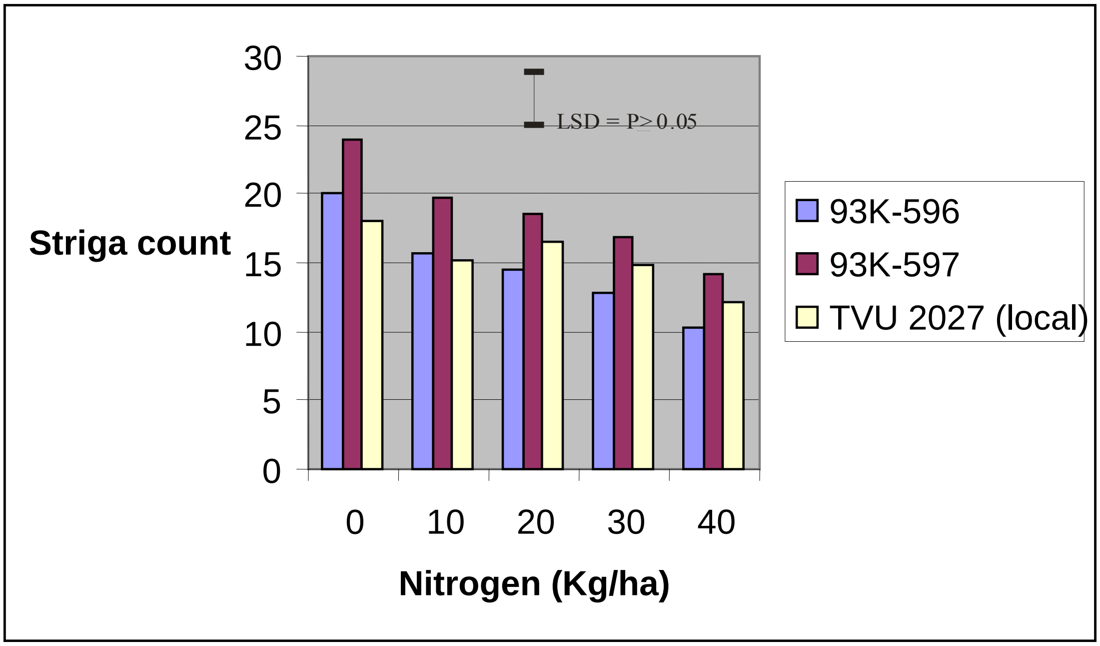

Figure 1: Effect of cowpea variety x Nitrogen level on striga population at location

The cowpea varieties significantly (p≤0.05) differ in their dry matter yield. The means from the two locations shows that dry matter yield of 585.9Kg/ha was recorded as the highest from variety 93K-597, followed by TVU 2027 with 579.6Kg/ha dry matter yield.

Nitrogen application significantly (p≤0.05) increased the dry matter yield of cowpea (Table 1). This result consistently followed a similar trend at the locations. The combined results (from the two locations) gave a mean dry matter yield of 590.8kg/ha recorded from the application of 40KgN/ha as the highest. It was however noted that the DMY recorded from 20, 30 and 40KgN/ha were not significantly different from one another. Cowpea variety × Nitrogen did not significantly (p≤0.05) result in any difference in cowpeas' dry matter yield.

Nodulation significantly (p≤0.05) differ amongst cowpea varieties. The results consistently followed a similar trend at the two locations (Table1). Variety 93K-597, recorded the highest nodulation and TVU 2027 recorded the least.

The results show further that nitrogen significantly (p≤0.05) increased nodulation in cowpea. The highest nodule count was recorded from the application of 40KgN/ha, while the check recorded the lowest nodulation of cowpea.

Cowpea × cultivar nitrogen did not significantly (p≤0.05) resulted to a difference in cowpea nodulation at the two locations.

Experiment Two

The cowpea cultivars significantly (p≤0.05) differ in terms of the striga infestation recorded (Table 2). TVU 2027 (local) recorded the most significant reduction in striga infestation at the two locations which 93K-596 and 93k-597 recorded a non-significantly different (p≤0.05) striga population from the two locations.

The time of application of 30KgN/ ha to cowpea gave an inconsistent result between the two locations. At location one, the lowest striga infestation was common to basal application at three and four weeks after sowing (i.e. they did not record significantly (P≥0.05 different values of striga count from one another). While at location two, time of application of nitrogen was not observed to have any significant effect on cowpeas striga infestation.

The combined results from the two locations were observed to have recorded the highest striga infestation from nitrogen application at one and two weeks after sowing and the lowest at basal and application at four weeks after sowing.

Cowpea cultivars were observed to have recorded significantly ($p \leq 0.05$) different dry matter yield at the two (2) locations (Table2). The results from the two locations consistently followed similar trend with 93K-597 recording the highest dry matter yield and 93K-596 recording the lowest.

Time of application of nitrogen was observed not to have significantly ($p \leq 0.05$) resulted/affected the dry matter yield of cowpea at the 2 locations

Cowpea variety × time of application of nitrogen did not significantly ($p \leq 0.05$) resulted to any difference in cowpeas' dry matter yield at the two locations. Cowpea cultivars significantly ($p \leq 0.05$) different nodulation from one another at the 2 locations. Cultivar 93K-597, recorded the highest nodule count with a mean nodule count of 25.0 per plot for the 2 locations while 93K-596, recorded the lowest with a mean of 22.9 nodule count per plot for the 2 locations.

Time of application of nitrogen gave an inconsistent result between the two locations. At location 1, their was no significant ($p \leq 0.05$) difference in nodulation in response to time of nitrogen applied.

The application of 30KgN/ha at sowing (basal) one, two and four weeks after sowing gave similar nodule count that were significantly ($p \leq 0.05$) higher than the nodulation recorded at 3 weeks after sowing. Cowpea cultivar × time of application of nitrogen was observed no to have any significant ($p \leq 0.05$) effect on cowpeas' nodulation at the two locations.

Table 2 Effect of Time (Weeks after sowing) application of 30KgN/ha on cowpea at Maiduguri in the year 1997.

	Striga count			Dry matter yield(Kg/ha)			Nodule count/plot		
Treatment	L_1	L_2	Mean	L_1	L_2	Mean	L_1	L_2	mean
A. Cowpea variety									
93K-596	17.4[a]	18.2[b]	**17.8**	562.9[c]	589.1[c]	**576.0**	18.2[c]	21.6[c]	**19.9**
93K-597	20.4[a]	21.5[b]	**21.0**	565.6[a]	592.1[a]	**578.9**	21.2[b]	24.6[b]	**22.9**
TVU 2027 (local)	12.4[c]	13.2[c]	**12.8**	564.9[b]	591.1[b]	**578.0**	23.1[a]	26.9[a]	**25.0**
SE ±	3.2×10^{-16}		1.32		$0.224.8 \times 10^{-15}$			0.12	0.28
LSD ($p \leq 0.05$)	9.0×10^{-16}		2.72		$0.601.3 \times 10^{-14}$			0.30	0.78
B. 30KgN/ha (WAS)									
Basal	16.1[c]	16.2[a]	**16.2**	542.7[a]	583.4[a]	**563.1**	23.1[ab]	19.2[a]	**21.2**
One	17.7[b]	18.2[a]	**18.0**	562.3[a]	613.2[a]	**587.8**	25.8[ab]	21.8[a]	**23.8**
Two	18.4[a]	19.4[a]	**18.9**	580.7[a]	585.1[a]	**582.9**	27.1[a]	22.4[a]	**24.8**
Three	16.8[c]	17.4[a]	**17.1**	546.5[a]	583.4[a]	**565.0**	22.4[b]	20.5[a]	**21.5**
Four	14.9[c]	17.1[a]	**16.0**	583.7[a]	570.9[a]	**577.3**	23.3[ab]	20.3[a]	**21.8**
SE ±	1.0	1.3		18.7	29.4		2.2	1.6	
LSD ($p \leq 0.05$)	2.01	NS		NS	NS		4.6	NS	
C. A×B	NS	NS		NS	NS		NS	NS	

L_1= University of Maiduguri L_2= Ramat polytechnic Maiduguri *=Significant at P=0.05 NS=Not significant at P=0.05. WAS= weeks after sowing. Means followed by same letter do not significantly differ at 5% level of probability using LSD

Discussion

A slight inconsistency was observed between the results obtained from the two experimental sites. This could be a consequence of the variation in the environment. These include the soil physio-chemical characteristics and local/micro climate such as temperature and rainfall. Although the two locations are situated within the same agro-ecological zones, they are still separated by some distance in kilometers apart. Thus, the soil and climate element varies slightly. This explanation agrees with Fukai and Trenbath (1993). Experimental results are sites specific and season-to-season variation is high. This is a common problem in agronomic research even sole cropping.

Another biological factor that could be seriously affected by the crops environment/location is striga. The distribution of striga seed may be erratic within and between locations in agreement with IAR (1985). This tends to be one of the reasons for the variation observed in striga infestation between the two locations.

There appeared to be varietal responses by the cowpea to striga infestation. The consistently lowest striga population recorded by variety 93K-597 relative to the two others in agreement with Atokple (1988), Aggarwa (1991) and Zary (1978). The relatively superior result may be due to genetic factors like himunity and resistance. Variety 93K-597 coincidentally was observed to have recorded the highest dry matter yield. This consequently means a bigger or larger canopy coverage of the soil at the base of the crop. This might have in turn led to moisture conservation at the root zone and a modification (i.e. reduction) of this soil temperature. This observation (in agreement with Olasantan 1988b, Odiamgbo and Ariga 2004; Gworgwor 2004), could be due to a reduction in soil temperature and increase in soil moisture. These two factors could delay or totally prevent the germination of striga seed.

The varietal variation observed in cowpea nodulation could be due to genetic factors as well. This agrees with Zary *et al* (1978); Umar (1989); Adu and Nnadi (1990)

The significant reduction in striga infestation on cowpea in response to nitrogen is consistent with Ado and Nnadi (1990), Gucheru and Rao (2001); Chieye *et al* (2005) and Kamara *et al* (2004). Nitrogen increases the population of cytokinin and Gibberelic acid (which are components of root extrudates). These hormones according to the explanation by Parker (1984) suppress the striga seed germination.

Nodulation in cowpea was increased by nitrogen. This could be explained from physiological point of view that nitrogen is involved in the crops physical structure formation. This includes the active cell division leading to the formation of gall that the bacteria inhabit as the root nodules. This reaction is depressed/suppressed by excessive application of mineral nitrogen while an appropriate optimum amount promotes the reaction. This result explanation agrees with Adu and Nnadi (1990); Sprent *et al* (1993) and Petu Ibikunle (2008).

The application of 30KgN/ha at different time as recommended by (weeks after sowing), did not result in a significant difference for dry matter yield, striga infestation and nodulation at location 1 where significant differences were observed, translated to erratic results as they don't follow any meaningful or consistent-trend. The earlier discussed environmental factor may explain the variations in the result between the two locations. Meanwhile, the non significant difference generally observed may be due to the nitrogen rate used. the 30KgN/ha recommended by Bavely and Jarrel (1978) may be too low to sustain the crop. Nitrogen supplied as urea is highly volatile the high solubility in water might have lead to losses due to leaching, erosive washing (especially due to the high rainfall in the month of August). This results conflicts with Umar (1989) where higher rates of nitrogen were used, but agrees with Graham and Scott (1984) where cowpea failed to give significant response to starter nitrogen at rates as low as 30 KgN/ha.

Variety × nitrogen showing that striga reduction may be more specific to 93-596 in agreement with Neves (1978).

Conclusion and Recommendations

A choice of a tolerant/resistance variety to striga (TVU 2027) and promising fields characters (i.e. nodulation and dry matter yield) which is an index of good grain yield potential with the application of 40 KgN/ha preferably at land preparation may be optimum for improving the field performance/productivity of cowpea in Maiduguri and its environs

Based on the result of this experiment, cowpea cultivar TVU2027 could be recommended for this zone while, variety 93K-597 may be tried further for possibility of introduction to the Sudan savannah ecology. Basal nitrogen application at 40Kg/Ha is also recommended for boosting the field performance of these two varieties in this zone.

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