Niger Agric. J. 30 (1999): 32 -40

EFFECT OF TIME OF APPLICATION OF NITROGEN ON NODULATION, DRY MATTER AND MINERAL NUTRITION OF COWPEA (Vigna unguiculata) (L) Walp) IN THE DELTA AREA OF NIGERIA

BY
A. U. OMOREGIE AND G. O. OKPEFA

Dept. of Agronomy,
Edo State University
Ekpoma, Nigeria.

(Accepted November 1998)

ABSTRACT

A two year field study of the effect of time of N application on the nodulation, mineral nutrition and dry matter yield of cowpea was carried out in the Delta area of Nigeria. Treatments consisted of application of N at 7, 14 and 21 days after planting (DAP).

Cowpea responded positively and significantly (P = 0.05) to N application. Effect of time of N application was also significant. Highest dry matter was produced when N was applied 7 DAP. Early N application reduced nodulation. There was a significant positive correlation (r = +0.38) was found between dry matter yield of root and nodule number.

N application increased N, P. Ca, Mg, Na and Cu contents of the shoot of cowpea, though not appreciably. But the K, Fe, Mn and Zn levels in the shoot were reduced by N fertilization. In the same vein, Ca and Mg levels were raised by N but K, Na, Fe, Cu, Zn, N, P and Mn contents in the root were depressed. Nitrogen, P, Ca and Mn levels were higher in the shoot than root and the opposite was the case for N, Mg, Na, Fe and Zn contents.

INTRODUCTION

Average crop yields throughout sub-Saharan Africa are amongst the lowest in the world. Today's world population has generated a massive hunger problem. The development and widespread use of improved crop cultivars has had little impact as soil nutrient deficiencies impose severe limits on plant production (Haque and Jutzi, 1984).

Of the many possible nutrient deficiencies, lack of N imposes the most widespread and strongest restrictions on plant and animal production. It is also an expensive element to replace by chemical fertilizers, particularly in a developing country like Nigeria.

The well-known alternative to fertilizer N, is the N fixed by legumes. Apart from soil fertility improvement (Anander-Kur, 1990; Agboola 1977) legumes are essentials for livestock feed and soil conservation. The association of rhizobia and leguminous plants is unique. The symbiotic N-fixation mechanism is a beneficial as well as inexpensive phenomenon (Allen, 19730. Yet even with this ostensibly simple and cheap approach, many environmental, nutritional, biological and economic factorsrestricttheNfixing potentials of the legume Rhizobium association (Data and Halliday, 1980).

Although legumes may fix N from the atmosphere, fixation may not occur soon after the seeds are sown. There might thus be a part in the life cycle of the cowpea in which the requirement of N is critical for dry matter (forage) production. This is particularly important in soils which are low in organic matter and nitrogen; major soil constituents found to be widely deficient in Nigeria (Nye and Greenland, 1960; Omoregie, 1995).

There is no consensus of opinion on the desirability of inorganic N, fertilization of cowpea under Nigerian climatic and soil conditions (Oke, 1966). The paucity of information on when to apply N to cowpea for forage legume production in the Delta area of Nigeria prompted this study. The results of the study will assist in the effective integration of cowpea into both crop and animal production system.

MATERIALS AND METHODS

The experiment was carried out in the Teaching and Research Farm of Delta State University, Abraka, Lat. 5^0 47'N and Long $6^0$6'E. It is located within the tropical humid zone of Nigeria

with an annual rainfall of about 2,590mm and mean temperature of 23°C. The site used had not previously received fertilizer.

The experiment was laid out in a randomised complete block design with four replications. The experiment was carried out in April, 1990. Nitrogen was applied as Urea at a rate of 40kg/ha. Phosphorus and K were applied respectively at the rates of 30 and 25kg/ha as basal doses during land preparation. Each plot measured 2m x 3m. There were five treatments: No Nitrogen (NO); N applied at planting (NP); N applied at 7 days after sowing (N7), N applied at 14 days after sowing (N14) and N applied 21 days after sowing (N21).

Uninoculated cowpea (local variety) were sown at 60cm and 45cm between and within the rows respectively. Thinning to a plant per stand was done 6 days after germination. Weeding was done by hoeing and handpulling as required throughout the experimental period.

At 35 days after sowing (pre-flowering), six plants per plot were harvested by carefully up-rooting them. They were separated into shoot (stem plus leaves) and roots ensuring as much as possible that roots were not left in the soil. The roots were carefully washed to remove attached soil by dipping them in a cylinder containing distilled water and later air-dried briefly. The nodule number per plant were counted and recorded after removal from the roots. The shoot and roots were later oven-dried at 60°C for 48 hours to determine the dry matter yield (forage yield). A repeat of the experiment was carried out in April, 1991.

Prior to application of N, soil samples were taken at the experimental sites, air dried and screened to pass through a 2mm sieve and analysed for particle size, pH, organic carbon, exchangeable cations, total N, available P and exchangeable acidity were carried out following the standard procedures described by IITA (1979). Nitrogen, P, K, Ca, Mg and micro-elements contents of cowpea shoots and roots were determined on dry matter basis using the methods described by AOAC (1970) after they had been ground in stainless hammer mill.

RESULTS AND DISCUSSION

The physico-chemical properties of the soil used are presented in Table 1. Results showed that the

experimental site was low in N and other elements.

Table 1: Physico-Chemical properties of experimental site.

pH (Water)	6.50
Sand (%)	92.70
Silt (%)	1.80
Clay (%)	5.50
Na cmol/kg	0.02
K cmol/kg	0.12
Ca cmol/kg	3.23
Mg cmol/kg	0.46
ECEC cmol/kg	4.03
Exchangeable acidity cmol/kg	0.20
Available Phosphorus mg/kg	9.94
Total Nitrogen (%)	0.08
Organic carbon (%)	0.99

*ECEC = Effective cation exchange capacity.

Effect of N on nodulation

Application of N (at 40kg/ha) reduced nodule number per plant when compared to the control by 10.37, 13.93 and 51.86% when applied at planting, 7 and 14 days after sowing respectively (Table 2). But an increase of 22.85% in nodule number/plant was observed when N was applied at 21 days after sowing. In a previous observation, N was found to reduce nodulation in cowpea under a subhumid condition in a Nigerian Savanna (Agbenin et al, 1990). This is consistent with the result of the present study. In an earlier work, a decrease in cowpea nodulation with early application of N was observed by Agbenin et al. (1990). Similar results have also been obtained in Ghana (Tewari, 1965) and in Western Nigeria (Agboola, 1977). The result

obtained in this study suggests a depression in nodulation at early stage and a restoration in the later part of cowpea growth. The reduction in nodulation caused by applied N may suggest also a depression in N fixation in this investigation.

Table 2: Effect of time of N application on nodulation and dry matter yield of Cowpea (first cropping).

Time of application	Nodule/no/ Plant	Dry matter	
		Shoot	Root
		g/plant	
No N (No)	36.75[b]	14.50[c]	1.40[d]
N applied at planting (NP)	32.94[b]	20.60[b]	2.23[b]
N applied at 7 days (N7)	31.63[b]	26.93[a]	3.70[a]
N applied at 14 days (N14)	17.60[c]	24.48[a]	2.55[b]
N applied at 21 days (N21)	47.63[a]	15.75[c]	2.10[c]

Values in the column bearing same letter do not differ significantly at 5% level.

Similar trend was observed in a repeat experiment in the following year (Table 3).

Effect of N on dry matter yield:
N application was found to increase dry matter yield of cowpea in a sandy loam in Nigeria. The yield increases varied with time of N application. The highest DM yield was obtained when N was applied 7 days after sowing. This represents an increase of 85.7% over the control and was significantly different from all other treatments (Table 2). The least dry matter yield was obtained when N was applied at 21 days after planting even though the highest number of nodules was produced in this treatment. A significant ($P = 0.05$) negative correlation ($r = -0.54$) between nodule number and dry matter yield of the shoot (leaves and stem) of cowpea was obtained. If nodulating legumes are able to fix sufficient N for their requirements, the application of N usually has no effect. Indeed it may raise soil nitrate to a level which depresses nodulation and N fixation. This may partly explain the observed

nodulation trend in this investigation.

Applied N significantly increased root development of cowpea (Tables 2 and 3). The application of N at seven days post planting significantly raised root development over all other treatments. A significant positive correlation (r = 0.38; P 0.050 between nodule number and dry matter yield of root was observed in the first year. This indicates that most of the N fixed were utilised in root development rather than shoot system (stem and leaves) development in this study.

Based on the significant response by cowpea to applied N, a starter dose of 40kg/ha is beneficial to the crop. This requirement is necessary particularly in soils low in nitrogen content such as the soil used in this investigation. In soils having low levels of minieralisable N, fertilization of cowpea with organic N is beneficial. It should also be observed that varietal effect could be a factor in cowpea response to N fertilisation since ability to nodulate and fix atmosphere N differs with variety (Agbenin et al., 1990). The results of the repeated experiment (Table 3) showed similar trends to the previous year.

Effect of N on the Mineral Composition of Cowpea

The N and mineral composition of the shoot and root of cowpea is influenced by time of N application represented in Table 3.

Table 3: Effect of time of N application on nodulation and dry matter yield of Cowpea (second cropping)

Time of application	Nodule/no/ Plant	Dry matter	
		Shoot	Root
		g/plant	
No N (No)	34.60^{b}	15.60^{b}	1.02^{c}
N applied at planting (NP)	30.42^{bc}	18.75^{b}	2.40^{b}
N applied at 7 days (N7)	29.16^{c}	27.20^{a}	3.76^{a}
N applied at 14 days (N14)	18.12^{d}	22.95^{a}	2.16^{b}
N applied at 21 days (N21)	45.23^{a}	15.00^{c}	1.90^{c}

Values in the column bearing same letter do not differ significantly at 5% level.

Nitrogen:

N application slightly raised N content in the shoot. Nitrogen contents in the roots were lower at all stages of N application than those found in the shoot. Also, lowest N contents were observed when N applied at 14 days post planting in both the shoot and root.

Phosphorus:

The P content in the shoot was observed to be slightly lower in the root than shoot. Although N application increased P contents in the shoot the reverse was the case in the root. Mean P level in the shoot (0.38%) was found to be highest when N was applied at planting.

Calcium:

The Calcium levels in the shoot ranged from 1.33 to 2.00% while the range in the root was 0.76 - 1.04%; thus Ca contents were higher in the shoot than the root. Early application of N raised Ca contents and late application depressed Ca level in both shoot and roots. Highest Ca levels were obtained when N was applied at 7 days of growth.

Magnesium:

Early application of N increased the mineral composition of Mg. The Mg content was higher in the root than in the shoot. The levels ranged from 0.25 to 0.33% with a mean of 0.29% in the shoot; while it ranged from 0.32 to 0.48% in the root with a mean of 0.38%.

Potassium:

Applied N slightly raised K content in the shoot when applied at planting. N applied at other times generally depressed K contents in both shoot and roots. Potassium content was higher in the root than in the shoot.

Sodium:

N had no appreciable effect on Na concentration. Sodium levels in root were higher than in the shoot. N depressed Na content in the root and insignificantly raised Na levels in the shoot.

Trace elements:

N application did not have appreciable effect on Fe, Cu, Zn, and Mn contents in cowpea. Also, time of N application was not related to the levels of these trace elements. Iron and Zn contents were higher in the root than shoot; while Mn was higher in the shoot. There was no difference observed in Cu contents in both root and shoots.

Table 4: Effect of Time of Nitrogen Application on Mineral Composition of Cowpea (Dry Matter Basis).

TREATMENT	N	P	Ca	Mg	K	Na	Fe	Cu	Zn	Mn
SHOOT	%DM						mg/kg DM			
No Nitrogen	4.35	0.33	1.64	0.27	2.76	0.44	3.62	0.06	0.47	0.60
N at planting	4.69	0.38	1.87	0.33	2.78	0.44	3.36	0.06	0.50	0.65
Mat 7 days	4.65	0.34	2.00	0.30	2.40	0.42	2.87	0.07	0.44	0.52
N at 14 days	4.42	0.35	1.89	0.32	2.46	0.54	3.88	0.08	0.39	0.48
N at 21 days	4.55	0.31	1.33	0.25	2.46	0.54	2.95	0.06	0.35	0.56
Mean	4.51	0.34	1.75	0.29	2.57	0.47	3.34	0.07	0.43	0.56
SEM	±0.07	±0.001	±0.14	±0.008	±0.06	±0.02	±0.001	±0.01	±0.001	±0.003
ROOT										
No Nitrogen	2.74	0.38	0.89	0.37	5.10	0.92	6.48	0.08	0.55	0.32
N at planting	2.47	0.35	0.94	0.48	3.75	0.75	3.52	0.07	0.43	0.26
N at 7 days	3.03	0.32	1.04	0.42	4.58	0.89	6.58	0.06	0.50	0.35
N at 14 days	2.33	0.31	0.92	0.33	4.73	0.69	3.45	0.07	0.44	0.25
N at 21 days	2.52	0.31	0.76	0.32	4.28	0.39	3.75	0.07	0.51	0.25
Mean	2.62	0.33	0.91	0.38	4.48	0.79	4.76	0.07	0.49	0.29
S.E.M	±0.05	±0.02	±0.001	±0.02	±0.01	±0.06	±0.06	±0.001	±0.03	±0.002

S.E.M = Standard Error of Means.

CONCLUSION

Although uncertainty exists on the need of N application to cowpeas in terms of grain yield, the results obtained here indicate that N is required for higher dry matter production which is of importance to ruminants as supplementary feed. In applying N, it is very important to take into consideration the time to apply it. Based on results obtained here, it is suggested that a week after sowing, probably when some roots have been developed, is best for N application to cowpea for dry matter production.

Application of N had inhibitory effect on nodulation but not on dry matter production. Further investigation is suggested to determine appropriate rate of N in relation to the time that it may be effective for nodulation under different soil and climatic conditionsusingdifferent varieties.

Though the results of this study is based on a single area of field study, where N deficiency had been previously reported, nevertheless, the investigation had supplied baseline information which will form the basis of future study in the forest zone of Nigeria.

REFERENCES

Agbenin, J. O., G. Lombin, and J. J. Owonubi, (1990). Effect of Boron and Nitrogen fertilization on cowpea nodulation, mineral nutrition and grain yield. Fertilizer Research 22: 71-78.

J. J.Agboola, A.A. (1977). The influence of soil organic matter on cowpea response to nitrogen fertilizers. Nig. Agric. Soc. Bull. I: 17 - 19.

Allen, O. N. (1973). Symbiosis: Rhizobia and leguminous plants. Pp. 98 - 104. In: Heath, M. E. Metcalfe, D. S. and Barnes, R. F. (eds.) Forages. The Science of Grassland and Agriculture. Third Edition. The Iowa State University Press, Ames, Iowa, U. S. A.

Anander-Kur, S. (1970). Evaluation of the Boron status of some Savanna soils using soil and plants analysis. Ph.D Thesis. Ahmadu Bello University, Zaria, Nigeria. 140pp.

AOAC (1970) Official methods of analysis (11th ed.) Washington DC.

Date, R. A. and J. Halliday, (1980). Relationships between Rhizobuim and Tropical Forage Legumes. Pp 597 - 601. In: Summerfield, R. J. and Bunting, A. H. (eds.) Advances in Legume Science Proc. Int. Legume Conf. Kew. Vol. 1. Royal Botanic Gardens, Kew; 31st Juiy - August 4, 1980.

Haque, I, and S. Jutzi, (1984).Nitrogen fixation by forage legumes in sub-Saharan Africa: Potentials and limitations. ILCA Bulletin. October pp 3 -13. Addis Ababa.

Nye, P. H. and D. J. Greenland, (1960). The soils under shifting cultivation. Technical Commission Bureau of Soils. Herperden, England.

Oke, D. O. (1960). The fixation and transfer of nitrogen in cowpeas. West Afr. Agric. Biol. Appl. Chem. 9: 17-19.

Omoregie, A. U. (1995). Forage yield and quality of two herbaceous legumes in relation to soil phosphorus in the sub-humid and semi-arid zones of Nigeria Ph. D Thesis, University of Ibadan, Nigeria. 161 pp.

Tewari, G. P. (1965). Effects of nitrogen, phosphorus and potassium on nodulation in cowpeas. Expl. Agric. 1: 253-256.