Research Paper

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Evaluation of Optimum N-Level for Early Establishment and Yield of Two Soybean Varieties in Southern Nigeria

Agriculture

KEYWORDS : N-level, soybean varieties, biomass yield, better establishment, varietal supremacy

OYATOKUN, O. STEPHEN Department of Agronomy, University of Ibadan, Nigeria.

ABSTRACT

Nitrogen is essential for the growth and development of a crop plant and is a major soil nutrient element of soybean. Its deficiency in soil before soybean root nodule formation constitutes the most limiting situation for its production after soil moisture. A screen house pot experiment was conducted in 2008 to examine the effects of N application on the establishment and yield of soybean on a ferric luvisol of southern Nigeria. Top soil samples were collected and used to carry out a 2 x 7 factorial experiment in a completely randomized design with three replications. Parameters measured include plant height, number of leaves, biomass yield and N-content. There were gradual increases in plant height with plant age across the varieties studied. While TGx1485-1D produced a significantly higher biomass yield of 1.03g/pot, TGx1448-2E produced 0.85g/pot. Similarly, TGx1485-1D accumulated more N in shoot (4.68%) than TGx1448-2E (4.11%). This revealed the varietal supremacy of TGx1485-1D over TGx1448-2E in terms of better establishment and yield. However, applied N proved no significant influence on yield and N accumulation of soybean, thus the cultivation of TGx1485-1D is therefore recommended in the area.

Introduction

Production of soybean is rapidly taking a centre place among cereals and grain legume production in the moist savanna zone of Nigeria. This stems from the fact that it is rapidly becoming a major food as well as an industrial crop in Nigeria (Brader, 1998). The growth in the area of cultivation and increase in the yield is due to farmers' adoption of newly bred soybean varieties at the International Institute for Tropical Agriculture (IITA). Soybean (*Glucine max* (L.) *Merr*), a legume, occupies a premier position among grain legume crops because of its high and virtually unrivalled, protein content (40%) and the rich source of high quality edible oil (20%) which makes it a food crop with great potential to improve the diet of millions of people in developing counties (Carrao & Gontijo, 1994). Numerous studies have shown that high soil N level decreases nodulation and suppresses biological nitrogen fixation (Awonaike *et al*., 1992; Taylor *et al*., 2005). There is a dearth of information on the required suitable N rate that synergies soybean early establishment to improve soil N status and grain yield of soybean. The application of N starter-dose is therefore important to overcome early N stress by stimulating early growth of leguminous crops and to induce the activity of nitrogen – fixing bacteria in most legumes. This paper therefore aims to determine the optimum N-level for early establishment and greater yield of two soybean varieties in southern Nigeria. The specific objectives are to:

(i) assess the optimum N fertilizer rate for early establishment of two soybean varieties, and
(ii) assess the nitrogen rate that enhances grain yield.

Materials and Methods

Location

The experiment was conducted at the screen house of the department of Agronomy, University of Ibadan, Nigeria.

Characteristics of soybean varieties

Two promiscuous soybean varieties TGx1448 – 2E and TGx1485 – 1D were planted in the course of this study. Variety TGx1448 – 2E is a medium/late maturing cultivar, it matures about 105-110 days after planting while TGx1485 - 1D is an early maturing type which matures about 90-100 days after planting. The 2 varieties are very efficient in nitrogen fixation (IITA 1984).

Soil sampling/Analysis

Top soil samples (0-15cm) from Gbonran (Latitude 8° 06' N; Longitude 03° 30' E) in Oyo North which lies within soybean production belt of the southern Nigeria were collected. The soils were air dried and sieved through 2mm-sieve for pre-planting routine soil analysis and characterized as *ferric luvisol* according to FAO/IUSS (2006).

Experimental procedures and design

Soils were filled into 5kg pots and arranged in the screen-house. Six (6) pots were planted to maize (Oba 98 hybrid, quality protein maize with high nitrogen requirement) and uprooted 2 weeks after planting (WAP) to mop up some native nitrogen in the soil. A total of forty-two (42) pots (including the 6 mopped-up pots) were planted to soybean varieties treated with *Apron plus*. Planting was done in pots at the rate of 4 seeds per pot and later thinned to 2 plants 1 week after planting (WAP). The experiment was a 2x7 factorial in a completely randomized design (CRD) with 3 replications. N fertilizer in the form of urea was applied 1 WAP at varying levels of M0 (mopped control), N0 (unmopped control), 5, 10, 15, 20 and 25 kg/ha. Planting materials are two varieties of soybean: TGx1448-2E and TGx1485 – 1D. Growth and crop establishment data (plant height and number of leaves) collection commenced 2 WAP and on subsequent weekly basis. While yield parameters (number of days to flowering, plant N accumulation and biomass production) were also measured during plant growing stage and at harvest. Data obtained were subjected to analysis of variance procedures using GENSTAT discovery edition 3 (www.vsni.co.uk). Means were also separated with least significant difference (LSD) at 5% probability level (Steel & Torrie, 1987).

Results and discussion

The chemical and physical properties of the soil used showed that the pH is 6.5, available P 1.34 mg/kg, organic carbon 9.5 g/kg, total N 0.70g/kg and K 2.37 cmol/kg. This showed that the soil is inherently low in fertility. The total N, available P and K were very low and the organic matter content was also low to hold nutrients. The soil textural class is loamy sand with particle size analysis as follows: clay (68g/kg), silt (120g/kg) and sand (812g/kg). The mopping therefore further impoverished the soil so that the effect of the treatment could be easily noticed on the soybean varieties planted.

Crop establishment and growth

There were gradual increases in plant height with plant age. TGx1485-1D variety showed significantly higher plant height at 2 and 4 WAP, and by 5 WAP there was no marked difference in varietal response.

(Table 1: N dose and varietal effects on the growth and yield parameters of soybean).

However, significant N level x variety interaction occurred in the plant height at 2WAP, with 10kgN/ha application rate where TGx1485-1D showed a dominant plant height response (Figure 1: Interactive the effect of variety x N-level on soybean plant height at 2WAP).

This revealed that TGx1485-1D showed better establishment than TGx1448-2E. These results agree with earlier works done by Okpara & Ibiam (2000) and Yusuf & Idowu (2000) who observed significant differences among soybean cultivars for plant height. In terms of the number of leaves produced, there was no significant varietal response.

(Table 1: N dose and varietal effects on the growth and yield parameters of soybean).

The application of N dose also has no significant effects on soybean plant height; however, the effect was significant on the number of leaves produced at 2WAP. The effects of variety x N level interaction were significant at 2WAP and 5WAP,

(Figure 2: Interactive effect of variety x N level on the number of leaves produced by soybean at 2WAP) (Figure 3: Interactive effect of variety and N level on the number of leaves produced by soybean at 5WAP) where the application rate of 10kgN/ha produced a significantly different response in terms of leaf production between the varieties studied.

Days to flowering.
The two soybean varieties TGx1485-1D and TGX1448-2E showed a marked difference in the number of days to flowering in soil. The number of days to flowering was 32.10 and 34.12 for TGx1485-1D and TGX1448-2E respectively. This corroborates the classification basis on maturity group, where early maturing variety was the first to flower. The application of N starter-dose did not give a remarkable difference in this attribute.

(Table 1: N dose and varietal effects on the growth and yield parameters of soybean).

Stem weight.
TGx1485-1D produced a significantly higher stem weight of 0.554g as against that of TGx1448-2E which was 0.475g.

However the application of N starter-dose did not significantly affect the stem weight of soybean.

(Table 1: N dose and varietal effects on the growth and yield parameters of soybean).

Leaf weight.
Varietal response was significantly different. TGx1485-1D produced leaf weight of 0.482g and TGx1448-2E produced leaf weight of 0.377g. Similarly, N dose at various rates did not give a marked difference on the weight of leaves at $p<0.05$.

(Table 1: N dose and varietal effects on the growth and yield parameters of soybean).

Shoot weight.
There was a significantly different response with respect to shoot weight at $p<0.05$. TGx1485-1D produced shoot weight of 1.027g/pot and TGx1448-2E produced shoot weight of 0.851g/pot. N application rates however, did not significantly affect soybean shoot weight.

(Table 1: N dose and varietal effects on the growth and yield parameters of soybean).

Shoot N accumulation.
Soybean varieties responded differently to shoot N accumulation. While TGx1485-1D accumulated 4.680%, TGx1448-2E accumulated 4.116%. Application of N as starter dose did not give any marked difference in shoot N accumulation.

(Table 1: N dose and varietal effects on the growth and yield parameters of soybean).

It is worthy of note that while soybean varieties varied responses in the soil, the effects of starter N application on all parameters measured were not significantly different. This might be due to the genetic make-up of the varieties. The result of this study is in conformity to works from various researchers that the application of N fertilizer did not have any effect on the performance of legumes, soybean inclusive [Hoeft *et al.* (2000); Heatherly *et al.* (2003); Scharf & Wiebood (2003); and Mehmet (2008)].

Conclusion
TGx1485-1D exhibited varietal supremacy in terms of early establishment and growth as well as in biomass production over TGx1448-2E and is therefore recommended in the study area, however, the application of starter N to soybean varieties has less effect on the plant performance indices such as plant height, number of leaves produced, number of days to flowering, N accumulation and biomass production.

Figure 1: Interactive the effect of variety x N-level on soybean plant height at 2WAP.

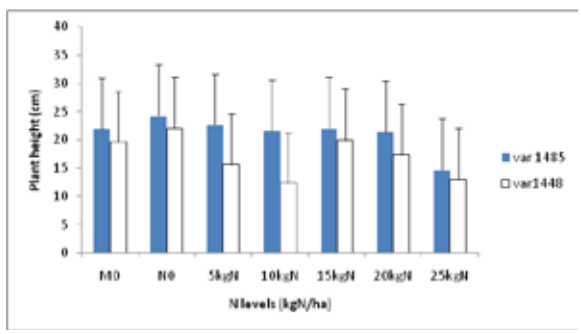

Figure 2: Interactive effect of variety x N level on the number of leaves produced by soybean at 2WAP.

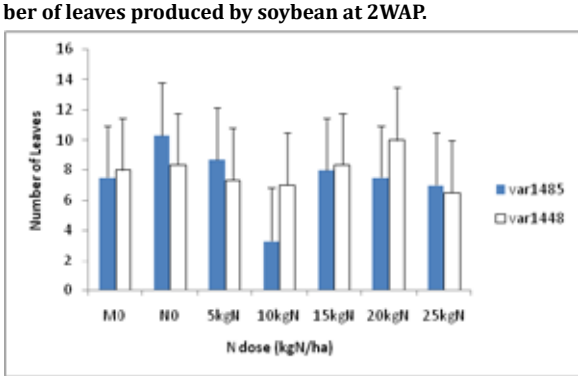

Figure 3: Interactive effect of variety and N level on the number of leaves produced by soybean at 5WAP.

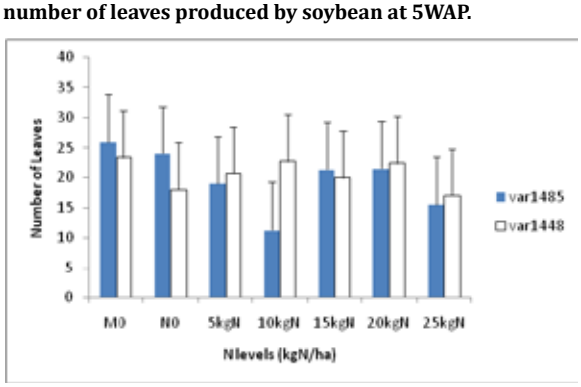

Table 1: N dose and varietal effects on the growth and yield parameters of soybean.

VARIABLE		PLANT HEIGHT (cm)			NO, OF LEAVES			DF	ST.WT (g)	LF.WT (g)	SHOOT WT (g)	N% in SHOOT
Variety	2WAP	4WAP	5WAP	2WAP	3WAP	4WAP	5WAP					
1485	21.26	44.90	58.70	7.48	10.83	14.40	19.80	32.10	0.55	0.48	1.03	4.68
1448	17.14	37.70	58.00	7.93	10.52	14.38	20.57	34.12	0.48	0.38	0.85	4.12
N LEVELS												

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M0	20.82	41.50	59.60	7.75	10.33	13.83	24.65	33.00	0.61	0.58	1.18	3.84
N0	23.17	52.20	77.30	9.33	11.67	14.83	21.00	33.17	0.56	0.46	1.02	4.52
N1	19.17	44.50	65.80	8.00	11.83	15.00	19.83	32.00	0.55	0.43	0.94	4.67
N2	17.00	37.40	50.10	5.17	10.33	13.42	17.00	33.50	0.49	0.39	0.88	4.24
N3	21.00	42.50	66.80	8.17	10.33	15.00	20.67	33.17	0.52	0.43	0.95	4.25
N4	19.42	35.20	40.70	8.75	10.50	15.17	21.92	33.17	0.47	0.37	0.83	4.42
N5	13.83	35.80	48.20	6.75	9.75	13.50	16.25	33.75	0.42	0.35	0.77	4.86
S.E.D												
Variety	1.66*	3.15*	6.27	0.64	0.49	0.72	1.46	0.26*	0.05*	0.04*	0.08*	0.18*
N-Levels	3.11	5.89	11.72	1.20*	0.92	1.34	2.72	0.49	0.09	0.07	0.16	0.33

*Significant at p=0.05
WAP = Weeks After Planting
DF = Days to Flowering
ST.WT = Stem Weight
LF.WT = Leaf Weight

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