GROWTH, YIELD AND YIELD COMPONENTS OF SOYBEAN (*GLYCINE max* (L) MERRILL) AS INFLUENCED BY SOWING DATE AND PLANT POPULATION

BY

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DECLARATION

I hereby declare that this thesis has been written by me and that it is a record of my own research work. It has not been presented before in any previous application for a higher degree.

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CERTIFICATION

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DEDICATION

This work is dedicated to my beloved husband,

Mr. G. C. Iheanetu, for his encouragement and support.

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ABSTRACT

An investigation was carried out during the 1987 cropping year at Samaru, Zaria, to study the effect of three sowing datea (June 24, July 8 and July 22), three plant population (200,000; 350,000 and 500,000 plants/hectare) and two soybean varieties (TGX536.020 and TGX814-26D) on growth, yield and yield components of soybean.

Seed sown on June 24 with a mean seed yield of 2647.88kg/ha out-yielded that sown on July B and July 22, respectively. Delay in showing from June 24 to July 8 and July 22 led to a decrease in number of flowers, pods per plant, effective nodules (8 WAS), crude protein, oil content and 100-seed weight Increasing plant population led to increase in crude protein content, effective nodules (84AS), plant height and plant lodging.

Variety TGX814.26D out-yielded variety TGX536-02D in number of flowers, pods per plant, crude protein and had higher grain yield While variety TGX536-D2D had higher number of nodes, lodged plants and number of branchea than variety TGX814-26D.

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Chapter 1

INTRODUCTION

1.1 Origin and Distribution

The soybean (*Glycine max* (L.) Merrill) is a native of the orient. Historical and geographical evidence indicate that the crop was first domesticated around 11th century B.C. in China Tanimu *et. al.* (1982). According to Purseglove (1977) the soybean crop spread world-wide into the United States of America around 1804 but was mostly used as forage and pasture crop. However, the need for edible oil arose and this led to its commercial production in America. According to Hadjichristodoulou (1986), it is grown as a major crop in China and other Eastern Asian countries. It is also grown extensively in Brazil and Soviet Union.

1.2 Introduction into Africa and Nigeria

Leakey *et al.* (1977) reported that soybean was introduced into Africa by the colonial officers and missionaries around 20th century. That the crop came to Tanzania in 1907, and Uganda, in 1913 but that it was not until the 1940s that it became established. Ezue and Dina (1980) stated that soybean was introduced into Nigeria in 1910 and research work on the crop started at Samaru, Nigeria, in the 1930s. In 1914, the National Cereals Research Institute, Ibadan, began an active programme on soybean improvement (Ezue and Dina, 1980). In 1937, a variety, Malayan, was introduced and this was the

first variety to be recommended in the soybean growing area of Nigeria (Leleji and Adedżwa, 1983).

1.3 Soil and Climatic Requirements

Because of wide adaptation, Piper and Morse (1923) stated that soybean can be successfully grown on a wide variety of soils but best result is obtained in sandy or clay loams. According to Jacob and Van Vexkiill (1970) soybean likes a deep fertile soil with high calcium content. Optimum pH range lies between pH 5.7 and 6.2 and heavy impermeable soils are not suitable for soybean culture. It flourishes well on light soils which contain sufficient nutrient especially calcium. Richard *et al*. (1974) indicated that soybean requires about the same soil and climatic condition as maize.

1.4 World Soybean Production

Fielding, (1968), reported that interest in soybean production outside its natural environment started in the 1920s. Anon (undated) stated that production of the crop is centred mainly in the temperate growing regions of the world with North America and Asia leading in both hectarage and yield. Hunson and Hartwig (1977), also stated that United States of America leads the world in production, followed by the People's Republic of China, Brazil, Indonesia, Mexico, USSR and Canada. The FAO (1980) Production Year Book estimated world soybean production as 83,481,000 metric tonnes from a total harvested

area of 52,639,000 hectares. USA produced 50,468,000 metric tonnes from a harvested area of 27,460,000 hectares. China produced 10,026,000 metric tonnes, Brazil 15,153,000 metric tonnes and USSR 470,000 metric tonnes. According to Annon (undated). The average world soybean yield is 1.43 metric tonnes per hectare.

1.5 Production in Nigeria

The main soybean growing area in Nigeria according to Ashaye et al. (1974) is Benue State, followed by Niger State and the Southern part of Kaduna State. From FAO (1980) estimation, Nigeria produced 77,000 metric tonnes from a cultivated area of 197,000 hectares, which meant a production of 390 kilogramme per hectare. According to Matthew (1977), Nigeria's low production is based on the fact that soybean has not gained much prominence in the nation's agricultural cropping pattern. The crop is still unknown to majority of Nigerian farmers. Hendrick et al. (1985) reported that most soybean production is by small land holders and the low prices offered on the soybean produced are not enough incentive for the expansion of the crop in the country. Paullete (1978) reported that the main reason for the little use of soybean in Nigeria as food is the difficulty in cooking and the unpalatability of the beans when not well processed. Hendrick et al. (1985) reported that the crop is produced in small holdings of one or two hectares by farmers.

1.6 Economic Significance of Soybean

According to Hendrick et al. (1985) soybean has the highest biological value of all vegetable proteins. In the early years, soybean was used as green manure. Its importance as food is related to its high crude protein content of about 40% and oil content of about 21%. Hadgichristodoulou (1986) stated that because of soybean's high crude protein content, it has a variety of uses. Its oil is edible and it is also used in the paint industry. The meal is used as a source of protein in livestock feeds and in many human foods such as milk, cheese, soybean sause etc. It is also used as forage crop. Ashaye et al. (1974) reported that in Nigeria, soybean is prepared into many dishes such as "moi moi" "puff puff", "soy-ogi" and "dawadawa" for soup flavouring.

1.7 Justification for Soybean Production

The gross decline in the production of groundnut as indicated by FAO (1980) and oil palm which are the two main source of vegetable oil in Nigeria, added to the recent ban on importation of vegetable oil in order to cut down drastically on the foreign exchange expended annually have all made soybean an important alternative oil seed crop, in view of the enormous prospect which the crop holds for the agro-allied sector of the national economy. This investigation was proposed to dtudy.

This study is therefore undertaken to determine:

1. The appropriate sowing date and population that will

give optimum grain yield and yield components.

2. The interactions between sowing date, population and two soybean varieties.

Chapter 2

LITERATURE REVIEW

2.1 Effect of Sowing Date on Yield and Yield Components of Soybean

The date of sowing soybean influence the yield characteristics of the crop. In Hawaii, Beard et al. (1980) found that significant differences in soybean yield were associated with sowing date.

In USA, Beatty et al. (1982) reported that late planting can severaly reduced yield of soybean. This was supported by Cartter (1974) and Graves et al. (1978) who believed that plant height, pods per plant, seed weight, protein content and oil content decreased with late planting and that below normal rainfall occured for the late planting. This contributed to less vegetative growth which caused less photosynthesis, especially during pod filling. In Japan, Matsuii and Nishiiru (1981) observed that delay in sowing decreased flowering, maturity and seed yield. Also in Brazil, Lam-Sanchez and Yuyana (1979) found that seed yield, pod number per plant, plant height and stem diameter decreased with later planting.

Graves and HeCutchen (1978), at Milan, indicated that delayed sowing resulted in late flowering, maturity, reduced plant height and smaller seeds. Board (1985) in Louisinana, reported that seed yield reduction at non-optimal planting dates

were more associated with decreased branch number which was related to fewer branch nodes and consequently fewer branch pods. He stated that drought stress and photo-period were possible the environmental factors causing decreased branch yield at late planting.

Runge and Carmer (1973) in Illinois, observed that rainfall and maximum temperature during growing season were found to account for variation in soybean yield. In India, Yusuf et al. (1971), reported that early sown crop naturally had longer growing season than subsequent ones. At Yandev, Nigeria, Olufajo et al. (1983), reported that soybean crops planted between mid-June and mid-July yielded significantly greater than the ones planted either early or later. They observed drastic yield reduction in late sowing Schuster and Posselt (1979) in Germany found out in contrast with Cartter (1974) and Graves et al. (1973) that protein content increased with delay in sowing but while oil content decreased. A negative relation was found between protein and oil content. Abel (1970) in Southern California, reported that maximum lodging occured in early planting of soybean while delayed planting resulted in decreased lodging. Paul and Burnside (1985) from Nebraska, stated that soybean yields for early planting dates were generally higher than for the late planting dates.

2.2 Effect of Plant Population on Yield and Yield Components of Soybean

Report on soybean production at various plant populations

for yield by various workers have not been consistent. Alesi and Power (1982) in Nebraska, reported that number of pod per plant was significantly reduced by decreasing spacing within row.

Enyi (1973) in Tanzania, indicated that number of nodes per plant, number of pods per plant, number of branches and grain yield decreased with increase in population. He attributed the reduction in yield to the inadequate number of pods per plant high plant population. He further observed that plant population influenced the crop growth rate and yield of the plant. In Nandan, Alesi and Power (1982), indicated that soybean yield were frequently increased by planting in narrow rows. That the effect of narrow rows showed that the closer canopy that result may intercept a large percentage of the solar radiation, thereby increasing photosynthesis and reducing soil evaporation losses. Beatty et al. (1982) reporting from USA, said that when planting is late, increased yields will result from narrow rows spacing of 50cm or less. In Iowa, Taylor (1980) believed that there is an interaction between row spacing and seasonal water supply in their effect on soybean yield. Canopy closure by the time that pod-filling starts allow more photosynthesis to occur and yields were greater in narrow rows when seasonal water supply was high.

Beaver and Johnson (1981) in Northern USA, indicated that the proportion of seeds planted that produced mature plants with pods decreased as the seeding rate increased from 350,000 to 650,000 plants per hectare and that plant height and podding

height increased as the seeding rate increased from 350,000 to 650,000 plants per hectare.

In Swaziland, Piggot and Farrel (1982) found that as seeding rate increased, plants were taller and displayed greater internode lenght, a reductior in node number, pod number per plant but there was slight decrease in seed per pod and seed weight. Coaster et al. (1980) working in Brazil, reported that increased plant population decreased number of branches per plant and increased lodging. Shroyer and Whigan (1981) in USA, reported that plant height, number of nodes and lodging increased as row spacing decreased.

Hicks et al. (1969) from Minnesota, reported that loding is one of the major factors affecting yield response to increased plant population. When lodging occured, yields were reduced as plant density increased. They further reported that environmental variation significantly affected level of lodging. Yield components of soybean changed as plant population increased and the number of seeds, pods, branches per plant decreased linearly as plant population increased. At low densities, soybean plants compensate by producing more branches and more pods per plant. In Swaziland, Douherty (1969) obtained slightly high oil content when soybean was grown at low plant population.

Highest yield, according to Cooper (1977), from Illionois, were obtained in the lowest seeding rate and that yields tended to increase with decrease in row width.

Chapter 3

MATERIALS AND METHODS

3.1 Description of Experimental Site and Soil

During the 1987 rainy season, an experiment involving two varieties of soybean (Glycine max (L) Merrill) TGx536-02D and TGx814-26D was conducted at the Institute for Agricultural Research farm at Samaru ($11^{0}11^{'}$N 07^{0}, 38^{1}E) 686 meters above sea level in the Northern Guinea Savanna ecological zone, to determine effect of sowing date and plant population on yield and yield components of soybean. The soil of the site is sandy loam and the details of physio-chemical analysis of the soil are contained in Table 1. Also details of the meteorological records during the period of the experiment are contained in Appendix I.

3.2 Experimental Design, Plot Size and Treatment

3.2.1 Block design and plot size

The experiment consisted of 18 treatments which were laid out in a randomized complete block design with four replications. The gross and net plot sizes were 22.5m^2 and 15m^2, respectively.

3.2.2 Treatment

The treatments consisted of two varieties of soybean TGx536-02D an early maturing variety and RGx814-26D a later maturing variety. Three plant populations of 200,000, 350,000

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Randomized Complete Block Design

	BLOCK I		BLOCK II		BLOCK III		BLOCK IV	
	5m	5m	.75m		1.5m			
45m	1 $D_2V_2P_3$	10 $D_3V_2P_3$	19 $D_1V_2P_2$	28 $D_1V_1P_2$	37 $D_1V_1P_3$	46 $D_3V_2P_2$	55 $D_3V_1P_3$	64 $D_3V_1P_1$
.75m	2 $D_2V_1P_3$	11 $D_1V_1P_3$	20 $D_3V_2P_1$	29 $D_3V_2P_2$	38 $D_2V_2P_2$	47 $D_1V_1P_1$	56 $D_2V_2P_1$	65 $D_2V_1P_1$
	3 $D_1V_1P_2$	12 $D_1V_1P_1$	21 $D_2V_2P_3$	30 $D_2V_1P_3$	39 $D_1V_2P_1$	48 $D_2V_2P_1$	57 $D_3V_1P_2$	66 $D_2V_1P_2$
	4 $D_2V_1P_1$	13 $D_3V_1P_3$	22 $D_2V_1P_2$	31 $D_3V_1P_3$	40 $D_2V_1P_1$	49 $D_3V_1P_1$	58 $D_3V_2P_1$	67 $D_1V_2P_3$
46.5 m	5 $D_1V_2P_2$	14 $D_3V_1P_2$	23 $D_3V_1P_1$	32 $D_1V_2P_3$	41 $D_3V_1P_2$	50 $D_1V_2P_3$	59 $D_3V_2P_3$	68 $D_1V_2P_1$
	6 $D_2V_1P_2$	15 $D_1V_2P_3$	24 $D_2V_1P_1$	33 $D_3V_1P_2$	42 $D_3V_2P_3$	51 $D_3V_2P_1$	60 $D_2V_1P_3$	69 $D_2V_2P_2$
	7 $D_3V_2P_1$	16 $D_3V_2P_2$	25 $D_1V_1P_3$	34 $D_1V_1P_1$	43 $D_2V_1P_3$	52 $D_1V_2P_2$	61 $D_1V_1P_1$	70 $D_1V_1P_3$
	8 $D_1V_2P_1$	17 $D_3V_1P_1$	26 $D_3V_2P_3$	35 $D_2V_2P_1$	44 $D_3V_1P_2$	53 $D_2V_1P_2$	62 $D_1V_1P_2$	71 $D_2V_1P_2$
	9 $D_2V_2P_2$	18 $D_2V_2P_1$	27 $D_1V_2P_1$	36 $D_2V_2P_2$	45 $D_1V_1P_2$	54 $D_2V_2P_2$	63 $D_3V_2P_3$	72 $D_1V_2P_2$

Keys

V = Variety

D = Date of Sowing

P = Plant population

Variety = V_1

Variety = V_2

Row spacing 75 cm

Within row spacing:

(a) 6cm
(b) 4 cm
(c) 2cm

Dates of Sowing

D_1 = First sowing date

D_2 = Second sowing date

D_3 = Third sowing date

Plant Population

6cm P_1 = 200,000/ha

4cm P_2 = 350,000/ha

2cm P_3 = 500,000/ha.

and 500,000 plants per hectare were used. Three sowing dates, spaced forth-nightly - 24th June, 8th July and 22nd July, were also used.

3.3 Cultural Practices

3.3.1 Land preparation

The experimental site was disc-ploughed, harrowed and ridged. Four blocks consisting of 18 plots each were laid out. Each block was 1.5 metres apart and the plots were 0.75 metre apart. A total of 72 plots were laid out.

3.3.2 Sowing

The seeds were sown on ridges 0.75 meter apart and 6, 4 and 2 centimeters within row, depending on the population desired.

3.3.3 Fertilizer application

Fertilizer, at the rate of 25kg/ha of Nitrogen (CAN) was used as a starter dose at planting while 80kg/ha of P_2O_5 (single superphosphate) was used as basal dressing before sowing the seeds.

3.3.4 Weed control

A pre-emergence herbicide-Ingram-Combi, at the rate of 3 litres (1.5 active ingredient) per hectare was applied immediately after sowing the seeds. Hoe weeding was carried out 4 and 8 weeks

after sowing, respectively.

3.3.5 Disease and pest control

No disease attack was observed. The plant maintained a healthy appearance throughout their growth. Only a few grasshoppers which tried to feed on the leaves were observed. The plots were sprayed with 50mls of Cymbush (a pesticide) mixed with 10 litres of water for the control of the grasshopper infestation (blanket spraying).

3.3.6 Harvesting

This was carried out when the leaves of the soybean plants turned yellow and eventually dried out in the field. Harvesting was based on the maturity of each variety. The plants were cut at the base and threshed immediately to avoid losses through shattering. The four inner ridges were harvested as net plots.

3.3.7 Threshing

The pods were threshed and the chaff was separated from the seeds by winnowing with trays. The clean seeds from each plot were weighed and dried.

3.4 Data Collection

- Five plants were randomly selected and tagged.

3.4.1 Time to 50 flowering

This was recorded from the sowing date to the time 50% of the plants in each plot flowered.

3.4.2 Number of flowers per plant

The five tagged plants in each plot were used for the counting 8 weeks after sowing.

3.4.3 Number of pods per plant

The five tagged plants were used for the counting at harvest as above.

3.4.4 Lodged plants

The number of plants that lodged in each plot were counted before harvesting the crop.

3.4.5 No of nodules (effective)

This was determined on the 4th and 8th weeks after sowing. Five plants randomly selected were uprooted and the effective nodules determined by cutting each nodule into two. The effective nodules exhibited pinkish, light pink or reddish colouration while the ineffective ones, when cut into two was hard and greenish. The number of effective nodules was divided by 5 to get the mean.

3.4.6 Number of nodes per plant

The five tagged plants were used for counting the nodes after the plants were harvested.

3.4.7 Stand count (at harvest)

The number of plants that survived were counted before the crops were harvested.

3.4.8 Plant height (cm)

The five tagged plants from each plot were measured before the crops were harvested. The crops were measured from the ground level to the tip.

3.4.9 Number of branches per plant

The five tagged plants from each plot were used for the counting after harvesting.

3.4.10 Grain yield (kg/ha)

Plants in each net plot were harvested and the grains after being separated from the chaff, were weighed and the yield of each plot noted. From this, the weight of the grain per hectare was determined.

3.4.11 Crude protein content(%)

This was determined using micro kjedhl method. A kjedahl flask containing conc sulphuric acid, calalyst and hydrogen peroxide was digested for 45 minutes. The flask was filled to 100 ml. mark with distilled water. A known quantity of the alliquot was pipelled into a distillation apparatus and sodium hydroxide was added into it. A conical flask containing boric acid and an indicator was placed under the condenser. A known quantity of distillate was collected and tritrated using 0.1 N standard hydrochloric acid, giving a pink-grey is in colouration. A blank was also digested

distilled and titrated. The two readings were used to calculate the per cent nitrogen content. The per cent nitrogen content multiplied by a conversion factor gave the per cent protein content.

Oil determination:

1) Weigh in 3.5g of samples in a thimble
2) Add 100 ml petroleum spirit (Ether) 40-60^{0}C.
3) Extract for 5 hrs (boil)
4) Dry at 50^{0}C 1 hour (in an oven)
5) Cool in desscator for 20 minutes.
6) Heigh (H_2)
7) Calculation % Oil $= \frac{\text{Loss in Height}}{\text{Sample Weight}} \times \frac{100}{1}$

3.4.12 Oil content (%)

The oil content was determined using ether extraction method. Weigh the sample in a themble (W_1). Place the thimble on the extraction unit. Extract for 5 hours. Put thimble in the oven and dry. Cool in a desiccator. Then weigh again (W_2). The calculate the % oil $= \frac{\text{Loss in weight}}{\text{Sample weight}} \times \frac{100}{1}$

3.5 Statistical Analysis

All the data collected were immediately analysed as described by Leclerg et al. (1962). The means were compared where "F" test showed significance using Duncan's multiple range test (Duncan, 1955).

Chapter 4

RESULTS

4.1 Yield Component and Yield as Influenced by Sowing Date, Population and Variety

4.1.1 Number of flowers per plant

Sowing date had significant influence on number of flowers formed, (Table 2). Sowing early on June 4 produced significantly more number of flowers than sowing late (July 8 or July 22), respectively. Second sowing date (July 8) was significantly higher than the third sowing date (July 22).

Flower number was not significantly affected by plant population but at a population of 350,000 plants/hectare, plants tended to produce slightly more flowers (5.9% or 3.8%) than when grown at 200,000 or 500,000 plants/hectare.

The two varieties, TGx536-020 and TGx814-260 did not differ in the number of flowers formed.

4.1.2 Pods per plant

The number of pods was highest on the first sowing date (June 24) and showed a significant decrease when sowing was delayed by two weeks (July 8) (Table 3). When planting was further delayed by four weeks (July 22), there was a significant decrease in the number of pods between the second and third sowing date. The median, a population of 350,000 plants per hectare had

more pods than the highest or lowest population, although differences were not significant. Variety did not influence the number of pods per plant significantly but variety TGx814-26D tended to have more pods than variety TGx536-02D.

4.1.3 Number of effective nodules

At four weeks after sowing (WAS), the number of effective nodules produced for the June 24 and July 8 sowing were similar (Table 4). Delaying sowing (till July 22) significantly decreased the number of effective nodules (4 WAS) by (49% and 52.8%, respectively). However the number of effective nodules at eight weeks after sowing (WAS) was not influenced significantly by sowing date.

Plant population and variety had not significant effect on the number of effective nodules formed at four and eight weeks after sowing (WAS).

4.1.4 Per cent crude protein

Sowing date, population and variety did not influence the per cent crude protein content of the soybean plant significantly (Table 5). However, delayed planting caused a gradual decrease in protein content.

The highest plant population of 500,000 plants per hectare had the highest protein content. While decreasing the population from 500,000 to 350,000 or 200,000 plants per hectare caused a

decrease of the protein content by 3.1% or 2.2%, respectively. However these differences were not significant.

There was no difference in the protein content between the first variety TGx536-02D and the second variety TGx814-26D (0.38%) which however was not significant.

4.1.5 Per cent oil content

Sowing date, population and variety did not significantly influence the oil content of the soybean (Table 6). There was slight differences in the oil content of the three sowing dates, three populations and the two varieties.

4.1.6 One hundred seed weight (gram)

Sowing date had significant influence on hundred seed weight (Table 7).

Seed weight decreased by 9.3% when sowing was delayed for two weeks. A further delay of two weeks in the sowing date caused a decrease of 13.13%. There was no differences in the weight among the populations. Variety TGx814-26D tended to produce heavier seeds than the variety, TGx536-02D.

4.1.7 Grain yield per hectare (kg)

Planting early on June 24, gave the highest yield per hectare than planting later on either July 8 or July 22. The first sowing date (June 24) gave a significantly higher yield 17.9% and 33.3% respectively than the other sowing dates (July 8 or

July 22) (Table 8).

A population of 350,000 plants per hectare tended to yield more than the lowest population or the highest population by 5.2% 6.09%, however these differences were not significant.

Variety TGx814-26D had a very small yield advantage over variety TGx536-02D (1.3%).

4.2 Growth Characteristics as Influenced by Sowing Date, Population and Variety

4.2.1 Number of days to 50% flowering

Sowing date, plant population and the interactions between variety and sowing date greatly influenced the number of days it took the soybean plant to reach 50% flowering (Table 9).

Sowing early on June 24 or later on July 22, respectively took longer days to 50% flowering than sowing on July 8. Though the effect of population is significant, only slight difference exist among the populations. Variety TGx814-26D took 10.083 days longer to reach 50% flowering than variety TGx536-02D.

Variety TGx814-26D took 10.083, 6.0 or 12.167 days longer than variety TGx536-02D on all three sowing dates to reach the 50% flowering stage, but not significantly.

4.2.2 Number of nodes

Sowing date and population did not significantly influence

number of nodes per plant. Variety PGx536-02D significantly had more nodes than variety TGx814-26D (Table 10).

The interaction between sowing date and variety was significant. The average number of nodes for variety TGx536-02D was higher than for variety TGx814-26D for all the three sowing dates.

4.2.3 Plant height (cm)

Sowing date, population and variety had no significant influence on plant height (Table 11). However, plants sown on June 24 were slightly taller than those sown on either July 8 or July 22 by 3.262cm or 3.337cm, respectively.

The highest population produced the tallest plants. The two varieties did not vary much in height. Variety TGx536-02D was only 0.775cm taller than variety TGx814-26D.

The interaction between sowing date and variety was significant. Variety TGx536-02D was taller than variety TGx814-26D on the first sowing date (June 24) and third sowing date (July 22) by 4.175cm and 0.850cm, respectively. While variety TGx814-26D was taller than variety RGx536-02D on the second sowing date (July 8) by 5.650cm.

4.2.4 Lodging (%)

Sowing date significantly affected per cent lodging. Sowing on July 8 resulted in more lodging than on June 24 or on

July 22 (Table 12). The plants lodged least when the sowing was done on June 24.

Increasing plant population from 200,000 plants per hectare to 350,00 or 500,000 plants per hectare increased lodging but not significantly. More lodging occured at the highest population. Variety TGx536-02D lodged more (10.5%) than variety TGx814-26D.

4.2.5 Stand count

Plant survival were highest for July 22 and decreased when sowing was done earlier on June 24 or later on July 8 (Table 13).

4.2.6 Branch number per plant

Sowing date; variety; variety x population; variety x sowing date and variety x sowing date x population significantly influenced number of branches (Table 14 and 15). The later sowing dates (July 8 and July 22) had significantly lower number of branches (40% and 37%), respectively, than sowing early on June 24. Population did not influence number of branches produced by the soybean plant. Variety TGx536-02D had significantly higher number of branches than variety TGx814-26D by 1.78 branches.

The interaction between population and variety showed that variety TGx536-02D had highest number of branches per plant at a population of 350,000 plants per hectare while variety TGx814-26D

had the highest number of branches per plant at the highest population of 500,000 plants per hectare. Increasing the population led to significantly lower number of branches for variety TG-536-02D while decreasing the population significantly reduced the number of branches for variety TGx814-26D.

On the interaction between sowing dates and variety, variety TGx814-26D had more branches than variety TGx536-02D when sowing was done early on June 24. When planted later (July 22) variety TGx536-02D had decreased branches. The smallest number of branches per plant was recorded for variety TGx536-02D for the July 22 sowing. While the highest number of branches was also recorded by variety TGx536-02D on July 8.

4.3 Correlation

Analysis of correlation coefficient between different growth characters, yield components and seed yield of soybean was done to determine their relations. There were significantly possitive correlation between seed yield and number of flowers, effective nodules, number of branches per plant, number of pods per plant and one hundred seed weight.

Chapter 5

DISCUSSION

5.1 Sowing Date

5.1.1 Effect on yield and yield components

Observation carried out in the farm showed that delay in sowing from June 24 to July 8 and July 22, decreased the number of flowers, by 11.6% and 47.6%, respectively. Number of pods per plant and 100-seed weight followed the same trend. This result agreed with Carter (1974); Graves et al. (1978); Lam-Sanchez and Beatty et al, (1982) who believed late planting can severely reduce yield. Lam-Sanchez and Yuyama (1979) also believed that late sowing caused a decrease in seed yield and pod number. The rainy season for 1987 had decreased when the second and third sowing were flowering and producing pod. This may be the cause of the decrease in yield for the late sowing.

The early sown crop (June 24) out-yielded the late sown crop (July 8 and July 22) by 17.9% and 33.3%, respectively. This result agrees with the work of Paul and Burnside (1985) who indicated that soybean yields for early planting was generally higher than late planting dates. Runge and Carmer (1973), believed that rainfall and maximum temperature during growing season account for variation in soybean yields. Also early sown crops naturally have longer growing season than subsequent ones as reported by Yusuf et al. (1971). With adequate rainfall and

optimum temperature, they were able to develop vigorously hence increasing the ability of the crops to compete among themselves for assimilates.

As a result of the decrease in rainfall by September 1987, when the second and third sowing were flowering and forming pods, the crops must have suffered from drought stress and other environmental factors causing a decrease in yield components and grain yield.

5.1.2 Seed quality

Delaying sowing by two weeks (July 8), caused a 2.24% decrease in protein content and a further delay in sowing by two weeks (July 22) caused the protein content to further decrease by 6.7%. This is in comformity with the findings of Beatty et al. (1982); Cartter (1963); Cartter (1974); Graves et al. (1978). But Schuster and Posselt (1974) in contrast, reported increased protein content with delay in sowing. The decrease in protein content with late sowing may be due to the decrease in the number of effective nodules when sowing was delayed. Hence the plant may not have fixed enough atmospheric nitrogen for protein synthesis. Delaying sowing from June 24 to July 8 or July 22 resulted to a slight decrease in oil content. These results agreed with the findings of Beatty et al. (1982); Schuster and Posselt (1974); Cartter (1974) and Graves et al. (1978).

5.1.3 Growth characteristics

The first sowing date (June 24) recorded the least number of survived plants (at harvest). The second (July 8) and the third (July 22) sowing dates had higher number of plants that survived. This is attributed to the activities of birds on the soybean plants at the early stage of their development. The activities of the birds was curtailed after employing bird scarers.

During the development of the plants, it was observed that crops planted on July 8 took the least number of days to reach 50% flowering. While sowing on June 24 or July 22 took longer days. This is because the second sowing date (July 8), developed and flowered under favourable condition, hence it had uniform growth. Unlike the first sowing date (June 24) and third sowing date (July 22) that spent part of their development under harsher condition when rainfall was less. Hence the two sowing dates (June 24 and July 22) did not have uniform growth and, therefore, took longer days to reach 50% flowering.

Sowing early on June 24, gave the tallest plants while delaying sowing to July 8 or July 22, resulted in shorter plants. This may be as a result of the first sowing date (June 24) making adequate use of the nitrogen fertilizer which was used as a starter dose before the plants were able to start trapping atmospheric nitrogen and because there was less rainfall at the early part of the plants' growth, hence less leaching of the

nitrogen fertilizer. Unlike the second and third sowing dates (July 8 and July 22) that started their early growth under heavy rainfall, hence fast leaching of the nitrogen fertilizer. This must have affected the early take off of the second and third sowing dates (July 8 and July 22) resulting to shorter plants. This result conformed those of Lam-Sanchez and Yuyana (1979); Beatty et al. (1982); Graves and NcCutchen (1978) who reported, shorter plants for late sowing.

More lodging occured for the second sowing date (July 8) than the first and third sowing date (June 24 and July 22). This may be due to the fact that the first sowing had matured and started flowering while the third sowing was still very small at the height of the rains. While the second sowing was at the peak of its growth but not yet matured. Because of the tender nature of the plants, the heavy rains forced many of them to lodge. This result differed from the findings of Abel (1969) whose maximum lodging occured with early sowing.

Sowing early (June 24) resulted in higher number of branches than sowing late (July 8 or July 22). Because of the effect of the nitrogen fertilizer on the first sowing date, (June 24), the plants grew taller than the second and third sowing dates (July 8 and July 22). The effect of the nitrogen fertilizer must have contributed to the increase in number of branches for the first sowing date (June 24), because the plants had adequate growth. This result differs from Beatty et al. (1982) whose result showed no significant decline in number of

branches at late planting.

5.2 Population

5.2.1 Effects of population on yield and yield components

Even though population had no significant effect on number of flowers per plant, number of pods per plant, 100-seed weight and grain yield. A population of 350,000 plants per hectare yielded more flowers, more pods, had heavier seeds and higher grain yield than both the lowest and highest populations (200,000 or 500,000) plant/hectare. These results do not agree with the findings of Cooper (1977) who obtained highest yield at the lowest population and Enyi, whose pod number per plant and grain yield decreased with an increase in plant population. It may be because of the damaging activities of the birds that caused the second population (350,000 plants/hectare) to have higher number of yield components and, therefore, higher yield.

Population had no significant effect on the number of effective nodules (4 and 8 WAS).

5.2.2 Seed quality

Though the effect of population on oil content was not significant this variable was slightly higher in the lower population (200,000 plants/hectare) than population 350,000 or 500,000 plants per hectare. This is in agreement with Dougherty (1969) who obtained slightly high oil content when soybean was

grown at low plant population.

The highest population had the highest protein content. The explanation is that even though the highest population (500,000 plants/hectare) had the least number of effective nodules at 4 WAS, it had the highest number of effective nodules at 8 WAS. Hence the protein content was higher at the highest population (500,000 and 350,000 plants/hectare).

5.2.3 Growth characteristics

Plants were tallest at the highest plant population. This result agrees with the findings of Piggot and Farrel (1982); Banset et al. (1973) Shroyer and Whigam (1981) who reported that plant height increased as seeding rate increased. This is as a result of competition among the plants for sunlight that each plant tried to outgrow the other for space due to the crowded nature of the plants. This competition caused the highest population (500,000 plants/hectare) to have very tall plants.

More lodging occured at the highest population (500,000 plants/hectare). The result comformed those of Coaster and Pendleton (1979), who reported increased lodging at high plant population. As population increased, plants tended to compete among themselves for light and available space. This situation made the plants to develop spindly and weak stems which made them to lodge.

Even though population did not influence number of branches per plant the lowest population (200,000 plants per hectare) and the highest number of branches per plant. This agrees with with Coaster et al. (1980) who reported that increased in plant population decreased number of branches. According to Hick et al. (1969) at low densities soybean plants compensate by producing more branches.

5.3 Variety

5.3.1 Yield and yield components

Variety TGx814-26D out yielded variety RGx536-02D in number of flowers per plant, number of pods per plant, effective nodules (4 and 8 WAS), 100-seed weight and grain yield. The geneticel make up of variety TGx814-26D must possess some characters that is superior to that of variety TGx536-02D in the production of the yield components which incidentally led to increased yield.

5.3.2 Seed quality

Result of the analysis carried out showed that variety TGx814-26D had more protein than variety TGx536-02D. Here that inherent character is still the reason why variety RGx814-26D surpassed variety TGx536-02D. Variety TGx814-26D had more number of effective nodules and therefore higher protein content.

5.3.3 Growth characteristics

Among the two varieties, TGx536-02D excelled TGx814-26D in the number of nodes per plant, and number of branches. Variety TGx536-02D possesses that inherent character that enabled the variety to outgrow the other variety when the two are planted under one environment.

5.4 Intgractions

On the interaction between variety and sowing date, both varieties gave significantly equal number of nodes per plant when sown on either June 24 or July 8. But the number of nodes per plant was significantly higher in variety TGx536-02D than variety TGx814-26D when sowing was delayed till July 22.

The interaction also showed that variety TGx814-26D registered the highest number of days to 50% flowering when sowing was delayed till July 22. While variety TGx536-02D registered the lower number of days when sowing was delayed till July 8 and July 22, respectively. There was a significant difference in the number of days between the two varieties when sowing was done early on June 24.

The tallest plants were obtained in variety TGx536-02D when sown on June 24 and variety TGx814-26D when sown on July 8. However, the plant height of the two varieties were statistically at par with one another for all other sowing dates.

The highest number of branches was recorded when variety TGx814-26D was sown on June 24. The least branch number was recorded when variety TGx536-02C was sown on July 22. There was no significant difference when the two varieties were sown on July 8.

The interaction between veriety and population showed that variety TGx814-26D recorded the highest number of branches at the highest plant population (500,000 plants/hectare) while variety TGx536-02D recorded the least number of branches at the lowest and highest plant populations (200,000 and 500,000 plants/hectare) respectively. There was significant differences in the number of branches between the two varieties in all the populations.

Chapter 6

SUMMARY AND CONCLUSION

An experiment was carried out to determine the effect of sowing date and plant population on yield and yield components of soybean (Glycine max (L) Merrill). The experiment was carried out during the 1987 cropping season at the Institute for Agricultural Research Farm at Samaru, Zaria. The treatments consisted of two soybean varieties (TGx536-02D and TGx814-26D); three sowing dates (June 24, July and July 22) and three plant populations (200,000, 350,000 and 500,000 plants/hectare.

Among the sowing dates tested, sowing early (June 24) gave the highest number of flowers per plant number of pods per plant, highest per cent crude protein, per cent oil, 100-seed weight, number of branches per plant and grain yield. Planting on the other planting dates led to decrease in these variables.

Sowing date had no significant effect on number of effective nodules (8 WAS), per cent crude protein number of nodes per plant and plant height.

Delay in sowing (2 weeks) caused an increase in the number of effective nodules, stand count (at harvest) and lodging. While delay in sowing (4 weeks) caused a decrease in number of effective nodules (4 WAS) and lodging and an increase in the number of days to 50% flowering.

Plant population had no significant effect on yield, yield

components and growth characteristics of all the parameters under study except number of days to 50% flowering which was significant. Number of flowers per plant, number of pods per plant, number of effective nodules (4 WAS), 100-seed weight and grain yield increased with an increase in plant population from 200,000 to 350,000 plants per hectare.

Increasing the population from 200,000 to 500,000 plants/ hectare caused an increase in effective nodules (8 WAS); crude protein, height and lodging.

Variety TGx814-26B out yielded variety TGx536-02D and had higher number of pods per plant, number of effective nodules (4 and 8 WAS), higher per cent crude protein, 100-seed weight, more days to 50% flowering and higher stand count (at harvest), while variety TGx536-02D surpassed variety TGx814-26D in number of nodes per plant, height, lodging, and number of branches.

The interaction between variety and sowing date in number of days to 50% flowering, variety TGx814-26D surpassed variety TGx536-02D in July 22 sowing and there was no difference in number of nodes between variety TGx536-02D and variety TGx814-26D in June 24 and July 8 sowing but variety TGx536-02D surpassed variety TGx814-26D when sowing was done on July 22.

The effect of interactions between population and variety, sowing date and variety and between sowing date, population and variety on number of branches were all significant.

The correlation analysis were significant and possitive between seed yield and number of flowers, effective nodules, number of branches, number of pods, 100-seed weight.

Planting soybean early when there is adequate rainfall and optimum temperature (June 24) resulted in higher grain yield than late planting (July 8 and July 22).

Variety TGx814-26D out-yielded variety TGx536-02D and had higher values in number of pods, number of effective nodules, per cent crude protein, 100-seed weight and grain yield (yield components and yield) while variety TGx536-02D surpassed variety TGx814-26D in number of days to 50% flowering, number of nodes, height, lodging stand count (2 WAS) and branches (growth characteristics).

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Table 1: Physico-chemical analysis of soil at the experimental site at Samaru, 1987.

Soil Composition	Soil Depth 0 - 15	15 - 30
Texture %		
Sand	62.80	55.60
Silt	27.60	26:40
pH in water	9.60	18.00
pH in 0.01m $CaCl_2$	5:3	5.40
Organic Carton (%)	4.9	5:60
Total Nitrogen (%)	0.324	0:292
Available P (ppm)	0.256	0.264
Exchangeable Cations (Meg./100g of soil)		
Na	0.05	0.05
K	0.18	0.19
Ca	2.84	2.85
Mg	0.88	0.86
Cation Exchange capacity (Meg/100 of soil)	5.44	7.04

Appendix 1: Mean temperature, relative humidity, sunshine hours and total Rainfall at 10-days interval during the period of the trial in 1987 wet season at Samaru, 1987.

Month	Days	Total Rainfall (mm)	Mean Temperature		Mean Relative humudity (%)		Sunshine (hours)
			Max	Min	Am	Pm	
June	1-10	8.5	29.8	20.6	81.5	63.5	6.4
	11-20	1.6	32.1	21.8	71.2	53.8	8.9
	21-30	4.5	30.1	21.0	76.7	68.2	7.5
July	1-10	5.2	30.5	20.6	77.6	61.7	8.4
	11-20	10.6	30.6	20.6	78.9	64.3	7.9
	21-31	10.7	29.2	19.7	82.6	68.6	6.8
August	1-10	10.5	29.9	19.9	83.0	67.7	7.0
	11-20	7.6	28.5	19.2	86.6	76.6	5.1
	21-31	8.0	29.2	20.4	86.5	72.8	6.1
September	1-10	3.3	29.9	20.4	78.7	64.8	8.0
	11-20	5.7	30.4	20.4	75.9	65.6	7.1
	21-30	1.2	31.0	20.3	73.2	59.1	8.9
October	1-10	4.3	30.8	20.0	73.4	57.1	8.0
	11-20	0.0	31.4	10.7	62.6	47.3	9.4
	21-31	0.0	30.4	14.1	20.4	28.8	8.3
November	1-10	0.0	31.2	11.4	22.0	19.0	9.4
	11-20	0.0	31.3	12.8	23.7	19.7	9.2
	21-30	0.0	33.0	13.0	22.3	18.1	10.1

Table 2: Number of flowers 6 (WAS) as influenced by sowing date, population and variety, at Samaru, 1987.

Treatment	No. of Flowers
Sowing Date	
June 24	25.625_{a}+
July 8	22.667_{b}
July 22	13.417_{c}
SE (±)	0.959
Population (plants/ha)	
250,000	20.00
333,000	21.25
500,000	20.459
SE (±)	0.959
Variety	
TGx536-02D	20.503
TGx814-26D	22.556
SE (±)	0.983

+Means followed by different letter(s) within a treatment are statistically different at 5% level of significance using DMRT.

Table 3: Pods per plant of soybean as influenced by sowing date, population and variety at Samaru, 1987.

Treatments	Mature pods per plant
Sowing date	
June 24	130.542_{a}+
July 6	96.708_{b}
July 22	71.833_{c}
SE (±)	5.911
Population (Plants/ha)	
200,000	98.50
350,000	103.417
500,000	97.167
SE (±)	5.911
Variety	
TGx536-02D	96.694
TGx814-26D	102.694
SE (±)	4.827

+ Means followed by different letter(s) within a treatment are statistically different at 5% level of significance using DMRT.

Table 4: Effective nodule count per plant of soybean 4 weeks and 8 weeks after sowing as influenced by sowing date population and variety at Samaru, 1987.

Treatment	Effective Nodule Count (4 WAS)	(8 WAS)
Sowing Date		
June 24	10.375_{a}+	30.042
July 8	11.208_{a}	25.167
July 22	5.292_{b}	22.167
SE(±)	0.998	2.954
Populations (Plants/ha)		
200,000	8.917	24.917
350,000	9.583	25.167
500,000	8.375	27.292
SE (±)	0.998	2.954
Variety		
TGx536-02D	9.278	23.444
TGx814-26D	9.639	28.139
SE (±)	0.815	2.412

+ Means followed by different letter(s) within a treatment are statistically different at 5% level of significance using DMRT.

Table 5: Crude Protein (%) of soybean as influenced by sowing date, population and variety at Samaru, 1987.

Treatments	Crude Protein (%)
Sowing Date	
June 24	42.245
July 8	41.297
July 22	39.428
SE (±)	0.998
Population (Plants/ha)	
200,000	39.96
350,000	40.849
500,000	42.161
SE (±)	0.998
Variety	
TGx536-02D	40.911
TGx814-26D	41.069
SE (±)	0.815

Table 6: Oil content (%) as influenced by sowing date, population and variety at Samaru, 1987.

Treatments	Oil Content (%)
Sowing Date	
June 24	9.885
July 8	9.106
July 22	8.927
SE(±)	0.322
Population (Plants/ha)	
200,000	9.691
350,000	9.543
500,000	9.085
SE(±)	0.322
Variety	
TGx536-02D	9.429
TGx814-26D	9.236
SE(±)	0.269

Table 7: One hundred seed weight of soybean as influenced by sowing date, population and variety at Samaru, 1987.

Treatment	100-seed weight (gram)
Sowing Date	
June 24	13.204_{a}+
July 8	11.972_{b}
July 22	10.400_{c}
SE(±)	0.257
Population (Plants/ha)	
200,000	11.943
350,000	11.993
500,000	11.639
SE(±)	0.257
Variety	
TGx536-02D	11.688
TGx814-26D	12.029
SE(±)	0.210

+ Means followed by different letter(s) within a treatment are statistically different at 5% level of significance using DMRT.

Table 8: Total Grain yield/hectare of soybean as influenced by sowing date, population and variety at Samaru, 1987.

Treatment	Grain yields/hectare (kg)
Sowing Date	
June 24	2647.88_{a}+
July 8	2175.066_{b}
July 22	1767.43_{c}
SE(±)	114.868
Population (Plants/ha)	
200,000	2163.91
350,000	2282.68
500,000	2143.77
SE(±)	114.868
Variety	
TGx536-02D	2183.01
TGx814-26D	2211.57
SE(±)	93.789

+ Means followed by different letter(s) within a treatment are statistically different at 5% level of significance using DMRT.

Table 9: Number of Days to 50% flowering of soybean as influenced by sowing date, population, variety and interaction between variety and sowing date at Samaru, 1987.

Treatment	Days to 50% Flowering
Sowing Date	
June 24	52.792_{a}+
July 8	50.503_{b}
July 22	60.503_{c}
SE(±)	0.097
Population (Plant/ha)	
200,000	54.417_{b}+
350,000	54.75_{b}
500,000	54.792_{a}
SE(±)	0.097
Variety	
TGx536-02D	49.611
TGx814-26D	59.694
SE(±)	0.079

	Sowing Date			
	June 24	July 8	July 22	Mean
TGx536-02D	47.75_{d}	46.583_{a}	54.5_{e}	49.811_{b}
TGx814-26D	57.833_{b}	54.503_{c}	66.667_{a}	59.381_{a}
SE (Interaction)		0.137		

+ Means followed by same letter(s) within a treatment are not significantly different at 5% level of significance using DMRT.

Table 10: Number of nodes per plant of soybean as influenced by sowing date, population and variety and interaction between variety and sowing date at Samaru, 1987.

Treatment	Number of Nodes per plant
Sowing Date	
June 24	11.083
July 8	10.583
July 22	10.083
SE (±)	0.323
Population(Plants/ha)	
200,000	10.335
350,000	10.576
500,000	10.417
SE (±)	0.323
Variety	
TGx536-02D	11.111_a
TGx814-26D	11.056_b
SE (±)	0.323

	June 24	July 8	July 22	Mean
TGx536-02D	10.833_a	11.167_a	11.333_a	11.111_a
TGx814-26D	10.333_a	11.00_a	0.833_b	10.06_b
SE (Interactions)				

Means followed by same letter(s) within a treatment are not statistically different at 5% level of significance using DMRT.

Table 11: Plant Height of soybean as influenced by sowing date, plant population, variety and interaction between sowing date and variety at Samaru, 1987.

Treatments	Plant Height (cm)
Sowing Date	
June 24	71.654
July 8	68.392
July 22	68.317
SE (±)	1.779
Population (Plants/ha)	
200,000	69,063
350,000	69.233
500,000	70.067
SE (±)	1.779
Variety	
TGx536-02D	69.85
TGx814-26D	69.085
SE (±)	1.453

Variety	Sowing Date			
	June 24	July 8	July 22	Means
TGx536-02D	75.242_{a}	65.567_{d}	68.742_{c}	69.850_{a}
TGx814-26D	68.067_{c}	71.217_{b}	67.892_{cd}	69.025_{b}
SE (Interactions)		2.526		

+ Means followed by same letter(s) within a treatment are not statistically different at 5% level of significance using DMRT.

Table 12: Plant lodging of soybean as influenced by sowing date, plant population and variety at Samaru, 1987.

Treatment	Plant lodging (%)
Sowing Date	
June 24	36.125_{b}+
July 8	63.375_{a}
July 22	38.292_{b}
SE (±)	5.130
Population (Plants/ha)	
200,000	43.875
350,000	44.083
500,000	49.033
SE (±)	5.130
Variety	
TGx536-02D	48.472
TGx814-26D	43.309
SE (±)	4.189

+ Means followed by the same letter(s) within a treatment are not statistically different at 5% level of significance using DMRT.

Table 13: Stand count per ($15m^2$) (at harvest) as influenced by sowing date, population and variety at Samaru, 1987.

Treatments	Stand Count at Harvest
Sowing Date	
June 24	169.125_{b}+
July 8	224.75_{a}
July 22	$254,542_{a}$
SE (±)	20.475
Population (Plants/ha)	
200,000	189.075
350,000	229.025
500,000	229.792
SE (±)	20.475
Variety	
TGx536-02D	215.472
TGx814-26D	324.278
SE (±)	16.718

+ Means followed by same letter(s) within a treatment are not statistically different at 5% level of significance using DMRT.

Table 14: Number of Branches per plant of soybean as influenced by sowing date population, variety and interaction between variety and sowing date at Samaru, 1987.

Treatments	Branch Number/Plant
Sowing Date	
June 24	7.042_{a}
July 8	4.167_{b}
July 22	4.375_{b}
SE (±)	0.235
Population (Plants/ha)	
200,000	5.50
350,000	5.208
500,000	4.075
SE (±)	0.235
Variety	
TGx536-02D	6.083_{a}
TGx814-26D	4.306_{b}
SE (±)	0.192

	Sowing Date			
	June 24	July 8	July 22	Means
TGx536-02D	5.75_{b}	4.00_{c}	3.167_{d}	4.306_{b}
TGx814-26D	8.333_{a}	4.333_{c}	5.583_{b}	6.083_{a}
SE (Interactions)	0.332			

+ Means followed by same letter(s) within a treatment are not statistically different at 5% level of significance using DMRT.

Table 15: Number of Branches per plant of soybean as influenced by interactions between variety and population; variety, sowing date and population at Samaru, 1987.

Treatments		Branch Number/Plant			
Variety		Population			
		200,000	350,000	500,000	Means
TGx536-02D		4.5_{c}	4.917_{bc}	3.5_{c}	4.306_{b}
TGx814-26D		5.917_{abc}	6.083_{ab}	6.25_{a}	6.410_{a}
SE (Interactions)		0.332			
Sowing Date		Populations (plants/ha)			
		200,000	350,000	500,000	Means
TGx536-02D	June 24	5.0_{cd}	7.75_{a}	4.5_{de}	5.75_{b}
	July 8	8.5_{a}	8.25_{a}	8.25_{a}	8.25_{a}
	July 22	5.25_{c}	3.5_{ef}	3.25_{efg}	4.00_{c}
TGx814-26D	June 24	4.0_{def}	4.75_{cde}	4.25_{de}	4.33_{c}
	July 8	3.25_{f}	3.5_{ef}	2.75_{fg}	3.17_{d}
	July 22	5.25_{c}	5.25_{c}	6.25_{bc}	5.50_{b}
SE (Interactions)		0.575			

+ Means followed by same letter(s) within a treatment are not statistically different at 5% level of significance using DMRT.

Table 16: Correlation Coefficient of Yield and Yield Component of Soybean

	1	2	3	4	5	6	7	8	9	10	11	12	13
1													
2	-.014	1											
3	-.117	.303*	1										
4	-.274	.317*	-219	1									
5	-.004	.104	.002	.199	1								
6	-.413	.210	.314**	.585**	-.18	1							
7	-.45	.363	.039	.036	.067	.497**	1						
8	-.024	.003	-. 167	.15	-.009	.067	.117	1					
9	-.453	.302**	.316*	.334*	.068	.383**	.402**	-.08	1				
10	-.136	.027	.033	.275	.113	.30	-.276	-.186	.041	1			
11	-.007	.070	-.104	-.543	.174	-.262	-.305	-.124	-.13	-.104	1		
12	-.013	.04	-.109	-.017	.282	-.223	.095	.018	-.068	-.202	.122	1	
13	-.196	.042	-.24	-.014	-.091	-.002	.208	.069	.034	-.104	-.015	0	1

1) Number of flowers per plant (8 weeks after sowing)
2) Effective Nodules per plant (4 weeks after planting)
3) Effective Nodules per plant (8 weeks after planting)
4) Mature Pods per plant
5) Number of Nodes per plant
6) Number of branches per plant
7) 100-seed weight
8) Crude protein (%)
9) Grain Yield/hectare (kg)
10) Oil content (%)
11) Stand Count at Harvest
12) Plant Lodging
13) Plant Height.

* Significant at 5% level of significance.
** Significant at 1% level of significance.

BIOGRAPHY

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Previous Qualifications

Institutions Attended	From	To	Diploma/Degree
St. Theresa's Cath. School, Yola	1949	1952	Standard Two
Govt. Primary School, Afikpo	1953	1956	Standard Six
Union Sec. Sch. Ibiaku Ikot Ekpene	1957	1961	W.A.S.C.
School of Agriculture, Umudike	1962	1963	OND - Equivalent
University of Nigeria, Nsukka	1964	1971	B.Sc. (Agric.)

Work Experience

Organisation	From	To	Position
Ministry of Agric. & N/Resources	1962	1971	Agric. Assistant.
Ministry of Agric. & N/Resources	1972	1974	Agric. Officer II.
Ministry of Agric. & N/Resources	1975	1978	Agric. Officer I.
Ministry of Agric. & N/Resources	1979	1982	Snr. Agric. Officer.
Ministry of Agric. & N/Resources	1983	1987	Prin. Agric.Officer.
Ministry of Agric. & N/Resources	1988	Date	Asst. Chief Agric. Officer.

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