THE EFFECT OF TYPES AND LEVELS OF COMPOUND FERTILIZERS (NPK) ON YIELD AND YIELD COMPONENTS OF SOYABEAN VARIETIES (Glycine max (L.) Merrill)

BY

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A Thesis submitted to the Postgraduate SchooL Ahmadu Bello University in Partial fulfilment of the requirements for the degree of Master of Science (M.Sc) Agronomy.

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DEDICATION

This thesis is dedicated to my wife Elizabeth and my children Kumbo, Zong, Doh, Tiri and Dazang.

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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 in any previous application for a higher degree.

Pam, Zang Chuwang

Date____________________

The above declaration is confirmed.

Dr. U.F. Chiezey

Date 20/5/99

CERTIFICATION

This thesis entitled "The effect of types and levels of compound fertilizers (NPK) on the yield and yield components of soyabean varieties (Glycine max (L.) Merrill)" by Pam Zang Chuwang meets the regulations governing the degree of Master of Science of Ahmadu Bello University, Zaria, and it is approved for its contribution to scientific knowledge and literary presentation.

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ABSTRACT

A field experiment was conducted during the 1992 rainy season in Samaru in the northern Guinea Savanna ecological zone of Nigeria to investigate the effect of different levels of two types of compound fertilizers on yield and yield components of three varieties of soyabean (Glycine max (L.) Merrill). The treatments consisted of three varieties of soyabean (Samsoy-2, TGX 1019-2E. and TGx 923) and two types of compound fertilizers (NPK: 15:15:15 and NPK 27-13-13) at four levels each (0, 100, 200 and 400 Kg/ha).

The investigation revealed that application of compound fertilizers significantly enhanced growth, yield and yield components of soyabean. The highest yield (1935 Kg/ha) was obtained at the highest fertilizer level (400 kg/ha).

Application of NPK 15:15:15 resulted in better growth, higher yield and yield components of soyabean than NPK 27:13:13. Amongst the varieties of soyabean tested, Samsoy-2 produced more pods per plant and resulted in the highest yield whereas TGX 1019-2E was the most vigorous in growth; produced highest LAI and TDM. TGX 923 on the otherhand, had most branches and the tallest plants.

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ABBREVIATIONS AND SYMBOLS

Kg.	=	Kilogram(s)
Kg/ha	=	Kilogram(s) per hectare
WAS	=	Weeks after sowing
TDM	=	Total dry matter
LAI	=	Leaf area index
RGR	=	Relative growth rate
i.e	=	that is
etc	=	and so on
(L.)	=	*Linneaus*
et al	=	and the rest
Wt	=	Weight
g	=	gram(s)
M^2	=	Square meters
%	=	Percent
N	=	Total Nitrogen
P	=	Elemental Phosphorus
K	=	Total Potassium
ppm	=	Parts per million
P_2O_5	=	Phosphorus pentoxide
Cm	=	Centimeters

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CHAPTER 1

INTRODUCTION

1.1 Origin and distribution

Soyabean (Glycine max (L.) Merrill) also known as chinese pea, soybean, soyabean and manchurian bean had been in cultivation before 2928 BC as one of the five sacred grains that sustained the ancient Chinese civilization (Morse, 1950). Eastern Asia, especially the Manchuria region appears to be the centre of origin of the crop, as the progenator (Glycine ussuriensis) could be found (Piper and Morse, 1923 and Morse, 1950).

From the Orient, the crop spread to other parts of the world; Europe in the 18th century and America in the 19th century (Hymowitz, 1988). It was introduced to Nigeria about 1905 (Ezedinma, 1964). Today the United States of America is the largest producer of soyabean with an annual production of 59.8 million metric tonnes followed by Brazil with 19.2 million metric tonnes, Argentina (11.3 million metric tonnes) and China with 9.4 million metric tonnes (Appendix 1).

1.2 Economic importance

Soyabean has several uses among which are the following:-

1.2.1 Food:- With very high protein (30-50%) and oil (14-25%) contents (Purseglove, 1984), soyabean can be processed into food products like "soyogi", "stew", "soyakara", "soymoimoi" and soymilk as well as high quality edible vegetable oil extracted at several oil mills spread accross Nigeria (Dashiell et al., 1990).

1.2.2 Other uses Soyabean residues and byproducts like the haulms, seed coats, seed cakes etc are used as livestock feeds.

Being a legume, soyabean has the ability to fix Nitrogen in symbiosis with the appropriate strain of Bradyrhizobium japonicum, so it can be used to enhance the Nitrogren status of the soil. Infact about 195 kg of N per hectare can be fixed by some varieties (Anon, 1978). At a very high plant density, about 500,000 plants/ha, soyabean can be used as a cover crop (Chiezey et al., 1991).

1.3 Soyabean Production in Nigeria

Nigeria is currently the largest producer of soyabean in Africa with an estimated annual output of 160 thousand metric tonnes, due largely to the fact that the country has the largest total land area under soyabean cultivation in Africa (Appendix 1). The yield per unit area is relatively low compared to the African average (Appendix 1). This could be attributed to poor agronomic practices characterised by low plant density (Chiezey, 1990) and inadequate fertilizer application (Pal et al., 1985, 1989) as well as the problem of free nodulation with the indigeneous Bradyrhizobia (Singh et al., 1987). Given the importance of the crop, research into improving agronomic practice has been going on at The International Institute for Tropical Agriculture (IITA), Ibadan and the Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria where large germplasm are maintained.

1.4 Objective of the Research

Fertilizer research work on soyabean in Nigeria has mostly centred on the use of single or straight fertilizers. However, compound fertilizer (NPK) appears to be the most available to farmers. The compound fertilizers also have some relative economic advantage over single fertilizers because they contain the three key macro-elements. This makes it easier for potential and rural farmers to handle.

The objectives of this investigation were:-

(1) To study the effect of different compound fertilizers (NPK 15:15:15 and 27:13:13) on the growth, yield and yield components of three soyabean varieties.

(2) To determine the optimum level of application and most suitable types of compound fertilizer for optimum grain yield.

CHAPTER 2

2.0 REVIEW OF LITERATURE

There is need to reiew what has been known of the crop so as to fill any gaps in research work on soyabean, especially as it affects mineral nutrition.

2.1 Nitrogen Nutrition

Reports from various parts of the world on the subject of soyabean N nutrition indicate that opinions vary on whether fertilizer N application is necessary for grain production or that innoculation with the right strain of Bradyrhizobium japonicum alone is adequate. Stouchton (1984) in the United States of America, Li et al., (1989) in China and Nedelvics et al., (1985) in Romania, all observed significant increases in grain yield with N application. However Sabbe (1989) in the United States of America didn't observe any significant increase in grain yield with N application. Others who hold the opinion that effective nodulation is adequate as a source of N for soyabean are Rodley (1968), Arnold (1969) and Pal et al (1983) in some locations in Nigeria. Under indigineous cultivation, soyabean receives no nitrogen fertilizer application (Pal et al., 1985, 1989). Poor nodulation by some high yielding varieties as a result of their inability to form a symbiolic relationship with the indigineous strains of Bradyrhizobia has been reported in Nigeria (Kueneman and Root, 1983). Fisher (1982) obtained very high yields (between 3 and 4 tons per hectare) with heavy N application (between 60kg/ha and 150 kg/ha) to five varieties of soyabean at Pankshin, Nigeria.

In view of the controversy over N application and the uncertainty surrounding the nodulation and N fixation by soyabeans, it appears as if the best position to take is to investigate the application of N to soyabean.

2.2 Phosphorus Nutrition

From available evidence, soyabean responds to P fertilizer readily. Scientists are in aggrement on the fact that soyabean responds to phosphorus but they are divided as to the optimum level to recommend. Afolabi and Osiname (1980) recommended 12 kg/ha P for the Forest zone of Nigeria while 26 kg/ha P was recommended as the optimum level by Olufajo (1986) and Chiezey et al;, (1991) for the norther Guinea Savannah zone of Nigeria. It is likely that these different rates are as a result of differences in the fertility status of the soils or ecological differences. Goldsworthy and Heathcote (1963) when studying responses of soyabean to fertilizer in Northern Nigeria, observed marked responses to superphosphate in the southern Guinea Savanna ecological zone. Other scientist that have reported responses of grain yield to P are Pal et al., (1989); Stouchton and Rickert (1986) and Park et al., (1990).

Most of the P taken up goes into the formation of seed phytin, nucleic acids, phospho-proteins, the energy rich compounds (ATP, ADP etc) and other important metabolic intermediaries (de Mooy et al., 1973). De Mooy et al., 1973 also reported increase in nodulation by 18-22%, increased total yield by 50%, higher seed/top ratio, higher oil and protein contents of seeds with increased phosphorus uptake.

2.3 Potassium nutrition

Like nitrogen, soyabean response to potassium is not certain. In some instances responses were observed while no response was observed in others. Most of the Potassium taken up by soyabean is absorbed by the leaves, branches and stem and if the shoot is worked back into the soil, most of the K will be recovered (Chiezey, 1990). Hudax et al. (1989) observed that increasing K level from O to 40 kg/ha increased yield, and yield increase continued up to 80 kg/ha of K above this level, no responses were obtained. Lixandru et al. (1979) Rizk et al. (1986) and Stouchton and Rickert (1986) all have reported significant increases in grain yield with K application. However, Pal (1982) and Pal et al., (1983 and 1985) reported no response to K but in 1989 they observed a response to K in Yandev but not in Samaru, Nigeria. Response to K by soyabeans may as well be due to soil fertility and other ecological factors including physical, biological and human activities hence it is wise to apply K to forestall any likely diffeciences.

2.4 Compound Fertilizers

Not much has been done in the area of compound fertilizer research on soyabean, but most of the reports have been from work with mixtures of these three elements (NPK) at varying ratios and rates. Tulin (1983) applied 45 kg/ha each of N, P_20_5 and K_20 and observed increased seed yield and crude protein content of seeds. Pyzik et al., (1986) also observed marked increases in grain yield over the (no fertilizer) control with N, P_20_5 and K_20 ratios of 3:2:3 or 60 kg/ha, 40 kg/ha and 60 kg/ha respectively. Rahman et al. (1976) recorded increases in number of pods per plant, seed carbohydrate and total seed yield with ratios of 1:1:1 at different levels, they recorded the highest seed yield and protein content with the highest fertilizer levels but seed oil content was lowest.

In Nigeria, Adedzwa and Leleji (1982) suggested 200 kg/ha of NPK 15:15:15 for two varieties Samsoy-1 and Samsoy-2 as the optimum level for growth but it appears as if this rate is inadequate considering the fact that the crop needs almost 30 kg/ha of phosphorus (Chiezey et al., 1991) there bye there is the need for further investigation.

2.5 Varietal Differences

There are several varieties of soyabean which exhibit different characteristics. The ideal variety should posses desirable traits like high yielding capacity, resistance to shattering, promiscuity with indigeneous strains of Bradyrhizobia, resistance to pests and diseases as well as adaptation to the ecological zones under cultivation, that is, South Western Nigeria, Northern and Southern Guinea Savanna ecological zones of Nigeria (Emechebe, 1983).

2.5.1 **Length of time to maturity**:- Soyabean varieties can be divided into three groups based on the length of time they reach maturity, namely, early maturing varieties e.g Samsoy-1 and Samsoy-2, improved Pelican etc (Adedzwa and Leleji, 1982), medium maturing varieties e.g TGX 17-2GE, TGX 183-1D, TGX 330-102D, TGX 330-036C, TGX 303-036D TGX 1019-2E. (Olufajo et al., 1983) and the late maturing varieties are TGM 244, TGM 579, TGX 17-2GL and Malayan. TGX 932.

2.5.2 **Yield Potential**:- There are high yielding varieties that are genetically superior to others and given the right cultural and ecological requirements can produce high yields e.g Bossier, Samsoy-1, Samsoy-2 TGX 297-192C, TGX 927-35C, TGX 533, TGX 303-036C etc all with yield potentials of well over 2 tonnes/ha (Leleji and Adedzwa, 1983; Kueneman and Root, 1983; Uwalla, 1986).

2.5.3 **Promiscuity with Indigeneous Bradyrhizobia**:- The ability to nodulate is a function of the ease with which the soyabean forms a symbiolic relationship with the indigeneous strains of Bradyrhizobia. Some varieties are good in this relationship while others are not promiscuous. Samsoy-2, Malayan, Samsoy-1 TGX 326-034D, TGX 454-060C and TGM 918 are promiscuous while Bossier is not. (Kueneman and Root, 1983).

2.5.4 **Resistance to Shattering**:- Some soyabean varieties shatter and spill their seeds in the field before harvest and losses of between 30 and 50% have been attributed to shattering (Emechebe, 1983). TGX 1489-1D, Samsoy-2 TGX 923 and TGX 1019-2E are moderately resistant to field shattering while Malayan shatters easily.

2.5.5 **Resistance to Major Pests and Diseases**:- Insect pests that pose the greatest danger to soyabean in Nigeria are the pod sucking bugs of the family Pentatomidea (Jackai and Kueneman, 1983) some varieties have been tried for resistance to these pests but results are not conclusive (Anon, 1985).

The bacterial postule [Xanthomonas phaseoli (E.F. Smith) Dowson variety sojensis (Hedge) Starr and Burkholder] and bacterial blight [Xanthomonas glicinea coerper] are the major bacterial diseases in Nigeria. (Erinle, 1981) Some varieties tried exhibited varying degree of resistance to both e.g TGX 849-297D and TGX 854-33E (Root, 1986). The fungal frog eyed disease (Cercospora sojina) is resisted by TGX 1489-1D TGX 849-294D, TGX 888-44 and TGX 1483-3D. (Root, 1985) Dashiell et al.,(1990).

The soyabean dwarf virus (SDV) disease transmitted by the white fly (Bamisia tabaci) is another important disease of soyabean in Nigeria, these varieties; TGM 7, Bossier and Improve Pelican exhibit high resistance to the disease. Rossell et at 1983.

CHAPTER 3

3.0 MATERIALS AND METHODS

3.1 Experimental Site

The experiment was conducted on the Institute for Agricultural Research (IAR) farm at Samaru, Nigeria (11°11'N and 7° 38'E) in the Northern Guinea Savanna ecological zone. The average yearly rainfall of Samaru over 64 years is 1054mm spread between May and September (Appendix 2). The soil is classified as Alfisols characterised by accumulation of clay in the B horizon of its profile due to intensive leaching (Moberg and Esu, 1989). The soil also have low exchangeable bases and CEC and a pH of 5.6 ($CaCl_2$) Singh et al. (1983).

3.2 Treatment

Two types of compound fertilizers were tried (NPK 15:15:15 and NPK 27:13:13) at 4 levels of each (0, 100, 200 and 400 kg/ha). Three varieties of soyabean were tested (Samsoy-2, TGX 1019-2E and TGX 923). Samsoy-2 is early maturing, has medium height and produces alot of branches. The pods cluster in the middle section in a bunch on the shoots.

TGX 1019-2E - A variety released by the International Institute for Tropical Agriculture, Ibadan, grows up to 1.2 meters tall and it is a large and strong plant with several branches, it is also medium maturing and has low shattering rate of 1.8% (Anon, 1993).

TGX 923 is another variety released in Ibadan which grows very thin and tall with small seeds and few branches. It matures late and doesn't shatter much. The trifoliate leaves are slender.

3.3 Experimental Design

The experiment was laid out in a split-plot design with varieties as the main treatments and factorial combination of fertilizer level and type as the sub-treatment plo

3.4 Plot Size

There were 72 plots of $18m^2$ each measuring 4m x 4.5m. Inter plot distance wa 0.5m and distance between replicates 1m. The net plot was $9m^2$ while the gross plot s was $18m^2$. Interrow distance was 75cm.

3.5 Crop Husbandry

The crops were sown on the 3rd of July, 1992. A 400,000 plant/ha population was maintained. Planting 2 seeds approximately 7cm apart on well prepared seed beds which were ploughed, harrowed and ridged using a disc. ridger. The fertilizer treatme was band placed as a single dose at planting. No serious incidences of pests and diseas were observed - Hoe weeding was done 4 and 8 weeks after sowing (WAS).

3.6 Observations

The following observations were made:-

3.6.1 **Soil analysis**:- Soil samples from the experimental site were taken at two depth 0-15cm and 15-30cm. Analysis of physical and chemical properties were done using standard laboratory procedure (Table 9).

3.6.2 **Weather Record**:- The meteorological Unit of the IAR supplied the rainfall distribution record for the year 1992 (Appendix 3).

3.7 Plant Parameters

Ten plants were sampled randomly from each plot from the outer ridges leaving the 4 inner ridges for net harvest.

3.7.1 **Plant height**:- The heights of 10 sampled plants were measured from the soil level to their tips at 4, 8 and 12 WAS and at harvest.

3.7.2 **Number of Functional Leaves per Plant**:- The number of functional leaves were counted 4, 8 and 12 WAS.

3.7.3 **Leaf Area Index (LAI)**:- Twenty leaves were sampled randomly and notched with a cork borer of known area. The twenty discs together with the leaves of the sampled plants are oven-dried to a constant weight and weighed seperately. The leaf area was calculated by regressing dry weight an area as described by Watson (1937).

$$\text{Leaf area} = \frac{\text{Total leaf dryweight}}{\text{dry weight of 20 disc}} \times \frac{\text{Area of 20 discs}}{1}$$

$$\text{Leaf area index} = \frac{\text{Leaf area}}{\text{Area of ground per plant}}$$

3.7.4 **Total dry Matter (TDM)**:- 10 sampled plants were oven dried to constant weight and weighed using mettler scale model P1210 at 4, 8, 12 WAS and harvest.

3.7.5 **Relative Growth rate**:- This was calculated using the data obtained from TDM using this formula as discribed by Blackman (1919).

$$RGR = \frac{\log_e W_2 - \log_e W_1}{t_1 - t_2} \text{ or } \frac{dwt}{dt} \frac{1}{w} = g/g/wk$$

3.7.6 **Days to 50% Flowering**:- The days to the time when half the population of plants in each plot bloomed was noted

3.7.7 **Number of Branches per Plant**:- The number of branches per plant was counted from 10 sampled plants and their mean worked out per plant.

3.7.8 **Pod Number per Plant**:- The means of the number of pods counted from 10 sampled plants were worked out.

3.7.9 **Pod Yield Per Plant**:- The weights of pods from 10 sampled plants were taken and the means worked out per plant.

3.7.10 **Grains yield per Plant**:- 10 Plants were harvested from the side rows from each plot, the pods were threshed, seeds were dried and weighed using mettler scale model 1210.

3.7.11 **Total grain Yield (Kg/ha)**:- Four inner rows were harvested from each of the plots and the pods were hand threshed. The grains were collected, winnowed and weighed on the mettler scale model 1210. The yield obtained was converted to kg/ha using this formula.

$$10{,}000M^2 \text{ (1ha)} \times \frac{X}{9M^2} = kg/ha$$

where X is the yield from the net plot of $9M^2$ and $10{,}000M^2$ is the area of on hectare.

3.7.12 **100 Seed Weight**:- 100 seeds were randomly counted from each treatment and weighed.

3.7.13 **Threshing Percentage (%)**:- Using the total weight of the unthreshed pods and the threshed grains the threshing percentage was worked out by this formula.

$$\text{Threshing \%} = \frac{\text{Weight of threshed grains}}{\text{Weight of unthreshed pods}} \times \frac{100}{1}$$

3.7.14 **Nutrient Content of Leaf Tissues**:- The total nitrogen phosphorus and potassium contents of the leaves were analysed using standard laboratory procedure at 12 WAS.

3.8 Data Analysis

Analysis of the data obtained was done by computer using 'F' test to determine the significance of the effects of various treatment factors as described by Steel and Torrie (1980). The singificant effects and or interactions were compared using Duncan's Multiple Range Test (DMRT) as described by Duncan (1955).

CHAPTER 4

4.0 RESULTS

4.1.0 Vegetative growth

4.1.1 Plant height:- There were significant differences in height among the three varieties tested (Table 1) TGX 923 was 14.7% taller than TGX 1019-2E which was also 31.5% taller than Samsoy-2 at harvesting. Of the two compound fertilizers applied, NPK 15:15:15 produced significantly taller plants at harvesting than those given NPK 27:13:13 by 10.8%. Fertilizer levels influenced plant height significantly. Plants receiving 100 kg/ha of compound fertilizer were 36.7% taller than those given no fertilizer. However, no significant increase in plant height was observed by increasing fertilizer level above 100 kg/ha. There was significant interaction between fertilizer level and type on plant height at harvest (Table 1B). Plants treated with 400 kg/ha of NPK 15:15:15 produced the tallest plants while those given 100 kg/ha of 27:13:13 were the shortest apart from the no fertilizer control.

4.1.2 Number of functional leaves:- The number of leaves differed significantly among the varieties at 4, 8 and WAS (Table 2). At 12 WAS TGX 923 had more leaves than those of Samsoy-2 which weren't significantly different from those of TGX 1019-2E. There was no significant difference in the number of functional leaves due to either fertilizer level or type. Interactions were also not significant.

4.1.3 Total dry matter accumulation:- Total dry matter (TDM) Production differed significantly among the varieties tested at harvest (Table 3). Plants of TGX 1019-2E accumulated 27% more TDM than Samsoy-2 which had more TDM than TGX 923 but not significantly. Except at 4 WAS The difference in TDM between the two fertilizers tried was significant. At harvest NPK 15:15:15 producing plants which accumulated 33.0% more TDM than those that received 27:13:13. Fertilizer level significantly influenced TDM at 8, 12 WAS and harvest. Plants treated with 100 kg/ha and 200 kg/ha of compound fertilizer accumulated 152.3% and 150.1% more dry matter than those given no fertilizer at harvest. However, no further significant increase in dry matter was observed when fertilizer level increased above 200 kg/ha. Interaction between fertilizer level and variety and fertilizer level and type as well as amongs fertilizer type, level and varieties were significant (Tables 3B, C, D). From all the interactions TGX 1019-2E supplied with 200 and 400 kg/ha of NPK 15:15:15 produced the highest TDM compared to all other treatment combinations whereas TGX 923 supplied 100 kg/ha of NPK 27:13:13 yielded the least TDM apart from control (Table 3D).

4.1.4 <u>Leaf Area Index (LAI)</u>:- Leaf area index was significantly influenced by variety at 4, 8 and 12 WAS (Table 4) At 12 WAS TGX 1019-2E when was not significantly different from Samsoy-2 had 41.5% more LAI than TGX 923. Comparing the two compound fertilizers, NPK 15:15:15 induced the production of higher LAI in the plants than 27:13:13 by 30% at 12 WAS. Fertilizer levels also affected LAI significantly at 8 and 12 WAS. Plants that received 100 kg/ha and 200 kg/ha recorded 109% and 206.5% increases in LAI over the control at 12 WAS but increasing fertilizer level above 200 kg/ha resulted in no further LAI increase. Interactions of the various treatment factors did not affect LAI significantly.

Table 1: The effect of rates of compound fertilizers on plant height of three varieties of soyabean in Samaru, Nigeria (1992)

Treatment	Plant height(cm) 4 WAS	Plant height (cm) 8 WAS	Plant height(cm) 12 WAS	Plant height(cm) at harvest
Varieties				
Samsoy-2	13.4 a	43.4 c	51.3 c	51.7 c
TGX 1019-2E	12.1 b	59.0 b	67.6 b	68.0 b
TGX 923	11.8 c	69.1 a	77.6 a	78.0 a
Mean	12.4	57.2	65.5	66.5
S.E. ±	0.19	1.9	1.9	1.9
Fert. type				
NPK 15:15:15	12.5	60.9 a	68.9 a	69.93 a
NPK 27:13:13	12.3	53.4 b	62.8 b	63.11 b
S.E. ±	0.21 (NS)	0.52	0.51	0.51
Fert. level (kg/ha)				
0	11.6	38.4 c	48.4 b	49.05b
100	12.9	56.8 b	64.3 a	67.06 a
200	13.7	65.6 ab	72.2 a	72.41 a
400	12.8	67.7 a	76.9 a	77.50 a
SE ±	0.32 (NS)	2.6	3.3	3.7
Interactions				
Fert. level x variety	NS	NS	NS	NS
Fert. level x type	NS	Ns	NS	NS
Fert. type x variety	NS	NS	NS	NS
Fert. type x level x variety	NS	NS	NS	NS

Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of porbability (DMRT).
* - Significant at 5%
NS - Not significant at 5%

Table 1B: Interaction between fertilizer level and type on plant height at harvest

Treatment Fert. level (kg/ha)	Fertilizer Type NPK 15:15:15	 NPK 27:13:13
0	50.8 d	46.1 d
100	70.7 b	57.8 cd
200	76.7 ab	69.0 bc
400	82.4 a	71.5 ab
S.E. ±	4.0	

Means followed by the same letter(s) are not significantly different at 5% level of probability (DMRT)

Table 2: The effect of rates of compound fertilizers on the number of leaves per plant of three varieties of soyabean in Samaru, Nigeria (1992)

Treatment	Number of leaves 4 WAS	Number of leaves 8 WAS	Number of leaves/ Plant at 12 WAS
Varieties			
Samsoy-2	4.5 b	8.0 b	14.3 b
TGX 1019-2E	4.3 b	8.7 b	14.0 b
TGX 923	6.2 a	12.0 a	22.5 a
Mean	4.0	9.2	16.9
S.E. ±	0.18	0.33	0.7
Fert. type			
NPK 15:15:15	5.2	9.61	17.6
NPK 27:13:13	4.9	8.92	16.2
S.E.D	0.21 (NS)	0.39 (NS)	0.61 (NS)
Fert. level (kg/ha)			
0	4.2	8.6	12.7
100	5.1	9.3	17.4
200	5.3	9.6	18.8
400	5.1	9.5	18.7
SE ±	0.33 (NS)	0.61 (NS)	1.3 (NS)
Interactions			
Fert. level x variety	NS	NS	NS
Fert. level x type	NS	Ns	NS
Fert. type x variety	NS	NS	NS
Fert. level x type x variety	NS	NS	NS

Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT).

NS - Not significant at 5%

Table 3: The effect of rates of compound fertilizers on the total dry matter (TDM) accumulated per plant of three varieties of soyabean in Samaru, Nigeria (1992)

Treatment	TDM/Plant (g) at 4 WAS	TDM/Plant (g) at 8 WAS	TDM/Plant (g) at 12 WAS	TDM/Plant at harvest
Varieties				
Samsoy-2	0.66 a	9.71 b	12.01 b	13.17 b
TGX 1019-2E	0.62 a	11.74 a	15.93 a	16.79 a
TGX 923	0.53 b	8.59 b	12.73 b	12.44 c
Mean	0.60	9.99	13.22	14.39
S.E. ±	0.02	0.42	0.52	0.55
Fert. type				
NPK 15:15:15	0.60	11.58 a	13.22 a	16.43 a
NPK 27:13:13	0.61	8.40 b	11.90 b	12.35 b
S.E.D	0.3 (NS)	0.45	0.56	0.57
Fert. level (kg/ha)				
0	0.41	4.91 c	6.87 c	7.56 c
100	0.61	8.18 b	10.61 b	11.83 b
200	0.65	13.95 a	17.87 a	19.08 a
400	0.66	13.49 a	17.84 a	19.17 a
SE ±	0.05 (NS)	0.57	0.80	0.81
Interactions				
Fert. level x variety	NS	NS		*
Fert. level x type	NS	Ns	NS	*
Fert. type x variety	NS	NS	NS	NS
Fert. Type x level x variety	NS	NS	NS	*

Means followed by the same letter(s) within a treatment are not significantly different at 5% level of probability (DMRT).
NS - Not significant at 5%
* - Significant at 5%

Table 3B: Interaction between fertilizer level and varieties on Total dry matter accumulation per plant at 12 WAS

Treatment		VARIETIES	
Fert. Level (kg/ha)	Samsoy-2	TGX 1019-2E	TGX 923
0	6.31 h	8.33 gh	8.05 gh
100	13.31 def	11.85 efg	10.35 fg
200	19.02 bc	22.94 ab	15.06 cdef
400	17.16 cd	24.07 a	16.29 cde
S.E ±		1.20	

Table 3C: Interaction between fertilizer level and type on Total dry matter accumulation per plant at 12 WAS

	FERTILIZER TYPE	
Fert. Level (kg/ha)	N:P:K 15:15:15	N:P:K 27:13:13
0	7.61 d	7.51 d
100	13.69 c	9.98 d
200	23.23 a	14.78 bc
400	21.19 a	17.15 b
S.E ±	1.02	

Means followed by the same letter(s) are not significantly different at 5% level of probability (DMRT).

Table 3D: Interaction among fertilizer type, level and varieties on total dry matter accumulation per plant at harvest (g)

	VARIETIES					
	Samsoy-2		TGX 1019-2E		TGX 923	
Fert. level	Fert. Type		Fert. Type		Fert. Type	
(Kg/ha)	NPK 15:15:15	NPK 27:13:13	NPK 15:15:15	NPK 27:13:13	NPK 15:15:15	NPK 27:13:13
0	6.5 g	6.1 g	7.7 fg	8.9 fg	8.6 fg	7.5 fg
100	14.5bcde	12.0 def	14.2bcde	9.5efg	12.3cdef	8.37 fg
200	25.3ab	12.7cdef	26.5 a	19.3 b	17.9 bc	12.26def
400	17.5bc	16.8 bcd	29.2 a	18.9 b	16.9 bcd	15.71bcd
S.E. ±			1.62			

Means followed by the same letters are not significantly different at 5% level of probability (DMRT).

Table 4: The effect of rates of compound fertilizers on leave area index (LAI) of three varieties of soyabean in Samaru, Nigeria (1992)

Treatment	LAI at 4 WAS	LAI at 8 WAS	LAI at 12 WAS
Varieties			
Samsoy-2	0.21 a	3.04 a	4.34 a
TGX 1019-2E	0.17 b	3.51 a	4.94 a
TGX 923	0.15 c	2.41 b	3.49 b
Mean	0.18	2.98	4.26
S.E. ±	0.074	0.13	0.19
Fert. type			
NPK 15:15:15	0.18	2.60	4.81 a
NPK 27:13:13	0.17	3.37	3.70 b
S.E.D	0.008(NS)	0.18(NS)	0.20
Fert. level (kg/ha)			
0	0.11	1.51 c	1.84 c
100	0.19	2.68 b	3.85 b
200	0.21	3.90 a	5.64 a
400	0.20	3.82 a	5.86 a
SE ±	0.02(NS)	0.19	0.5 a
Interactions			
Fert. level x variety	NS	NS	NS
Fert. level x type	NS	Ns	NS
Fert. type x variety	NS	NS	NS
Fert. level x type x variety	NS	NS	NS

Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT).

NS - Not significant at 5%

Table 5: The effect of rates of compound fertilizers on number of branches/plant at harvest, relative growth rate (RGR) and days to 50% flowering of three varieties of soyabeans in Samaru, Nigeria, (1992)

Treatment	Number of branches per plant at harvest	RGR (g/g/week) 4-8WAS	RGR(g/g/week) 8-12 WAS	Days to 50% flowering
Varieties				
Samsoy-2	8.17 b	0.65 c	0.11	41.63 c
TGX 1019-2E	6.67 c	0.70 a	0.11	55.46 b
TGX 923	9.33 a	0.69 b	0.11	60.88 a
S.E. ±	0.22	0.71 a	0.0073 (NS)	0.36
Fert. type				
NPK 15:15:15	8.11	0.65 b	0.11	50.87 b
NPK 27:13:13	8.00	0.15	0.11	54.47 a
S.E.D	0.2 (NS)	0.56	0.0061 (NS)	0.38
Fert. level (kg/ha)			0.11	
0	6.11 b	0.65		46.06 d
100	8.28 a	0.77	0.12	51.89 c
200	9.44 a	0.75	0.12	54.56 b
400	8.56 a	0.013	0.10	58.11 a
SE ±	0.41	NS	0.01 (NS)	0.69
Interactions			NS	
Fert. level x variety	NS	NS		NS
Fert. level x type	NS	NS	NS	NS
Fert. type x variety	NS	NS	NS	NS
Fert. level x type x variety	NS	NS	NS	NS

Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT).

NS - Not significant at 5% level of probability.

in LAI over the control but increasing fertilizer level above 200 kg/ha resulted in no further LAI increase. Interactions of the various treatment factors did not affect LAI significantly.

4.1.5 **Number of branches per plant**:- The three varieties tested showed significant differences in the number of branches produced per plant at harvest (Table 5). TGX 923 had 14.3% more branches than Samsoy-2 which inturn had 22.5% more branches than TGX 1019-2E. The difference in the number of branches per plant due to fertilizer type was not significant. However Fertilizer levels affected the number of branches per plant significantly. Plants that received 100 kg/ha had 35.5% more branches than those without no fertilizer and there was no further increase in number of branches per plant beyond 100 kg/ha fertilizer level. Interactions among the various treatment factors had no significant influence on the number of branches per plant.

4.1.6 **Relative growth rate**:- During the second interval (4-8 weeks) Relative growth rate (RGR) differed significantly among the three varieties tried (Table 5). There was, however, no significant effect of variety, on RGR during the first and the thrid period of growth (8-12 weeks) TGX 1019-2E grew 1.6% faster than TGX 923 which inturn had 6.2% higher RGR than Samsoy-2. Comparing the two types of compound fertilizer, plants treated with 15:15:15 grew 9.9% relatively faster than those treated with 27:13:13. Fertilizer levels had no significant effect on RGR in the second interval (4-8 WAS). There was a 19.6% increase in RGR over the control when plants were supplied 100 kg/ha and another 17.8% increase in RGR when fertilizer level was raised from 100 kg/ha to 200 kg/ha which was at par with 400 kg/ha level of application.

4.1.7 **Days to 50% flowering**: The three varieties tested showed significant differences in the number of days they took to reach 50% flowering (Table 5). Half the population of Samsoy-2 flowered significantly earlier than TGX 1019-2E which also flowered significantly earlier than TGX 923. Comparing the two types of fertilizers, half the population of plants treated with NPK 15:15:15 flowered significantly earlier than those given NPK 27:13:13. Fertilizer levels significantly delayed days to 50% flowering. Days to 50% flowering singificantly increased when plants were treated with 100 kg/ha and 200 kg/ha fertilizer by 12.75 and 18.5% respectively over the control. When plants were supplied 400 kg/ha there was an additional 26.1% increase in days to 50% flowering.

4.2.0 **Yield and Yield Components**

4.2.1 **Number of pods per plant**:- The difference in the number of pods among the varieties was significant (Table 7). Samsoy-2 plants produced 19.7% more pods than TGX 923 plants which also had 8.9% more pods than TGX 1019-2E. The number of pods differed significantly between the two types of compound fertilizers under trial. Plants supplied NPK 15:15:15 prouced 11.9% more pods than plants which had NPK 27:13:13. The number of pods harvested per plant increased significantly with increased fertilizer application. At 100 kg/ha fertilizer level, there was a 96% increase in number of pods over the control.

Table 6: The effect of rates of compound fertilizers on some yield components (pod weight/plant, grain yield/plant and Threshing %) of three varieties of soyabean in Samaru Nigeria (1982)

Treatment	Pod Weight (g) per plant	Grain yield per plant (g)	Threshing %
Varieties			
Samsoy-2	9.81 a	7.35 a	76.2 a
TGX 1019-22	8.02 b	5.89 b	70.8 b
TGX 923	8.15 b	4.76 c	58.6 c
Mean	8.66	6.00	68.5
S.E ±	0.41	0.35	1.99
Fert. Type			
NPK 15:15:15	8.72	6.38	68.3
NPK 27:13:13	8.60	5.61	69.5
S.E. ±	0.48(NS)	0.43(NS)	2.2(NS)
Fert. Level (kg/ha)			
0	3.46 c	2.24 c	61.8
100	7.30 b	5.27 b	70.8
200	11.16a	8.63 a	74.4
400	12.73a	8.63 a	67.1
SE ±	0.98(NS)	0.70	1.99(NS)
Interactions			
Fert. Level x variety	*	*	NS
Fert. level x type	NS	NS	NS
Fert. Type x variety	NS	NS	NS
Fert. level x type x variety	NS	NS	NS

Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of prbability (DMRT).

NS - Not significant at 5%
* - Significant at 5%

Table 6B: Interaction between fertilizer level and variety pod weight/plant (g)

FERT. LEVEL	VARIETIES		
(kg/ha)	Samsoy-2	TGX 1019-2E	TGX 923
0	4.09 cd	3.33 cd	2.96 d
100	9.61 b	5.49 cd	6.80 bc
200	10.61 ab	10.65 ab	12.21 a
400	14.93 a	12.61 a	10.65 ab
S.E ±		1.20	

Table 6C: Interaction between fertilizer level and variety on grain yield per plant (grams)

Fert. Level	VARIETIES		
(kg/ha)	Samsoy-2	TGX 1019-2E	TGX 923
0	2.59 d	2.52 d	1.61 d
100	7.85 b	3.98 cd	3.97 cd
200	7.48 b	8.24 b	7.87 b
400	11.49 a	8.31 b	5.59 c
S.E ±			

Means followed by the same letter(s) are not significantly different at 5% level of probability (DMRT).

Increasing fertilizer level to 200 kg/ha and 400 kg/ha resulted in subsequent increase of 40.38 % and 9.4% respectively. Pod number per plant was significantly influenced by interactions between fertilizer level and variety as well as between fertilizer level and type (Tables 7C and 7D). Interaction between fertilizer levels and varieties reveal that Samsoy-2 which received 400 kg/ha of compound fertilizer performed significantly better than other treatment combinations (Table 7D). Interactions between fertilizer level and type also showed that plants given 400 kg/ha of both NPK 15:15:15 and 27:13:13 performed significantly better than other treatment combinations in this category (Table 7E).

4.2.2 **Pod weight per plant:**- The yield of pods harvested per plant differed significantly among the three varieties (Table 6). Pods from Samsoy-2 were 20.2% heavier than those from TGX 1019-2E which was not significantly different from TGX 923. The yield of pods was not significantly affected by fertilizer type. Pod yield was influenced significantly by application of the different levels of fertilizer. Plants treated with 100 kg/ha of fertilizer produced 110.9% heavier pods than those without fertilizer while plants that received 200 kg/ha produced 52.9% heavier pods than plants which had 100 kg/ha. There was no further significant increase in pod weight when fertilizer level was increased above 200 kg/ha. The yield of pods was significantly influenced by the interaction between fertilizer levels and variety (Table 6B), Samsoy-2 plants given 400 kg/ha of fertilizer produced heavier pods than all other combinations whereas TGX 1019-2E plants produced the least yield of pods when supplied with 100 kg/ha of fertilizer excluding control.

4.2.3 **Grain Yield Per Plant**: There was significant differences in grains yield harvested per plant among the varieties tested (Table 6). Samsoy-2 plants yielded 24.8% more grains than TGX 1019-2E which also produced 23.7% more grains than TGX 923. Grain yield per plant was not significantly influenced by fertilizer type. Grain yield per plant was significantly affected by fertilizer levels. Plants treated with 100 kg/ha and 200 kg/ha of fertilizer produced 135.3% and 285.3% more grains respectively than plants which received no fertilizer. Above 200 kg/ha fertilizer level there was no significant increase in grain yield per plant. Interaction between fertilizer level and variety significantly affected grain yield per plant(Table 6C). The highest grain yield was harvested from Samsoy-2 plants which were given 400 kg/ha fertilizer while the lowest yield were obtained from TGX 923 and TGX 1019 - 2E plants which received 100 kg/ha fertilizer.

4.2.4 **Threshing Percentage**:- Threshing percentage differed significantly among the three varieties (Table 6). Pods from Samsoy-2 threshed 7.6% better than those of TGX 1019-2E which also threshed 20.9% better than TGX 923. Threshing percentage was not significantly affected by fertilizer levels and type. There was also no significant effect of interactions.

Table 7: The effect of rates of different compound fertilizers on total grain yield (kg/ha, 100 seed weight (g) and number of pods/plant at harvest of three varieties of soyabean in Samaru, Nigeria.

Treatment	Grain yield (kg/ha)	100 Seed weight (g)	Number of pod/plant at harvest
Verieties			
Samsoy-2	1721 a	10.2 b	66.2 a
TGX 1019-2E	1259 b	11.2 a	50.6 c
TGX 923	1029 c	8.1 c	55.1 b
Mean	1336	9.8	56.3
S.E ±	69.4	0.2	0.9
Fert. Type			60.5 a
NPK 15:15:15	1421 a	9.88	
NPK 27:13:13	1252 b	9.76	54.1 b
S.E. ±	79.2	0.27 (NS)	0.9
Fert Level (kg/ha)			
0	595 c	9.65	26.3 d
100	1193 b	9.81	51.5 c
200	1621 ab	9.67	72.3 b
400	1935 a	10.14	79.1 a
S.E ±	162.1	0.42 (NS)	1.7
Interactions			
Fert. Level x variety	*	NS	*
Fert. Level x Type	NS	NS	*
Fert. type x variety	NS	NS	NS
Fert. level x type x variety	*	NS	NS

Means followed by the same letter(s) within the same column and treatment column are not signitifcantly different at 5% level of probability (DMRT).

NS - Not significant at 5%
* - Significant at 5%

Table 7B: Interaction between fertilizer levels and varieties on Total grain yield (kg/ha)

Fert. Level (kg/ha)	Varieties (Total Yield kg/ha)		
	Samsoy-2	TGX 1019-2E	TGX 923
0	692 d	691 d	403 d
100	1749 b	948 cd	884 cd
200	1890 b	1501 bc	1473 bc
400	2555 a	1894 b	1353 bc
S.E. ±		197.7	

Table 7C: Interaction among fertilizer level, type and varieties on total grains yield (kg/ha)

Fert. Level (kg/ha	VARIETIES					
	Fert. Type		Fert. Type		Fert. Type	
	NPK 15:15:15	NPK 27:13:13	NPK 15:15:15	NPK 27:13:13	NPK 15:15:15	NPK 27:13:13
0	723ghij	662hij	510ij	671ghij	376j	431ij
100	1946cde	1550bcdefg	1169efghij	727 ghij	940fghij	468ij
200	2127bc	1652bcdef	16476bcdef	1353cdefgh	1478bcdefg	1468bcdefg
400	2895 a	2215ab	2001bcd	1795bcdef	1234efghi	1471bcdefg
S.E ±			240.0			

Means followed by the same letter(s) are not significantly different at 5% of probability (DMRT)

Table 7D: Interaction between fertilizer levels and varieties on number pods/plant at harvest.

Fert. Level	VARIETIES		
	Samsoy-2	TGX 1019-2E	TGX 923
0	25.7 f	24.0 f	29.2 f
100	66.3 d	41.0 e	47.2 e
200	80.3 b	67.2 d	67.3 cd
400	92.5 a	70.2 cd	74.6 bd
S.E ±		2.2	

Table 7E: Interaction between fertilizer levels and type on number/plant at harvest.

Fert. Level	VARIETIES		
	Samsoy-2	TGX 1019-2E	TGX 923
0	25.7 f	24.0 f	29.2 f
100	66.3 d	41.0 e	47.2 e
200	80.3 b	67.2 d	67.3 cd
400	92.5 a	70.2 cd	74.6 bd
S.E ±		2.2	

Means followed by the same letters(s) are not significantly differnet at 5% level of probability (DMRT).

4.2.5 **Total Grain Yield (Kg/ha)**:- The three varieties tried show significant differences in grain yield (Table 7). Samsoy-2 produced 36.7% more grains per hectare than TGX 1019-2E and 22.3% more grains were harvested from TGX from TGX 1019-2E when compared with TGX 923. Comparing the two types of compound fertilizerrs, crops treated with NPK 15:15:15 produced 13.5% more grains per hectare than plants given NPK 27:13:13. Total grain yield was significantly influenced by fertilizer levels. There was a 100.5% total yield increase over the no fertilizer control, when plants were supplied 100 kg/ha fertilizer increasing the fertilizer level from 100 to 200 kg/ha didn't result in any significant increase in total grain yield. However a 62% yield increase was observed when fertilizer level was raised from 100 kg/ha to 400 kg/ha which was at par with the yield at 200 kg/ha of fertilizer. Interactions between fertilizer levels and variety as well as among fertilizer level, type and variety significantly affected total grain yield (Tables 7B and 7C). Samsoy-2 supplied with 400 kg/ha of 15:15:15 produced the highest total yield while TGX 923 supplied 100 kg/ha of NPK 27:13:13 resulted in the lowest yield excluding control.

4.2.6 **100 Grains Weight**:- Grains from the three varieties under trial differed significantly in weight (Table 7) 100 grains from TGX 1019-2E were 9.8% heavier than 100 seeds from Samsoy-2 which were also 25.9% heavier than 100 seeds from TGX 923. The weight of 100 seeds was not significantly affected by fertilizer type and levels. The interactions of the various treatment factors were not significant.

Table 8: The effect of rates of compound fertilizers on the nutrient content of the leaf tissues (total nitrogen, phosphorus and Potassium of three varieties of soyabean in Samaru, Nigeria.

Treatment	Total N content of leaves (%)	Total P. Content of leaves (ppm)	Total K content of leaves (%)
Varieties			
Samsoy-2	2.51 b	1399 b	1.44 c
TGX 1019-2E	2.52 b	1331 b	1.60 b
TGX 923	3.06 a	1650 a	2.11 a
Mean	2.70	1460	1.72
S.E ±	0.103	66.3	0.061
Fert. Type			
NPK 15:15:15	2.67	1508	1.68
NPK 27:13:13	2.70	1411	1.76
S.E.D	0.11 (NS)	75.7 (NS)	0.06 (NS)
Fert. Level (kg/ha)			
0	2.62	1096	1.95
100	2.65	1301	1.74
200	2.74	1578	1.57
400	2.78	1864	1.61
S.E ±	0.09 (NS)	156.8 (NS)	0.62 (NS)
Interactions			
Fert. level x variety	NS	NS	NS
Fert. level x type	NS	NS	NS
Fert. type x variety	NS	NS	NS
Fert. level x type x variety	NS	NS	NS

Means followed by the same letter(s) within the same column and treatment are not significantly different at 5% level of probability (DMRT).

NS - Not significant at 5%.

Table 9: Physical and chemical properties of soil from thje experimental site at IAR Research Farm, Samaru (1992).

	Dept of Soil	
	0.15cm	15-45cm
Physical composition (% Aggregate Size)		
Sand	21	33
Silt	44	34
Clay	35	33
Textural Class	Loam	Clay Loam
Chemical Properties		
pH in H_20	5.2	4.4
Ph in 0.01M $CaCl_2$	5.0	4.2
Organic Carbon (%)	0.49	0.39
Available p. (ppm)	6.27	4.48
Total N. (%)	0.112	0.098
Exchangeable bases (meg/100g of soil)		
Ca	3.22	3.41
Mg	1.17	1.43
K	0.21	0.23
Na	0.11	0.13
CEC	5.70	6.30

4.3.0 Nutrient Content of Leave

Analysis of the total N, P and K contents of the leaves revealed that there were significant difference among the varieties (Table 8) TGX 923 contained 21.4% and 23.9% more N and P respectively than TGX 1019-2E which was at par with Samsoy-2. 31.9% more K was recovered from TGX 923 than TGX 1019-2E which also had 11.11% more than Samsoy-2. Difference in nutrient content due to fertilizer type and level were not significant so were the interactions of the various treatment factors.

4.4.0 Crop Ecology

From the rainfall data (Appendix 2) there was a fair distribution of rainfall trhoughout the growing season with an annual total of 1020.9mm. The soil fertility status was low (table 9) N(0.112% and 0.098% in the top and lower layer respectively). P in parts per million (PPm) 6.27 and 4.48 in the upper and lower layers of the root zone K in meq/100g of soil was 0.21 and 0.23 for the upper and lower layers respectively.

4.5.0 Correlation and Regression

Simple correlation studies carried out showed that the total grain yield (kg/ha) was significantly and positively influenced by some plant characters observed. Such plant character are plant height, TDM, LAI, number of branches and pods, others were RGR, Pod weight, grain yield per plant and threshing % (Table 9).

The response of soyabean to the two compound fertilizers in terms of total grain yield is represented by these quadratic equations, obtained from regressing grain yield against fertilizer levels.

4.5.1 <u>For both Fertilizers</u>:- $Y = 595 + 6.90x - 0.00886x^2$
$R^2 = 49.1\%$

Calculated optimum level is 389.4 kg/ha.

4.5.2 <u>For N.P.K (15:15:15)</u>:- $Y = 559 + 8.68x - 0.0134x^2$
$R^2 = 46.9\%$

Calculated optimum level is 348.8 kg/ha.

4.5.3 <u>NPK (27:13:13)</u>:- $Y = 614 + 5.32x - 0.00567x^2$
$R^2 = 53.4\%$
Calculated optimum level is 469.1 kg/ha

Table 10: Correlation mattrix of grain yield against other plant parameters

	1	2	3	4	5	6	7	8	9	10	11	12
Total grain yield (kg/ha)	1.00											
Grain yield/plant (g)	0.9306	1.00										
Pod weight/plant (g)	0.8500	0.9108	1.00									
Relative growth rate (g/g/wt) (4-8 wks)	NS 0.2006	0.5965	0.5764	1.00								
Number of pods/plant	0.7810	0.7541	0.7370	0.5940	1.00							
Number of branch/plant	0.3860	0.3550	0.4236	0.4132	0.5326	1.00						
Leaf area index (12 WAS)	0.7753	0.7461	0.7491	0.7825	0.7350	0.3253	1.00					
Leaf area index (8 WAS)	0.7930	0.7559	0.7000	0.7995	0.7026	0.2947*	0.9523	1.00				
Dry matter/plant (12 WAS)	0.6915	0.7161	0.6868	0.6915	0.8244	0.2664*	0.9523	0.9623	1.00			
Dry matter/plant (8 WAS)	0.6651	0.7110	0.6773	0.8331	0.6744	0.2509	0.9487	0.9582	0.9940	1.00		
Plant height (12 WAS)	0.3268	0.3757	0.4744	0.5670	0.4120	0.5269	.04967	0.4530	0.5041	0.5140	1.00	
Plant height (8 WAS)	0.3472	0.3987	0.5030	0.5904	0.4537	0.4637	0.5223	0.4830	0.5325	0.4960	0.9785	1.00

NS = Not significant at P = 0.05
All other figures are significant at P = 0.05

CHAPTER 5

5.0 DISCUSSION

5.1 Varietal Differences

5.1.1 Varietal Differences in Vegetative Growth:- Comparing the three varieties, Samsoy-2 appears to have grown faster than the other two because at 4 WAS, it had significantly taller plants, higher LAI and accumulated more dry matter as well as flowered earlier than both TGX 1019-2E and TGX 923. During the subsequent periods of observation (8 and 12 WAS) however, the plants from TGX 1019-2E and TGX 923 performed significantly better in these characters. The reason for this could be that Samsoy-2 is earlier maturing than both TGX 1019-2E and TGX 923, so that at 4 WAS it had grown better than the other two varieties but at the subsequent periods it had started the reproductive growth and vegetative growth had slowed down.

5.1.2 Varietal Differences in yield and Yield Components: Apart from TGX 1019-2E which had heavier 100 seeds, Samsoy-2 plants produced significantly more yield and yield components. Samsoy-2 plants still had the highest grain yield per plant and total grain yield per hectare. This may be attributed to the fact that Samsoy-2 plants had the highest number and heaviest pods. These two yield components contribute more towards yield than any other components. Similar observations had been made by other workers (Ogunbodede, 1986; Bullock, 1990 and Chiezey, 1990). Another reason may be because Samsoy-2 as a variety was released in Samaru for the northern Guinea Savanna ecological zone (Leleji and Adedzwa, 1983) and may have adapted better to this zone than TGX 1019-2E and TGX 923 which were released by the International Institute for Tropical Agriculture at Ibadan in the Tropical rain forest zone and may not have adotped quite well.

5.2.0 Effect of Fertilizer Type

5.2.1 Effect of Fertilizer Type on Vegetative Growth:- Of the two compound fertilizers tried, NPK 15:15:15 seems to have enhanced vegetative growth better than NPK 27:13:13 because plants that received NPK 15:15:15 grew taller, accumulated more dry matter, had more LAI (12 WAS) and had more branches than those given, NPK 27:13:13. This observation may be as a result of the higher P content in 15:15:15 compared to 27:13:13 and P had been shown by several workers to be the most critical of the three elements in the compound fertilizers for growth and yield (Afolabi and Osiname, 1980; Pal et al., 1983; Stouchton and Rickert, 1986). On the otherhand, the delay in flowering induced by the application of NPK 27:13:13 may probably be due to the very high N content of the fertilzier compared to NPK 15:15:15. Shafsak et al. (1988) have reported a delay in flowering due to high N application.

5.2.2 Effect of Fertilizer Type on Yield and Yield Components:- NPK 15:15:15 enhanced yield and yield attributes better than 27:13:13 because plants that received the former had more pods, more grain weight and higher total grain yield per hectare than the latter. The reason for this could be the fact that 15:15:15 has a higher P content than 27:13:13. P is the most critical element for the production of yield components and total grain yield in legumes and soyabean specifically (Matrone et al., 1954; Islam, 1964 and Ogunbodede, 1986).

5.3.0 Effect of Fertilizer Levels

5.3.1 Effect of Fertilizer Levels on Vegetative Growth:- All the vegetative growth characters observed except number of leaves per plant and days to 50% flowering showed significant responses to fertilizer level up to 200 kg/ha after which no significant responses were observed. This may be that the nutrients in the fertilizer induced vegetative growth to a point beyond which no significant responses could be observed. Leleji and Adedzwa (1983) had suggested 200 kg/ha of NPK 15:15:15 as adequate for soyabean growth. Days to 50% flowering increased with increase in fertilizer application right up to the highest level (400 kg/ha). This may be due to the prolonged vegetative growth stimulated by enhanced mineral nutrition (especially N. and P.) at 400 kg/ha. Delays in flowering as a result of high level of P and N have been reported. (Chiezey, 1990 and Shafsak et al., 1988).

5.3.2 Effect of Fertilizer level on Yield and Yield Compoents:- Apart from the number of pods per plant, the response of soyabean yield and yield components to fertilizer level is similar to that of the vegetative growth components, that is, no significant responses were obtained beyond 200 kg/ha fertilizer level. The reason may be that since vegetative growth did not increase beyond 200 kg/ha, it is unlikely that yield and yield components would, because yield and yield components depend to a large extent on how well the plant grows vegetatively. However, for grain yield, higher rates of nutrients (especially P.) are necessary as most of the P is absored after maximum vegetative growth; from full bloom to the end of grain filling (de Mooy et al., 1973). This may explain the significant response of total grain yield and mean number of pods to the highest level of compound fertilizer (400 kg/ha).

5.4.0 Interaction

5.4.1 Interaction Between Fertilizer Levels and Variety:- When Samsoy-2 plants were given 400 kg/ha of compound fertilizer, they produced the greatest number of pods, highest yield/plant, heaviest pods/plants and highest total grain yield (kg/ha) when compared with other treatment combinations. At 400 kg/ha, Samsoy-2 plants had adequate amounts of the fertilizer nutrients (NPK) and being high yielding as well as adapted to the northern Guinea Savanna ecological zone, this observation is justifiable. However, TGX 1019-2E which are large and vigorously growing plants when given 400 kg/ha of compound fertilizer would naturally accumulate the highest TDM when compared to other combinations.

5.4.2 Interaction Between Fertilizer Type and Level: Plants supplied 400 kg/ha of NPK 15:15:15 exhibited superior performance in most of the growth, yield and yield components. These components are; number of pods, pod weight, grain yield per plant, TDM, and total yield per hectare. This may be attributed to the fact that at 400 kg/ha, NPK 15:15:15 supplied 60 kg/ha N., 26.4 kg/ha P and 48 kg/ha K. These rates of the nutrient elements appear to be optimum because several scientists had recommended similar levels (Uwalla, 1986; Hudak et al., 1989 and Chiezey et al., 1991). The low performance of NPK 27:13:13 may be due to higher N:P ratio which may affect the uptake and utilization of P (Demoy et al. 1973).

5.4.3 Interaction Among Fertilizer Level, type and varieties:- For dry matter accumulation the most effective combination was TGX 1019-2E receiving 400 kg/ha of NPK 15:15:15. This may be that when 400 kg/ha of NPK 15:15:15 was applied, the large vigorously growing TGX 1019-2E received adequate levels of the three macro elements and would naturally accumulate most dry matter. For grain yield (kg/ha), the most effective combination was the high yielding Samsoy-2 receiving 400 kg/ha of NPK 15:15:15. Lower level of P and high N in 27:13:13 may be the reason behind its lower performance when compared to NPK 15:15:15

5:4:4 **Crop Ecology:-**

The low nutrient status of the soil especially the lower layer of the soil profile where the deep rooted soyabean crop feeds may explain the highly significant response recorded in the trial. The fair rainfall distribution reported also helped to enhance the fair growth and responses of the crop to the treatments

5.4.5 Correlation

The simple correlation figures are indicative of the fact that pod number/plant, LAI (12 WAS) and pod weight/plant contributed most towards total grain yield. Pod number, pod weight/plant and LAI have been reported to be the most important yield determinants (Ogunbodede, 1986; Bullock, 1990 and Chiezey, 1990). The leaves are the primary site of photosynthesis because of that, it would be logical to expect a linkage between LAI and yield. The pods form the main harvestable parts, so, their number and weight will determine to a large extent the total yield.

CHAPTER 6

6.0 SUMMARY AND CONCLUSION

A field experiment was conducted during the rainy season of 1992 at the Institute for Agricultural Research Farm in Samaru, in the Northern Guinea Savannah of Nigeria, to assess the effect of different levels of two types of compound fertilizers on yield and yield components of three varieties of soyabean (Glycine max (L.) Merrill).

The experiment consisted of 24 treatments (2x3x4) and laid out in a split-plot design replicated three times. The crops were established fairly well in the field from July to September. All Cultural Practices were executed as and when due

All parameters observed showed significant responses to variety except RGR (First and third intervals).

The effect of the type of compound fertilizer was significant on plant height, TDM, number of pods per plant, branches per plant and days to 50% flowering.

Fertilizer level significantly increased plant height, RGR, TDM, number of pods, pod weight, grain yield per plant, total grain yield (kg/ha) and days to 50% bloom.

From the regression analysis done and the effect of fertilizer level on total grain yield (kg/ha), it can be deduced that 348.8 kg/ha is the optimum level of compound fertilizer application for soyabean. Due to the superior performance of NPK 15:15:15 as it affects the most important yield determinants (pod number, pod weight, LAI and grain weight/plant) and total grain yield (kg/ha), it would be logical to conclude that NPK 15:15:15 be recommended as the better of the two fertilizers for soyabean production.

Samsoy-2 can also be selected as the best of the three varieties based on it's proven superior performance interms of yield and yield components.

In view of the above, it appears as if the most rational option is growing Samsoy-2 with 350 kg/ha of NPK 15:15:15.

It would be interesting to know how other soyanbean varieties apart from TGX 1019-2E, SamSoy-2 and TGX 923) would respond to NPK 15:15:15 and 27:13:13 and how other compount fertilizers apart from these two above will affect the growth yield and yield components of the most common soyabean varieties components of the most comon syoabean varieties we have around.

Appendix 1: Production statistics of soyabean 1991-1992

Region	Total Land Area x 1000 Hectares		Yield/Unit Area Kilograms/Hectare		Total Production x 1000 Metric tonnes	
Year	1991	1992	1991	1992	1991	1992
World	54048	54317	1917	2080	103,611	112,960
USA	23467	23626	2303	2530	54,066	59,780
Brazil	9618	9419	1553	2034	14,938	19,161
Argentina	4783	4940	2411	2290	11,530	11,315
China	7045	7204	1379	1306	9,718	9,405
Africa	471	443	1384	1215	652	538
Nigeria	160	160	956	1000	153	160
South Africa	87	83	1425	759	124	68
Zimbabwe	47	28	2372	1966	111	51
Rwanda	15	15	1267	1267	19	19

Culled from the FAO Quarterly Bulletin on Production statistics Vol. 6, Number 1 of 1993

Appendix 2: Rainfall Distribution for the year 1992 in Samaru Nigeria. Courtesy The Institute for Agricultural Research (IAR) Meteorological Station A.B.U., Zaria.

S/NO.	MONTHS											
	JAN	FEB	MA RCH	APR IL	MA Y	JUN E	JUL Y	AUG	SEP T	OCT	NO V	DE C
1.							26.8					
2.					14.8	46.2						
3.						18.8		1.3	7.7			
4.							5.4	43.0	36.4			
5.							1.5	0.5			2.6	
6.							31.5	18.8	13.9			
7.								73.4				
8.							9.1			1.3		
9.									5.9	3.4		
10.						7.3		13.7	9.0			
11.					16.1				42.0			
12.							13.3	20.0		35.2		
13.						3.7	9.8		22.8			
14.					3.0		11.6					
15.					3.7				21.6			
16.						7.2						
17.							4.6					
18.				32.3					3.1			
19.					2.2		91.6		34.7			
20.				3.5				36.2				
21.								31.1				
22.									32.6			
23.							7.4	3.6				
24.							3.0	15.5				
25.												
26.						21.1	5.6	10.0				
27.							12.0	0.1				
28.					7.1		1.3	6.5				
29.					3.1	8.1		11.2				
30.					14.0		9.1	2.4				
Monthly Total				23.3	73.1	112.4	243.6	287.3	229.7	39.9	2.6	-

Annul Total = 1020.0mm 64 years average total (1928 - 1992) = 1054mm.

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