# PERFORMANCE OF SOYBEAN (*Glycine max* (L.) Merr.) VARIETIES AS INFLUENCED BY SOWING METHODS AND WEED CONTROL TREATMENTS IN THE NIGERIAN SAVANNA

**A RESEARCH THESIS FOR THE DEGREE OF M.Sc. AGRONOMY**

**BY**

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**OCTOBER, 2017**

## DECLARATION

I hereby declared that this thesis was written by me and it is a record of my own research work through the help of Allah and the guidance of my supervisors. It has not being presented before in any previous application for a MSc. Degree. All references made to published literature have been duly acknowledged

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## CERTIFICATION

This thesis, **‘ Performance of Soybean (*glycine max* (l.) merr.) Varieties as influenced by Sowing Methods and Weed Control Treatments in the Nigerian savannah’** by AdebisiIsiakaAlimi meets the regulation governing the degree of Master of Science in Agronomy of Ahmadu Bello University, Zaria and is approved for its contribution to scientific knowledge and literary presentation.

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## DEDICATION

This research work is dedicated to ALLAH S.W.T the custodian of knowledge, who has given me the opportunity to be alive to start this programme and complete it by His grace. And to my late sister, Mrs.FadilatMukilaAdebisi, May her soul rest in perfect peace, Amen.

**ACKNOWLEDGEMENT**

All praises are due to Allah S.W.T who made it possible for me to start this programme at His own appointed time, today, the completion of the programme is to His Glory.

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## ABSTRACT

Two field trials were conducted during the wet season of 2016, one at Samaru ($11^{o}11'$N, $7^{o}$ 38'E 686 meters above sea level) in the northern Guinea savannah and the other at Bagauda (11'37N, $8^{o}$ 23'E, 500meter above sea level) in the Sudan savannah of Nigeria, to study the performance of two soybean varieties as influenced by Sowing method and weed control treatments. The experiment consisted of two varieties of soybean, (TGX 1448-2E and TGX 1987-10F), two Sowing methods (Dibbling and drilling) and four weed control treatments. Pendimethalin at 2.0kg a.i kg/ha applied as pre-emergence, fusillade 2.0 a.i kg/ha applied as post emergence, hoe weeding at 3, 6 and 9 WAS and weedy check. The treatments were laid in a split plot design with factorial combinations of weed control treatments and sowing method assigned to the main plot, while variety was assigned to the sub-plot. The results show that variety TGX 1448-2E recorded lower weed dry weight and produced taller and more vigorous crop plants that had wider canopy and higher grain yield at both locations than TGX 1987-10F. Drilling method of sowing recorded less weed dry weight, weed cover score, and produced more vigorous crop plants with wider canopy cover, higher total dry weight than the dibbling method of sowing. The weedy check plots recorded significantly higher weed dry weight, weed cover score and weed density than all the other weed control treatments. The treatments with fluazifop-butyl (fusillade) at 2.0kg a.i/ha resulted in significantly taller plant height with wider canopy cover and more vigour crops thanPendimethalin at the same rate. On the other hand, hoe weeding at 3, 6, and 9WAS recorded higher seed yields than other weed control treatments.

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# CHAPTER ONE

## 1.0 INTRODUCTION

Soybean (*Glycine max* (L) Merrill) is a member of the Leguminosae family and subfamily Papilinoideae. Soybean is an annual herbaceous legume that originated from North-eastern China and has been cultivated for the past three millennia (Simmond*et al.,* 1999). The crop is now cultivated throughout the world with the largest production in the United State of America, Brazil, China and Argentina (Javaheri and Baudoin, 2001).

Soybean which is popularly known as golden bean has become a miracle crop of the 21$^{st}$ century because it is widely cultivated throughout the world. The world production figure for soybean as at 2013 is about 283millions tonnes. While Nigeria production is 58 tonnes. Soybean is an excellent health food crop, containing 40-44% protein, which is more than in other food crops and common vegetable sources in Nigeria (Thakare*et al., 2006*). The protein yield of soybean on dry matter basis is about twice that of meat and most beans and nuts and four times that of milk (Dalley*et al*., 2004). Soybean seed contains about 20% oils on dry matter basis and it is 85% unsaturated and cholesterol-free. It also contains 20% carbohydrate and 0.69% phosphorous (Oyekan, 1987). The seed is used in making soymilk (Kanase*et al*., 2006). The crop has been described as the world cheap source of edible vegetable oil and protein in livestock feeds (Dalley*et al.,* 2004). It is a primary source vegetable of oil in local and international markets. It has the capability to fix 45-60kg/ha atmospheric nitrogen in the root nodules and adds about 0.5-1.5 t/ha organic matter through leaf fall (Kureh*et al*., 2005). Soybean cultivation has expanded as a result of its nutritional and economic importance and diverse domestic uses.

## 1.1 Production and Economic Importance

Soybean is among the major industrial and food crops grown in every continent of the world. The crop can be successfully grown in many states in Nigeria using low agricultural inputs (Dugje, 2009. Soybean cultivation in Nigeria has expanded as a result of its nutritive and economic importance and the diverse domestic uses (Omoigui, 2009). The crop is also an excellent source of vegetable oil in the international market.

Soybean is an annual grain legume crop that provides about one –quarter of the world dietary protein. According to Ezedinma, (1994), soybean and other leguminous crops are essential sources of plant protein for about 700 million people. About 35-40% of the total dry matter content of the whole soybean is protein. It compares favourably with animal protein sources and contains the most essential amino acids required by man. It has digestible nutrients of about 92%, which makes it a good source of energy (Mijindadi, 1987).

Soybean contributes to the improvement of soil fertility by fixing 60-70 kg-N-ha atmospheric nitrogen in the soil for the subsequent crop (Khan *et al.*, 2005). The crop has an average protein content of 40% and is more protein –rich than any of the common vegetable crops or animal food sources found in Nigeria (Dugje *et al.*, 2009). The crop can be used as soy-milk and vegetable oil. Soybean seed contains about 20% oil on a dry matter basis, which is 85% unsaturated and cholesterol- free (Kanase *et al.*, 2006)

## 1.2 Weed Infestation and Control in Soybean

Reduction in soybean yield due to weed infestation varies from 27-77%, (Fletcher *et al*., 1992) depending on the type of weeds and weed infestation intensity, soil type and rainfall pattern. It was reported that yield declined by as much as 84% as a result of weed infestation

(Mijindadi, 1987) .Weed infestation removed 21.4 kg N and 3.4 kg P per hectare in soybean (Hailu, *et al.,* 2010).

It was reported that two hand hoeing was very effective in suppressing weeds and increasing soybean seed yield (Ahmed *et al*., 2001). The conventional methods of weeding such as hoeing and hand pulling are expensive, laborious and the labour is not available during peak period of weeding (Khan *et al*., 2001). Presently, there is a great labour shortage and a rise in wages scale. Therefore the use of herbicides in legumes to control weeds appears to be very useful (Dadari, 2003). The use of post emergence herbicides is not yet a popular practice among farmers in the study areas. This may be due to lack of information on the benefits of using herbicides to control weeds, and the problem of availability and affordability. Chemical weed control method may be necessary in reducing production cost and increasing soybean productivity. There is need to evaluate some of the available pre and post emergence herbicides in the study area, taking into consideration their effect on soybean plants, their efficiency in weed control and their profitability in relation to the farmers practice of manual weeding.

### 1.3 Justification and Objectives of the Study

Soybean is an important leguminous crop that has great potential in both local and foreign trade, it can boost a nation's revenue base and enhance protein intake of the people. Soybean is a good source of protein for man and animals, and is more so among the poor who cannot afford animal protein. It is also a health food crop, as it has high unsaturated oil content which is low in cholesterol, a protein that has promoted heart disease in many people of the world (Olufajo., 1990). The role of soybean in improving soil fertility through atmospheric N-fixation is a factor to be considered under soil productivity maintenance programme.

For so many years, the crop has been widely grown in the world. However, optimum yield has not been efficiently harnessed in Nigeria. This is due partly to non-adoption of improve varieties and lack of efficient weed control strategy (Dugel, 2009). Despite the satisfactory manual hoe weeding to control weeds, the method is associated with series of problem ranging from drudgery, cost implication, time wasting and unavailability of labour at the peak period of demand. Many questions remain unanswered on how weeds in soybean can be effectively controlled using the alternative herbicides so as to achieve the yield potential of the crop with reduced cost of production. Also, the use of recommended varieties for a given ecology to achieve weeds suppression and improve soybeans performance remains unexplored.

There is also little information on the correct sowing method that will help to suppressed weeds and maximize crop productivity. Inadequate research in the above areas has been reported in the Northern Guinea savannah of Nigeria (Dugje*et al*., 2009). The knowledge of suitable varieties with efficient weed suppressing ability, as well as sowing method that can offer quick canopy development, smothering of understory weeds and enhancing seed yield must be explored. Integrating the two factors may go a long way in achieving effective and efficient weed control, which would in turn boost crop growth and yield.

It is in view of the above, that this research work is conceived and proposed to achieve the following objectives:

(a) To evaluate weed suppression ability and the performance of two varieties of soybeans

(b) To evaluate the effect of pre and post emergence herbicides on weeds growth and yield of two soybean varieties

(c) To evaluate the most appropriate sowing method for effective weed suppression and productivity of two soybeans varieties.

# CHAPTER TWO

## 2.0 LITERATURE REVIEW

### 2.1 Performance of Soybean Varieties

Modern agriculture is concerned with yield and nutritional quality of crops, but environmental factors do not favour the manifestation of their potentials (Dugje, 2009). Crop varieties differ in terms of their genetic constitution, maturity period, morphology, yield potential and photo-period, among others. A large number of soybean cultivars are distinguished on the basis of maturity period, plant height, seed colour and size as well as oil and protein contents of the seeds (Dugje*et al*., 2009). Early maturing types take between 85-95 days to mature, and have plant heights of 30-70cm; they usually have homogeneous ripening, and their production is more reliable than the medium and the late maturing varieties (Ahmed, 1993). Studies have shown that Soybean varieties exhibit variation in growth and development by various factors (Johson*et al*., 1980). They studied the performance of determinate and indeterminate varieties of soybean and reported that both yielded equally. They also observed that average yield of both soybean varieties increased significantly as row width was reduced. Beuerlin (1988), on the other hand found that the yield of determinate variety increased with increased sowing rate, regardless of the sowing date or row spacing, while the indeterminate variety did not respond to sowing rate.

Parvez*et al*. (1989) reported that number of nodes, pods number; leaf area index, total biomass and seed yield were significantly increased with increase in plant density, but no yield differences were observed between the determinate and the indeterminate cultivars.

## 2.2 Effect of Weeds on Soybean Performance

Weeds are a serious problem in soybean production, especially during the early growth stages (Dugje*et al*., 2004). They reported that a properly timed weed management program can minimize the effect of weeds on crop performance. In the Northern Guinea Savannah of Nigeria, grain yield losses in soybean due to weeds have been observed to range from 30-75%, (Shebayan and Lagoke, 1986; Lagoke*et al*., 1991). Shebayan (1998) reported that initial weed infestation in soybean at three weeks after sowing (3WAS) did not significantly affect crop growth parameters and grain yield of soybean provided that weeds were subsequently removed. Shebayan (1998) also observed that at 6WAS, weeds significantly depressed crop vigour score, plant height, number of seed per pod, 1000 seed weight and grain yield. Singh *et al*. (1996) reported that the knowledge of the critical period of weed competition in soybean can help growers to implement effective and timely weed control strategy. Chhokar*et al.* (1995) conducted field studies at Hisar in India to determine the critical period of weed competition in soybean and the influence of weed interference on soybean oil. They reported that the critical period of weed control was found to be from 27 to 40 days after sowing, and controlling weeds during this period resulted in 95.7% increase in grain yield of soybean over the weedy check.

## 2.3 Weed Control in Soybean

### 2.3.1 Conventional weed control in soybean

Soybean undergoes heavy weed competition, especially during the early growth stages. Lagoke (2001) reported that hoe weeding should be carried out two times, first at 2 weeks after sowing and the second at 5-6 after sowing, and that weeding should not be done immediately after rain fall, to avoid weeds being transplanted. Joy *et al*., (2006) reported that

hoe weeding at 20 and 40 days after sowing (DAS) was found to be the best in reducing weed biomass over the other weed control systems evaluated.

Most weed in soybean can be effectively controlled with existing conventional herbicides in well- planned management system (Wilcut*et al.,* 1996). Although there are many weed control options for soybean farmers, the main challenge of conventional herbicides program is the potential crop injuries which include stunted growth, yellowing of leaves, reddening of leaf veins and burning of leaves. While these symptoms do not always reduced yield, they sometimes delay canopy closure and increase weed competition with the crop (Padgett e*t al*., 1996).

### 2.3.2 Chemical weed control in soybean

This involves the use of herbicides to control undesirable plants. Herbicides could be selective or non-selective, contact or systemic, pre-emergence, post-emergence or pre sowing incorporated (Ado, 2007). Although chemical weed control in soybean is less developed in tropical Africa and Latin America than in S.E Asia, it however offers the most practical way of controlling weeds in the crop (Ado, 2007). It has been shown that appropriate herbicides used at the recommended rates offered good weed suppression and increased crop yield (Adekpe and Adigun, (2000). Abd-El Razik, (2006).Reported that crop weed competition is minimized by pre-emergence herbicide, it also resulted to decrease in weed dry matter and increase in soybean yield. The factors that have made chemical weed control more popular than manual and mechanical weeding methods are that there is less drudgery in the chemical than cultural methods. Weed plants can be selectively controlled without injury on the crop plants. Pre-emergence application of herbicides protects crops from the adverse effects of early weed competition. The labour requirement in chemical weed control is lower than in mechanical and manual control methods, and there is little or no soil disturbance, which

reduces the risk of soil erosion that is associated with the latter (Akobundu, 1987). In addition, it is simply a faster weed control method than the cultural measures, and is more effective against perennial weeds than the other methods if appropriate herbicides are used (Shebayan 1998).

However, chemical weed control is not a panacea for all weed problems in agriculture. There are many weed problems and cropping systems where a combination of two or more methods of weed control is more economical and better than either chemical or cultural weed control alone (Akobundu, 1987). The indiscriminate use of herbicides and the total dependence on them have led to some of the adverse effect of herbicides use, such as development of resistance to some herbicides by certain weeds. There is potential for crop injury resulting from poor sprayer calibration, wrong dosage calculation, faulty spraying equipment or failure to follow label indication. Special skills are required to use herbicides successfully. Pre-emergence herbicides may fail to work because of the occurrence of sudden dry spell that follows the application of the herbicides (Peer *et al.*, 2013). And chemical weed control requires special equipment that may not be readily available to farmers.

The chemical methods if used properly are safe and effective in controlling weeds in soybeans. The choice of herbicide depends on the predominant weed species and availability of herbicides. Herbicides such as Pendimethalin and fluazifop-butyl (fusillade) are used as pre and post emergence treatments to control weeds in soybean (Peer *et al.*, 2013).

### 2.3.3 Effect of pendimethalin on weed, growth and yield of soybean

Pendimethalin [N-(1-ethlpropyl)-3, 4-dimetyl-2-6 dinitrobenzone-amine] is a selective and systemic herbicide belonging to the chemical family, chloroacetamide. The trade name is Machete, Butanex. (Wikipedia, 2012). The herbicide is absorbed primarily by germinating shoots and secondarily by the roots, and translocated throughout the plant, giving higher

concentration in the vegetative than the reproductive part (Wikipedia, 2002). Pendimethalin is a pre-emergence herbicide for the control of annual grasses and certain broad leaved weeds. It inhibits cell division by blocking protein synthesis. The effective rate ranges from 1.0-4.5 kg a.i/ha. The activity of pendimethalin, depends on moisture availability through rainfall and irrigation.

Pendimenthalin at a rate of 1 to 2 kg a.i/ha has been reported to significantly reduced the density and dry weight of *Phaiaris minor* and other weeds in wheat and soybean (Omoigui*et al*., 2009). At a rate of 1.5kg a.i/ha, pendimenthalin has been reported to have produced a weedy mortality of 65-68% for *P.minor*, 92-94% for *Chenopodium album* and 80-87% for other weed species. (Peer et al., 2013) has also reported an effective control of *P. minor* in wheat with the pre-emergence application of pendimethalin at a rate of 1.5kg a.i/ha. The result of the trial carried out by Kenzevic*et al*., (2003) has shown a significant reduction in weed population and improved crop yield with pre emergence application of pendimethalin at 0.5 - 0.74kg a.i /ha. Pendimethalin at the rates of 1.0 to 1.5kg a.i /ha has been reported to cause significant increase in the yield of soybean with a corresponding reduction in weed dry weight (Kenzevi*et al.*, 2003).

### 2.3.4 Effect of fluazifop-butyl (fusilade) on weeds and growth and yield of soybean.

Fluazitop-butyl (R-2-[4- [[5-(trifluoromethyl)-2-pyridinyl]oxy] phenoxy] -propionate) belongs to the family of Aryloxyphenoxy-propionate. It inhibits root and shoot growth. Its mode of action is prevention of plant cell division and elongation in susceptible species (Wikipedia, 2012). The herbicide is marketed as fusillade and is recommended for weed control in soybean, potatoes, cabbage, pea, carrot, wheat. Fluazifop-butyl is formulated as emulsifiable concentrate for post-emergence weed control. The active ingredient is 150g

Fluazifop-p-butyi per litre. It is systemic in action and controls annual and perennial weeds in broad leafed crops. It is absorbed mainly through the leaves, and is recommended for use after weed emergence.

Fluazifop-p-butyl is a post-emergence phenoxy herbicide. It is absorbed rapidly through leaf surfaces and quickly hydrolyzes to fluazifop acid. The acid is transported primarily in the phloem and accumulates in the meristems where it disrupts the synthesis of lipids in susceptible species. Fluazifop-p-butyl inhibits acetyl CoA carboxylase, an enzyme that catalyzes an early step in fatty acid synthesis. Lipids are important components of cell membranes, and when they cannot be produced in sufficient quatities, cell membrane integrity fails, especially in regions of active growth such as meristems. Drewit (2000), reported an effective weed control of broad leaves weed with the application of Fluasifop-p-butyl in soybean and cowpea.

### 2.4 Effect of Sowing Method on Weeds and the Performance of Soybean

Soybean can be planted by drilling, dibbling or broadcasting, (Dugje, 2009). According to Kay (1979), the method used in sowing soybean depends on seriousness of the weeds problem and the method of control, either by manual or the uses of herbicides (Ado, 2007). Other important factors that determine the method of sowing is the variety, moisture condition of the soil, the general productive capacity of the soil and the uses of the crop. If soybean is being grown for seed, it is planted by dibbling in rows. Soybeans are usually planted by dibbling the seed in rows (Sweeney, 2015). Dugje, (2009) reported that sowing soybean 3-4 seeds per hole at a spacing of 75cm between rows and 10cm between stand gave a better seed yields. Sowing soybean by dibbling in rows has the advantages of better weed suppression, higher yields and better seed quality, uniformity of stands and reduction in lodging Dugje (2009). Soybean can also be planted in rows by drilling with a corn planter

equipped with soybean plates (Sweeney, 2014). Henry (1967) reported that soybean planted by drilling on a solid stand produce finer and more palatable hay than the dibbling sowing method.

Madanzi*et al*. (2010) reported that there was no significant advantage using dibbling method of sowing, but the highest stand counts were obtained when the seed was planted in furrow opened by an ox-drawn plough. Opening furrows with hand hoe after harrowing and without harrowing also achieved high stand counts. Madanzi (2010) reported that highest yield was achieved where furrows were opened by the plough and close with feet.

### 2.4.1 Effect of sowing by dibbling on growth and yield of soybean

Dibbling method of sowing soybean is the placing of seeds at cross marks made in the field with the help of marker. This sowing is done manually by hand dibbler. The method is suitable in crop like soybean, ground nut, castor and cotton etc. Madanzi*et al* (2003)reported that sowing by dibbling ensure spacing between rows and stands is maintained, seeds can be dibbled at desired depth in the moisture zone, optimum plant population can be maintained, and the quantity of seed required is usually less than other methods. In addition an intercrop can be planted in the wider spaced crops. It is laborious and time consuming, requires more labour, thus it increases the cost of cultivation, and only high valued and bold seeds are sown by this method, under strict supervision (Madanzi, *et al.*, 2010).

### 2.4.2 Effect of sowing by drilling on the growth and yield of soybean

Drilling or line sowing is the dropping of seeds into the soil with the help of implement such as seed drill and then the seeds are covered to have contact with the soil. Crops like soybean and wheat can be sown by this method seeds are placed properly and in uniform depth along

the rows, inter culturing can be practised uniform row to row spacing is maintained, seed requirement is less than in the broadcast methods. (Madanzi, *et al.* (2003). Sweeney (2014) reported thatplant to plant intra row spacing is not maintained when using drilling, skilled person is required and there is need for implement for this sowing method.

# CHAPTER THREE

## 3.0 MATERIALS AND METHODS

### 3.1 Experimental Sites

The experiment was conducted simultaneously during the wet seasons of 2016 at the research farm of the Institute For Agricultural Research, Samaru ($11^0 11'$N, 07◦38′E; 686m above sea level) in the Northern Guinea Savannah and at the irrigation sub- station of the research farm of the Horticultural Research Institute, Bagauda, ($11^0 39$` 08 02`E, 500M above the sea level) in the Sudan Savannah zone of Nigeria.

### 3.2 Meteorological Data

During the experimental period, record of rainfall, temperature, sunshine hour and relative humidity at each location was collected from the Institute for Agriculture Research meteorological Unit, Samaru.

### 3.3 Soil Sampling and Analysis

Before land preparation in each site, soil samples were randomly taken at various points at the depth of 0-30cm using soil auger, and the sample was taken to the laboratory in Agronomy Department, Ahmadu Bello University, Zaria for determination of soil Texture, pH, Organic Carbon, Organic Matter, Total Nitrogen, Available phosphorus, Exchangeable Bases such as potassium, Magnesium, Calcium and Sodium, and Cations Exchangeable Capacity (CEC), using standard procedures as described by Black (1965).

### 3.4 Treatments and Experimental Design

The treatments consisted of two varieties of soybean (TGX 1448-2E) and (TGX 1987-10F) , four weed control treatments (pendimethalin applied pre-emergence at 2kg a.i /ha, fluazifop-butyl applied post-emergence at 2kg a.i/ha at three weeks after sowing, hoe weeding at 3 and 6 WAS and a weedy check) and two sowing methods (Dibbling and drilling). The treatments were laid out in a split – plot design in three replicates. Factorial combinations of weed control treatments and sowing method were assigned to the main plots, and varieties to the sub plots.

### 3.5 Plot Size

The gross plot size was $18m^2$ (4.5m x 4m) consisting of 6 ridges, each 4m long and 0.75m apart and the net plot size was $12m^2$ consisting of the 4 inner ridges (3.0m x 4m).=$12m^2$. The spacing between the replicate was 1.5m while the spacing between the plots was 1.0m.

### 3.6. Variety Description

**3.6.1** TGX 1448-2Eis one of the recommended soybean varieties that were used in this experiment. It was released by IITA, Ibadan. It is a medium maturing variety and it is high yielding, and low shattering and high in oil content (Adigun, 1991). The morphological characteristics include erect growth, sturdy stem, with green based colouration. It has high oil content and good grain colour with potential yield of 1.5-2.0 tonnes per hectare. It is well adapted to the Southern and the Northern Guinea Savannah. It also has good *Striga* control ability and is resistance to rust and *Cercospora* leaf spot. It required 90-100 days from sowing to maturity.

**3.6.2** TGX1987-10F is a new variety released in year 2010 by IITA Ibadan .The outstanding characteristics of this variety include; early maturing, and high promiscuous nodulation, good resistance to rust, *Cercospora* leaf spot and bacterial pustule. Morphologically, it has erect, sturdy stem, with green-base coloration. It takes 75 to 90 days to mature. It is a low shattering, with high oil content and potential yield of 1.5-2.0 tonnes per hectare (Hailu*et al.*, 2010).

## 3.7 Cultural Practices

### 3.7.1 Land Preparation

The sites were ploughed and harrowed to obtain a fine tilth. Ridging was made at 75cm spacing and the field was marked into plots and replications. The space between the plots was 1m while the space between replications was 1.5m.

### 3.7.2 Sowing

Sowing was done according to treatment:Dibbling was done at10cm intra-row spacing on ridges, 75cm apart. Four seeds was sown per hole at the rate of 50kg/ha. The seedlings was thinned to 2 plants per stand at 14 days after sowing to give a population of 266666 plants/ha. Drilling was done by splitting crest of the ridge open and placing seed in drills at seed rate of 50kg/ha.

Sowing was carried out during the third week of June 2016. The seed were treated with Apron Star, using 1 satchet to treat 4kg of seed before sowing.

### 3.7.3 Weed control

The plots were treated according to treatment: Pendimethalin was applied pre- emergence using a CP15 Knapsack sprayer, fitted with a green deflector nozzle and set at pressure of 2.1kgcm$^2$. to deliver 250mls spray liquid/ha. Similarly, fluazifop-butyl was applied post-emergence at 3 WAS, using the same applicator. The weeded plots was achieved by hoe weeding at 3, 6 and 9 WAS.

### 3.7.4 Fertilizer application

Phosphorous fertilizer in the form of single super phosphate (18%$P_2O_5$) was applied at the rate of 30kg$P_2O_5$/ha at sowing in conjunction with 133kg/ha of NPK 15:15:15.

### 3.7.5 Pests and disease control

Farm sanitation and the use of clean seed were adopted to avoid infections. When the need arose, fungicide was used to control fungal diseases. Insect pests was controlled with Cypermenthrin+Dimethoate 10 EC, a broad spectrum insecticide at the rate of 1l/Ha.

### 3.7.6 Harvesting

The crop was harvested at physiological maturity; that is when the leaves have turned brownish or yellowish in colour and the pods turn brown and have dried. Harvesting was done by cutting the plants at the ground level with sickles. The plants were stacked loosely on tarpaulin and allowed to further dry under sun. They were beaten to release seeds from the pods, and the seed was separated from the chaff by winnowing to obtain clean seeds.

### 3.8 Data Collection

#### 3.8.1 Weed parameters

**Weed covers score**

**Weed density**

Weed cover score was obtained by visual observation at 6 and 9 weeks after sowing using a scale of 1- 9, where scale1 represent no weed cover and scale 9 represents complete weed cover.

**Cumulative weeds dry matter**

A quadrant of $1m^2$ was used randomly to collect samples of fresh weeds before weeding at 3, 6, 9 and 12 weeks after sowing. The weeds were cleaned of soil and oven dried at $70^{oc}$ to a constant weight and weighed using a mettler digital balance and the values were recorded. For each plot the values at the various sampling periods were added to give the cumulative weed dry weight

#### 3.8.2 Crop growth parameters

Ten soybean plants in each net plot were tagged for periodic observations during the crop growth period. The observations were made at 3, 6, 9, and 12 weeks after sowing (WAS) as follows:

**Crop injury Score**

A scale of 1to 9 was used for the crop injury score where scale 9 represent the most vigorous plant and 1 represent completely dead plants, this was visually observed at 3, 6, 9 and 12 WAS. The greenness and canopy of shoot, plant height and ground cover by crop were considered for scoring the plant

**Canopy spread (cm)**

The spread of branches of five tagged plants were taken at random by using a meter rule during the vegetative growth at 3, 6, 9 and12 WAS. The averages of the tagged plants were expressed in cm/plant.

**Plant height (cm)**

Plant heights of the tagged plants were measured from the base of plant to the highest leaf using a meter rule at 3, 6, 9 and 12 weeks after sowing. The average height of the sampled plants were computed and recorded for each plot.

**Number of leaves per plant**

The numbers of fully expanded leaves on the tagged plants were counted at 3, 6, 9 and 12 weeks after sowing and the average computed and recorded for each plot.

**Leaf area per plant (LA)**

Five plants were randomly selected outside the net plot and uprooted, and the leaves were removed and their area measured using the leaf area meter Model L1 -3100C at 3, 6, 9 and 12 WAS). The mean leaf area per plant was computed and recorded for each plot.

**Leaf area index (LAI)**

Measurements were taken at 3, 6, 9 and 12 WAS. Leaf area index was obtained by dividing LA by the ground area subtend by the plant to obtain LAI as described by Watson (1958) in the formula:

LAI = $\frac{A}{G}$ =Leaf area per plant /ground area per plant

Where A = leaf area per plant

G =ground area per plant

The leaf area index (LAI) can also be assessed using the comptometer (Model tp-80).

**Shoot dry matter**

Five plants outside each net plot were randomly taken at 3, 6, 9 and 12 WAS and cut at ground level. The samples were oven dried to a constant weight using Gallen-kamp oven at 70◦C. The dried samples were weighed using a mettler balance and the average weight per plant computed and recorded.

**Number of days to first flowering**

This was determined by counting to get the number of days from seed sowing to the first flower opening in each plot and this was recorded for each plot.

**Days to 50% flowering**

The numbers of days from seed sowing to when 50% of the plant had flowered were recorded in each plot.

**Crop growth rate (CGR)**

This was determined at 3, 6, 9 and 12 WAS from the sample plant after being oven dried to a constant weight. The value was calculated from formula described by Radford (1964):

$$\text{CGR} = \frac{w_2 - w_1}{t_2 - t_1} \times \frac{1}{GA} \text{ g}/m^2/\text{wk}$$

W1and $W1_2$ are dry weights in grams per plant at times $t_1$ and $t_2$ in weeks, respectively, while, GA is the ground area.

**Relative growth rate (RGR)**

This was calculated at 3, 6, 9 and12 WAS. It was determined after oven drying the sample plant to a constant weight using the formula describe by Radford (1964):

$$\text{RGR} = \frac{\log_e w2 - \log_e w1}{t_2 - t_1} \text{ (g/g/wk.)}$$

Where $w_1$ and $w_2$ are dry weights in grams per plant at times $t_1$ and $t_2$ in weeks, respectively, and $\log_e$ represent natural logarithm.

**Net assimilation rate (NAR)**

This was also determined at 3, 6, 9 and 12 WAS. It was calculated using the formula by Watson (1985) as follows:

$$\text{NAR} = \frac{W_2 - W_1}{A_2 - A_1} \text{ X } \frac{\log_e A_2 - \log_e A_1}{t_2 - t_1} \text{ (gm.}^{-2\text{wk}}\text{)}$$

Where $w_1$ and $w_2$ are dry weights in grams plant$^{-1}$ at times $t_1$ and $t_2$. and$_{A1,}$ and $A_2$ are leaf areas at time $t_1$ and $t_2$, respectively.

### 3.8.3 Yield and yield components

**Seed weight per plant**

The seed from the dried pods of five tagged plants were harvested, threshed and weighed, and the average weight recorded for each plot.

**100-seed weight**

One hundred seeds were randomly taken from each net plot yield and weighed. The weight was recorded as 100-seed weight for each plot

**Grain yield**

Each net plot was harvested, threshed and the seeds were weighed. Seeds weight obtained from each net plot was extrapolated to seed yield in kg/ha and the value was recorded for each plot.

**Haulms yield**

The haulms left after removing soybean seeds was air- dried under sun to constant weight. The haulms was weighed using Metler weighing balance and the values per net plots were extrapolated to kg/ha and recorded in each plot

**Harvest index (HI)**

This is the ratio of the seeds weight to the total dry matter per plant at harvest, which was calculated using the formula as follows:

$$HI = \frac{\text{Grain weight per plant}}{\text{Total dry matter per plant}} x100$$

### 3.9 Statistical Analysis

The data collected were subjected to analysis of variance using the F-test as described by Snedecor and Cochran (1994) to determine significance of differences between the treatment means. Differences among the treatment means were compared using the Duncan's multiple range test (DMRT) as described by Duncan (1955). The relationship between weed, crop Growth and yield parameters were determined by correlation coefficient as determined by Little and Hills, (1978)

# CHAPTER FOUR

## 4.0 RESULTS

### 4.1 Soil Analysis

The physical and chemical properties of the soil of the experimental sites are shown in Table 1.The analysis shows that soil in Samaru site was a loam. The soil was slightly acidic and relatively high in available phosphorous (10.34 mg $kg^{-1}$). While the soil in Bagauda was silty loam, slightly acidic and low in available phosphorous (2.75 mg $kg^{-1}$). The percentage of organic carbon and total nitrogen from both sites were low. The exchangeable bases, Mg, K and Na were also low, except Ca, which was moderate at both locations. The cation exchanges capacity (CEC) was moderate at both locations.

### 4.2 Effects of Crop Variety, Sowing Methods and Weed Treatments on Weed parameters

#### 4.2.1 Weed Cover Score

The effects of crop variety, sowing method and weed control treatments on weed cover score at Samaru and Bagauda are presented in Tables 2 and 3. The effect of variety was only significant at 3WAS in Samaru, where TGX 1448-2E recorded low weed cover score than TGX 1987-10F. The effect of sowing method on weed cover score was significant at 3 and 9WAS in Samaru (Table 2). Dibbling method of sowing recorded lower weed cover score compared with the drilling. The effect of weed control treatment on weed cover score in Samaru shows that at 6WAS the least weed cover score was recorded with hoe weeding followed by Pendimethalin at 2.0kg a.i/ha, which in turned gave lower weed cover than that

of fluazifop-butyl at 2.0kg a.i/ha and the weedy check. At 9 and 12WAS, fluazifop-butyl at 2.0kg a.i/ha and hoe weeding at 3 and 6WAS reduced weed cover score compared to the highest by the weedy check and Pendimethalin at 2.0kg a.i/ha.

At Bagauda, sowing method influenced weed cover score at 6 and 9WAS, when drilling depressed the parameter compared to dibbling (Table 3). At 3 WAS in this location, hoe weeding reduced weed cover score over the untreated control (weedy check). Treatment with pendimethalin and fluazifop-butyl had similar weed cover score as the weedy check.

At 6 WAS, pendimethalin and fluazifop-butyl at the given rates resulted in lower weed cover score than hoe weeding, which in turned was lower than the weedy check. At 9 WAS, hoe weeding resulted in lower weed cover score than pendimethalin at 2.0 kg a.i/ha; while at 12 WAS, the treatment with pendimethalin resulted in higher score than the other treatments, including the weedy check.

Table 1: Physical and chemical property of soil at experimental fields during 2016 rainy season at Samaru and Bagauda

| Location | Samaru | Bagauda |
|---|---|---|
| Soil depth (cm) | 0-30 | 0-30 |
| **Soil characteristics** | | |
| Particle size distribution (g $Kg^{-1}$) | | |
| Sand | 42.0 | 24.0 |
| **Silt** | 47.0 | 66.0 |
| Clay | 11.0 | 10.0 |
| Textural class | loam | Silt loam |
| **Chemical composition** | | |
| pH in $H_2O$ (1:2.5) | 6.30 | 6.22 |
| pH in 0.01M $Cacl_2$ (1:2.5) | 5.95 | 5.81 |
| Organic carbon (g $kg^{-1}$) | 1.24 | 1.12 |
| Available phosphorous (mg $kg^{-1}$) | 10.34 | 2.75 |
| Total nitrogen (g $kg^{-1}$) | 0.21 | 0.15 |
| **Exchangeable bases (c mol $kg^{-1}$)** | | |
| Calcium | 3.9 | 3.4 |
| Magnesium | 0.801 | 0.721 |
| Potassium | 0.015 | 0.072 |
| Sodium | 0.086 | 0.134 |
| CEC | 4.701 | 4.281 |

Soil analysed in the Analytical laboratory of Agronomy Department, Ahmadu Bello University, Samaru, Zaira.

Table 2:Influence of crop variety, sowing method and weed control treatments on weed cover score in soybean during the wet season of 2016 at Samaru

| | Weed cover score[1] | | | |
|---|---|---|---|---|
| Treatments | 3WAS[2] | 6WAS | 9WAS | 12WAS |
| **Variety** | | | | |
| TGX 1448-2E | 2.4a | 4.5 | 3.3 | 3.9 |
| TGX 1987-10F | 3.1b | 4.1 | 3.4 | 3.8 |
| SE± | 0.23 | 0.43 | 0.22 | 0.20 |
| **Sowing Methods (P)** | | | | |
| Dibbling | 2.5b | 4.2 | 3.6a | 3.9 |
| Drilling | 3.0a | 4.2 | 3.1b | 3.8 |
| SE± | 0.23 | 1.14 | 0.22 | 0.20 |
| **Weed Control Method (W)** | | | | |
| Pendimethalin at 2.0 kg/ha | 2. 8 | 3.9b | 4.2a | 4.5a |
| fluazifop-butyl at 2.0kg/ha | 3.0 | 4.0a | 3.0b | 3.2b |
| Hoe weeding at 3, 6 & 9 WAS | 2.7 | 2.3c | 2.1c | 3.2b |
| Weedy check | 2.6 | 6.9a | 4.2a | 4.6a |
| SE± | 0.33 | 0.61 | 0.31 | 0.29 |
| **Interactions** | | | | |
| V *P | NS[3] | NS | NS | NS |
| V*W | NS | NS | NS | NS |
| P*W | * | * | NS | NS |
| V*P*W | NS | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 1. Weed covers score using a scale of 1-9, when scale 1 represented no weed cover, and scale 9 represented complete weed cover, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability and * = Significant at 5% level of probability.

Table 3: Influence of crop variety, sowing method and weed control treatments on weed cover score in soybean during the wet season of 2016 at Bagauda

| Treatments | weed cover score[1] 3WAS[2] | 6WAS | 9WAS | 12WAS |
|---|---|---|---|---|
| **Variety (V)** | | | | |
| TGX 1448-2E | 3.0 | 4.3 | 2.3 | 2.4b |
| TGX 1987-10F | 3.1 | 4.1 | 2.3 | 2.6a |
| SE± | 0.14 | 0.35 | 0.16 | 0.14 |
| **Sowing Methods (P)** | | | | |
| Dibbling | 2.9 | 4.5a | 2.6a | 2.5 |
| Drilling | 3.3 | 3.8b | 2.1b | 2.5 |
| SE± | 0.38 | 0.35 | 0.16 | 0.14 |
| **Weed Control method (W)** | | | | |
| Pendimethalin at 2.0 kg a.i/ ha | 2.7bc | 3.4c | 2.6a | 2.9a |
| fluazifop-butyl at 2.0 kg a.i/ ha | 3.7a | 3.2c | 2.3ab | 2.5b |
| Hoe weeding at 3, 6 & 9 WAS | 2.4c | 4.3b | 2.1b | 2.4 |
| Weedy check | 3.5ab | 5.8a | 2.4ab | 2.2 |
| SE± | 0.53 | 0.50 | 0.23 | 0.20 |
| **Interactions** | | | | |
| V *P | NS[3] | NS | NS | NS |
| V*W | NS | NS | NS | NS |
| P*W | NS | NS | NS | NS |
| V*P*W | NS | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 1. Weed covers score using a scale of 1-9, when scale 1 represented no weed cover, and scale, 9 represented complete weed cover, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability and * = Significant at 5% level of probability.

The interaction of sowing and weed control methods on weed cover score was significant at 3 and 6 WAS (Table 4). At 3 WAS dibbling resulted in lower weed cover score than the drilling when pendimethalin was applied to control weeds but with other weed control treatments weed cover score was not significant by sowingmethod. On the other hand, pendimethalin gave lower weed cover score than the weedy check under both sowing methods and hoe weeding under dibbling only. The treatments had similar weed cover score. At 6 WAS, the weedy check resulted in higher weed cover score than the other weed control treatments under both sowing methods. The best weed suppression was achieved by pendimethalin under dibbling and two hoes weeding at 3 and 6 WAS under dibbling. On the other hand, dibbling depressed weed cover score compared to drilling when applied in conjunction with Pendimethalin at 2.0 kg a.i/ha and the untreated control, but with fluazifop-butyl at 2.0kg a.i/ha and hoe weeding at 3 and 6 WAS, drilling resulted in lower weed score than dibbling.

Table 4: Interaction of sowing and weed control methods on weed cover score at 3 and 6 WAS in 2016 wet season at Samaru

| **Sowing Methods** | | |
|---|---|---|
| **3WAS[1]** | | |
| Treatment | Dibbling | Drilling |
| **Weed Control Method (kg/ha** | | |
| Pendimethalin at 2.0 | 2.0c | 3.5a |
| fluazifop-butyl at 2.0 | 3.0ab | 3.0ab |
| Hoe weeding | 2.3bc | 3.0ab |
| Weedy check | 2.7bc | 2.5bc |
| SE± | 0.27 | |
| **6 WAS** | | |
| Pendimethalin at 2.0kg a.i/ha | 3.2cd | 4.7c |
| fluazifop-butyl at 2.0kg a.i/ha | 4.7c | 3.3cd |
| Hoe weeding | 2.7d | 2.0d |
| Weedy check | 6.2b | 7.7a |
| SE± | 0.49 | |

Means followed by same letter(s) are statistically similar at 5% level of probability using DMRT, 1. WAS = Weeks after sowing

### 4.2.2 Weed density

The effects of crop variety, sowing method and weed control treatment on weed density are presented in Tables 5 and 6. At Samaru, the effect of variety on weed density was not significant throughout the sampling period. However, the effect of sowing method on weed density was significant at 6-12WAS, when dibbling method of sowing recorded the higher weed density than drilling. The effect of weed control treatments on weed density at 3WAS shows that pendimethalin at 2.0kg a.i/ha gave lower weed density than all the other weed control treatments, which were similar. At 6 and 12 WAS, each weed control treatment resulted to lower weed density than the weedy check. At 9WAS the treatment with pendimethalin and hoe weeding at 3 and 6WAS gave lower weed density than fluazifop-butyl at 2.0kg a.i/ha and the weedy check.

Table 5: Influence of crop variety, sowing method and weed control treatments on weed density in soybean during the wet season of 2016 at Samaru

| Treatments | Weed density[1](g/cm$^2$) | | | |
|---|---|---|---|---|
| **Variety (V)** | 3WAS[2] | 6WAS | 9WAS | 12WAS |
| TGX 1448-2E | 66.5 | 87.4 | 86.5 | 88.9 |
| TGX 1987-10F | 66.1 | 82.0 | 92.7 | 84.5 |
| SE± | 4.31 | 5.63 | 6.07 | 3.52 |
| **Sowing Methods (P)** | | | | |
| Dibbling | 66.6 | 90.4a | 97.3a | 91.4a |
| Drilling | 65.9 | 79.1b | 81.9b | 82.1b |
| SE± | 4.31 | 5.63 | 6.07 | 3.52 |
| **Weed Control Method (W)** | | | | |
| Pendimethalin at 2.0kg/ha | 48.8b | 82.1c | 76.9b | 79.50c |
| fluazifop-butyl at 2.0kg/ha | 69.5a | 87.0b | 104.0a | 94.6b |
| Hoe weeding at 3,6 & 9 | 69.9a | 56.9c | 58.7c | 66.1d |
| WAS | | | | |
| Weedy check | 76.9a | 112.9a | 118.8a | 106.7a |
| SE±d | 6.09 | 7.97 | 8.59 | 4.98 |
| **Interactions** | | | | |
| V *P | NS[3] | NS | NS | NS |
| V*W | NS | NS | NS | NS |
| P*W | NS | NS | * | NS |
| V*P*W | NS | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT. 2. WAS = Week after sowing 3. NS =Not significant at 5% level of probability. *= Significant at 5% level of probability

Table 6: Influence of crop variety, sowing method and weed control treatments on weed density in soybean during the wet season of 2016 at Bagauda

| Treatments | Weed density[1](g/cm[2]) | | | |
|---|---|---|---|---|
| | 3WAS[2] | 6WAS | 9WAS | 12WAS |
| **Variety (V)** | | | | |
| TGX 1448-2E | 46.1 | 69.2a | 72.5b | 81.8 |
| TGX 1987-10F | 49.4 | 56.1b | 81.6a | 82.2 |
| SE± | 8.73 | 6.90 | 3.99 | 3.25 |
| **Sowing Methods (P)** | | | | |
| Dibbling | 54.9 | 67.3 | 83.9a | 89.8a |
| Drilling | 40.6 | 58.1 | 70.3b | 74.2b |
| SE± | 8.73 | 6.90 | 3.99 | 3.25 |
| **Weed Control Method (W)** | | | | |
| Pendimethalin at 2.0kg/ha | 34.8 | 43.8c | 67.6c | 69.1b |
| fluazifop-butyl at 2.0kg/ha | 49.3 | 56.8bc | 87.4b | 93.7a |
| Hoe weeding at 3,6 & 9 WAS | 53.1 | 64.3b | 55.0d | 67.2b |
| Weedy check | 53.8 | 85.8a | 98.2a | 98.0a |
| SE± | 12.34 | 9.76 | 5.46 | 4.60 |
| **Interactions** | | | | |
| V *P | NS[3] | NS | NS | NS |
| V*W | NS | NS | NS | NS |
| P*W | NS | NS | NS | NS |
| V*P*W | NS | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT. 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability and * = Significant at 5% level of probability

With drilling, hoe weeding gave lower weed density than all the other treatment, follow by pendimethalin which in turned was lower than by fluazifop-butyl at 2.0kg a.i/ha, and in the same vein, the weedy check.

At Bagauda TGX1448-2E resulted in lower weed density than TGX 1987-10F at 6WAS, but at 9WAS, the reverse was the case (Table 7).At 9 and 12WAS, drilling resulted in lower weed density than dibbling. However, the influence of weed control method was significant throughout the sampling period in this location. At 3WAS, treatment with pendimethalin and fluazifop-butyl at 2.0kg a.i/ha gave lower weed density than the hoe weeded and the weedy checks. At 6 and 9WAS, each weed control treatment gave lower weed density than the weedy check. At 12WAS, Pendimethalin and hoe weeding resulted in lower weed density than fluazifop-butyl at 2.0kg a.i/ha and weedy check.

The interaction of sowing method and the weed control treatments was significant at 9WAS in Samaru (Table7). With Pendimethalin, fluazifop-butyl and weedy check, sowing method did not influence weed density. But with hoe weeding at 3 and 6WAS, dirlling gave lower weed density than dibbling. On the other hand, pendimethalin at 2.0kg a.i/ha and hoe weeding at 3 and 6WAS resulted in similar weed density and each was lower than the weedy check and fluazifop-butyl at 2.0kg a.i/ha when applied in conjunction with dibbling.

Table 7: Interaction of weed control methods and sowing methods of soybean on weed density (g/cm$^2$) 9 WAS in 2016 wet season at Samaru

| Sowing methods[1] | | |
|---|---|---|
| Treatments | Dibbling | Drilling |
| **Weed Control (W)** | | |
| Pendimethalin at 2.0 kg a.i/ ha | 80.0cd | 73.8d |
| fluazifop-butyl at 2.0 kg a.i/ ha | 112.5ab | 95.5bc |
| Hoe weeding at 3, 6 & 9 WAS | 80.5cd | 36.8e |
| Weedy check | 116.0a | 121.7a |
| SE± | 7.01 | |

Means followed by same letter(s) are statistically similar at 5% level of probability using DMRT, 1. WAS =Weeks after sowing

### 4.2.3 Weed dry weight (g)

The effects of variety, sowing and weed control treatments on weed dry weight in soybean at Samaru and Bagauda are presented in Tables 8 and 9. The effect of variety on weed dry weight was not significant throughout the sampling period in Samaru and Bagauda. At Samaru, the effect of sowing method on weed dry weight was only significant at 9 WAS, in which the dibbling method of sowing produced more weed dry matter than drilling. The effect of weed control treatment on weed dry weight at 9 and 12WAS shows that the hoe weeded plots had the least weed dry weight, which was lower than all the other treatments. Treatments with pendimethalin and fluazifop-butyl resulted in similar weed dry matter production and each was higher than by the weedy check. At Bagauda, the effect of sowing method on weed dry weight was significant at 6 and 12 WAS (Table 9). At 9 WAS, drilling resulted in higher weed dry weight than dibbling. But at 12 WAS, dibbling had higher weed dry weight than drilling. At 9WAS in this location, endimethalin at 2.0kg a.i/ha and hoe weeding at 3 and 6WAS reduced weed dry matter production compared to the weedy check and the use of fluazifop-butyl at 2.0 kg a.i/ ha, both of which gave similar results. The interaction of sowing method and variety was significant at 3 WAS at Samaru (Table 10). The combination of TGX 1448-2E with dibbling gave lower weed dry weight than with drilling. With TGX 1987-10F, sowing method did not influence weed dry weight. Similarly, with each sowing method, variety did not affect weed dry weight.

Table 8: Influence of crop variety, sowing method and weed control treatments on weed dry weight in soybean during the wet season of 2016 at Samaru

| Weed dry weight[1](g/cm$^2$) Treatments | 3WAS[2] | 6WAS | 9WAS | 12WAS |
|---|---|---|---|---|
| **Variety (V)** | | | | |
| TGX 1448-2E | 54.4 | 62.2 | 99.9 | 150.3 |
| TGX 1987-10F | 53.2 | 57.7 | 99.0 | 155.1 |
| SE± | 7.85 | 6.65 | 6.83 | 15.93 |
| **Sowing Methods (P)** | | | | |
| Dibbling | 51.0 | 58.0 | 106.0a | 163.9 |
| Drilling | 56.6 | 61.9 | 93.0b | 141.4 |
| SE± | 7.85 | 6.65 | 6.83 | 15.93 |
| **Weed Control Methods (W)** | | | | |
| Pendimethalin at 2.0kg/ha | 42.2b | 51.4 | 106.9b | 150.7b |
| fluazifop-butyl at 2.0kg/ha | 50.1ab | 59.9 | 107.5b | 165.1b |
| Hoe weeding at 3,6 & 9 WAS | 70.2a | 62.1 | 58.3c | 66.3c |
| Weedy check | 52.8ab | 66.5 | 125.2a | 228.6a |
| SE± | 11.10 | 9.41 | 9.65 | 22.53 |
| Interactions | | | | |
| V *P | * | NS[3] | NS | NS |
| V*W | NS | NS | NS | NS |
| P*W | NS | NS | NS | NS |
| V*P*W | NS | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT. 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability and * = Significant at 5% level of probability

Table 9: Influence of crop variety, sowing method and weed control treatments on weed dry weight in soybean during the wet season of 2016 at Bagauda

| Weed dry weight[1](g/cm$^2$) Treatments | 3WAS[2] | 6WAS | 9WAS | 12WAS |
|---|---|---|---|---|
| **Variety (V)** | | | | |
| TGX 1448-2E | 38.7 | 61.9 | 96.5 | 178.4 |
| TGX 1987-10F | 35.1 | 64.9 | 98.5 | 172.8 |
| SE± | 8.32 | 6.32 | 4.12 | 22.16 |
| **Sowing Methods (P)** | | | | |
| Dibbling | 37.3 | 57.9b | 100.1 | 196.8a |
| Drilling | 36.6 | 68.9a | 94.9 | 154.4b |
| SE± | 8.32 | 6.32 | 4.12 | 22.16 |
| **Weed Control Methods (w)** | | | | |
| Pendimethalin at 2.0kg/ha | 34.1 | 57.1 | 96.5b | 112.3b |
| fluazifop-butyl at 2.0kg/ha | 40.3 | 65.6 | 109.2a | 144.7b |
| Hoe weeding at 3,6,9 &12 WAS | 41.8 | 60.1 | 65.9c | 149.3b |
| Weedy check | 31.5 | 70.9 | 118.3a | 296.2a |
| SE± | 11.78 | 8.94 | 5.84 | 31.33 |
| Interactions | | | | |
| V*P | NS[3] | NS | NS | NS |
| V*W | NS | NS | NS | NS |
| P*W | NS | NS | NS | NS |
| V*P*W | NS | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = and Significant at 5% level of probability.

Table 10: Interaction of weed control methods and sowing methods of soybean on weed dry weight ($g/cm^2$) at 3WAS in 2019 wet season at Samaru

| | Varieties | |
|---|---|---|
| Treatments | TGX1448-2E | TGX1987-10F |
| Sowing methods | | |
| Dibbling | 44.8b | 57.2ab |
| Drilling | 64.0a | 49.3ab |
| SE± | 6.41 | |

Means followed by same letter(s) are statistically similar at 5% level of probability using DMRT

### 4.3 Effects of Crop Variety, Sowing Method and Weed Control Treatment, on Growth and Yield Parameters

#### 4.3.1 Crop injury score

The effects of crop variety, sowing methods and weed control treatments on soybean crop injury score at 3WAS at Samaru and Bagauda are presented in Table 11. There was no significant influenced of crop variety, sowing method and weed control treatment on crop injury score at both Samaru and Bagauda.

The interactions of variety, sowing and weed control methods on crop injury score in both locations were not significant.

#### 4.3.2 Stand Count

The effects of crop variety, sowing method and weed control treatment on stand count of soybean in both locations are presented in Table 12. Stand count was significantly influenced by crop variety and sowing method throughout the sampling period in both locations. In both locations, TGX 1987-10F significantly had higher stand count than TGX 1448-2E at the two sampling periods and locations. Similarly, drilling method of sowing had more plant stands than the dibbling method at both sampling periods and locations. Weed control method did not have any significant effect on stand count in both the sampling period and locations.

The interactions of crop variety, sowing and weed control methods on stand count were not significant throughout the sampling period in both locations.

Table 11: Influence of crop variety, sowing method and weed control treatments on crop injury score in soybean during the wet season of 2016 at Samaru and Bagauda

| | Crop injury[1] | |
|---|---|---|
| Samaru Bagauda | | |
| Treatments | 3WAS[2] | 3WAS |
| Variety (V) | | |
| TGX 1448-2E | 1.42 | 1.54 |
| TGX 1987-10F | 1.58 | 1.83 |
| SE± | 0.12 | 0.17 |
| **Sowing Methods (P)** | | |
| Dibbling | 1.54 | 1.67 |
| Drilling | 1.46 | 1.46 |
| SE± | 0.12 | 0.17 |
| **Weed Control Methods (W)** | | |
| Pendimethalin at 2.0 kg/ha | 1.17 | 1.25 |
| fluazifop-butyl at 2.0 kg/ha | 2.75 | 3.00 |
| Hoe weeding at 3,6 & 9 WAS | 1.08 | 1.00 |
| Weedy check | 1.00 | 1.00 |
| SE± | 0.18 | 0.19 |
| **Interactions** | | |
| V *P | NS[3] | NS |
| V*W | NS | NS |
| P*W | NS | NS |
| V*P*W | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = Significant at 5% level of probability

Table 12: Influence of crop variety, sowing method and weed control treatments on Stand count of soybean during the wet season of 2016 at Samaru and Bagauda

| | Stand counts[1] | | | |
|---|---|---|---|---|
| | Samaru | | Bagauda | |
| Treatments | 3WAS[2] | 12WAS | 3WAS | 12WAS |
| **Variety (V)** | | | | |
| TGX 1448-2E | 16.0 | 15.2b | 18.8b | 17.7b |
| TGX 1987-10F | 18.9a | 17.9a | 23.5a | 22.8a |
| SE± | 1.53 | 1.40 | 2.41 | 2.16 |
| **Sowing Methods (P)** | | | | |
| Dibbling | 13.5b | 12.9b | 14.8b | 14.1b |
| Drilling | 21.4a | 20.1a | 27.5a | 26.4a |
| SE± | 1.53 | 1.40 | 2.41 | 2.16 |
| **Weed control methods (W)** | | | | |
| Pendimethalin at 2.0kg/ha | 16.9 | 16.1 | 24.0 | 23.1 |
| fluazifop-butyl at 2.0kg/ha | 18.9 | 17.8 | 19.2 | 18.3 |
| Hoe weeding at 3,6 & 9 WAS | 16.6 | 15.6 | 19.5 | 18.7 |
| Weedy check | 17.4 | 16.6 | 21.5 | 21.0 |
| SE± | 2.16 | 1.98 | 3.41 | 3.06 |
| **Interactions** | | | | |
| V *P | NS[3] | NS | NS | NS |
| V*W | NS | NS | NS | NS |
| P*W | NS | NS | NS | NS |
| V*P*W | NS | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = Significant at 5% level of probability

### 4.3.3 Crop Vigour Score

The effects of crop variety, sowing method and weed control treatments at Samaru and Bagauda are presented in Tables 13 and 14. In both locations, crop variety did not have any significant influenced on crop vigour score. The effect of sowing method on crop vigour shows that dibbling method of sowing soybeans produced more vigorous crop at 9 ans12 WAS in both locations. The effect of weed control treatments on crop vigour score shows that hoe weeded plots had the most vigorous plants at 6, 9 and12 WAS at Samaru, although the values were similar to the application of fluazifop-butyl at 2.0kg/ha and weedy check at 9 and 12WAS (Table 13). At Bagauda, the weedy check resulted in greater crop vigour than a Pendimethalin-treated plot at 3 and 12 WAS. At 12WAS, fluazifop-butyl at 2.0kg/ha resulted in more crop vigour than pendimethalin at 2.0kg a.i/ha.

The interactions of sowing and weed control treatments on crop vigour score were significant at 3WAS (Table 15). With dibbling, weed control methods did not influenced gour, but with drilling, hoe weeding resulted in more vigorous plants than the weedy check. On the other hand, crop variety did not influenced crop vigour score at each level of weed control treatment.

Table 13: Influence of crop variety, sowing method and weed control treatments on crop vigour score in soybean during the wet season of 2016 at Samaru

| Crop vigour score[1] | | | | |
|---|---|---|---|---|
| Treatments | 3WAS[2] | 6WAS | 9WAS | 12WAS |
| Variety (V) | | | | |
| TGX 1448-2E | 7.8a | 6.8 | 8.0 | 8.2 |
| TGX 1987-10F | 7.4b | 6.4 | 7.7 | 7.7 |
| SE± | 0.180 | 0.310 | 0.370 | 0.290 |
| **Sowing Methods (P)** | | | | |
| Dibbling | 7.5 | 6.4 | 7.4b | 7.6b |
| Drilling | 7.6 | 6.8 | 8.3a | 8.2a |
| SE± | 0.18 | 0.32 | 0.37 | 0.29 |
| **Weed Control Method (W)** | | | | |
| Pendimethalin at 2.0 kg/ha | 7.5 | 6.2b | 7.1b | 7.4b |
| fluazifop-but at 2.0 kg/ha | 7.6 | 6.8b | 8.0ab | 8.2ab |
| Hoe weeding at 3,6,9 &12 WAS | 7.4 | 7.6a | 8.6a | 8.3a |
| Weedy check | 7.8 | 6.7b | 7.7ab | 7.8ab |
| SE± | 0.26 | 0.44 | 0.52 | 0.14 |
| **Interactions** | | | | |
| V *P | NS[3] | NS | NS | NS |
| V*W | NS | NS | NS | NS |
| P*W | * | NS | NS | NS |
| V*P*W | NS | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = Significant at 5% level of probability.

Table 14: Influence of crop variety, sowing method and weed control treatments on crop vigour score in soybean during the wet season of 2016 at Bagauda

| Treatments | Crop vigour scores[1] | | | |
|---|---|---|---|---|
| | 3WAS[2] | 6WAS | 9WAS | 12WAS |
| **Variety (V)** | | | | |
| TGX 1448-2E | 7.1 | 7.6 | 8.3 | 8.5 |
| TGX 1987-10F | 7.4 | 7.7 | 8.4 | 8.33 |
| SE± | 0.220 | 0.290 | 0.270 | 0.250 |
| **Sowing Methods (P)** | | | | |
| Dibbling | 6.8b | 7.4 | 7.9b | 8.2b |
| Drilling | 7.7a | 7.9 | 8.8a | 8.6a |
| SE± | 0.22 | 0.29 | 0.27 | 0.25 |
| **Weed Control Method (W)** | | | | |
| Pendimethalin at 2.0kg/ha | 6.9b | 7.8 | 7.8b | 7.9b |
| fluazifop-butyl at 2.0kg/ha | 7.2ab | 7.8 | 8.8a | 8.5ab |
| Hoe weeding at 3,6 & 9 WAS | 7.2ab | 7.5 | 8.4ab | 8.5ab |
| Weedy check | 7.7a | 7.4 | 8.4ab | 8.7a |
| SE± | 0.31 | 0.42 | 0.39 | 0.35 |
| **Interactions** | | | | |
| V *P | NS[3] | NS | NS | NS |
| V*W | NS | NS | NS | NS |
| P*W | NS | NS | NS | NS |
| V*P*W | NS | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = Significant at 5% level of probability.

Table 15: Interaction of weed control treatment and sowing method of soybean on crop vigour at 3WAS in 2016 wet season at Samaru.

| | Sowing methods[1] | |
|---|---|---|
| Treatments | Dibbling | Drilling |
| **Weed Control method (W)** | | |
| Pendimethalin at 2.0 kg a.i/ ha | 7.3ab | 7.7ab |
| fluazifop-butyl at 2.0kg/ha | 7.5ab | 7.7ab |
| Hoe weeding at 3, 6 & 9 WASS | 7.8a | 8.0a |
| Weedy check | 7.5ab | 7.0b |
| SE± | 0.21 | |

Means followed by same letter(s) are statistically similar at 5% level of probability using DMRT

### 4.3.4 Plant height (cm)

The effects of crop variety, sowing method and weed control treatments on soybean plant height at Samaru and Bagauda are presented in Tables 16 and 17. In Samaru, the effect of crop variety on plant height was not significant at 3 and 6 WAS (Table 16). At 9 and 12WAS, TGX 1448-2E produced taller plants than TGX 1987-10F. Sowing method did not significantly influenced plant height at 3WAS in this location. However, at 6-12WAS, dibbled crop gave taller plants than the drilled. The effect of weed control treatments significantly influenced plant height at 6 and 9WAS only. At 6WAS, hoe weeded plot recorded taller plants than plots treated with Pendimethalin at 2.0kg a.i/ha. At 9WAS, hoe weeding gave taller plants than Pendimethalin treated plants. In each case, the other treatments gave similar plant height to both the tallest and shortest. The effects of crop variety, sowing methods and weed control treatments on plant height were not significant throughout the sampling period in Bagauda (Table 17)

The interaction of sowing and weed control methods on plant height was significant at 6WAS (Table 18). Drilled seed resulted in taller plants than the dibbled ones when applied in conjunction with Pendimethalin at 2.0kg a.i/ha, fluazifop-butyl at 2.0kg a.i/ha or the weedy check. On the other hand, weed control method did not influence plant height in the dibbled crop, while in the drilled crop Pendimethalin gave shorter plants than all the other treatments, which were similar.

Table 16: Effects of variety, sowing method and weed control treatments on plant height in soybean during the wet season of 2016 at Samaru

| | Plant height[1] (cm) | | | |
|---|---|---|---|---|
| Treatments | 3WAS[2] | 6WAS | 9WAS | 12WAS |
| **Variety (V)** | | | | |
| TGX 1448-2E | 23.6 | 50.4 | 83.9a | 93.3a |
| TGX 1987-10F | 23.6 | 48.2 | 79.1b | 87.3b |
| SE± | 0.52 | 1.80 | 2.41 | 2.15 |
| **Sowing Method (P)** | | | | |
| Dibbling | 23.3 | 47.3b | 78.9b | 92.6a |
| Drilling | 23.6 | 51.3a | 84.1a | 87.9b |
| **Weed Control Method (W)** | | | | |
| Pendimethalin at 2.0kg/ha | 22.8 | 45.9b | 77.6b | 89.2 |
| fluazifop-butyl at 2.0kg/ha | 23.6 | 49.0ab | 80.8ab | 90.7 |
| Hoe weeding at 3, 6, & 9 WAS | 23.6 | 52.0a | 84.4a | 89.8 |
| Weedy check | 23.9 | 50.3ab | 83.3ab | 91.3 |
| SE± | 0.74 | 2.55 | 3.41 | 3.04 |
| **Interactions** | | | | |
| V *P | NS[3] | NS | NS | NS |
| V*W | NS | NS | NS | NS |
| P*W | NS | * | NS | NS |
| V*P*W | NS | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = Significant at 5% level of probability.

Table 17: Effects of variety, sowing method and weed control treatments on plant height in soybean during the wet season of 2016 at Bagauda

| Treatments | Plant height[1] (cm) 3WAS[2] | 6WAS | 9WAS | 12WAS |
|---|---|---|---|---|
| **Variety (V)** | | | | |
| TGX 1448-2E | 21.9 | 54.7 | 76.8 | 81.3 |
| TGX 1987-10F | 23.1 | 57.3 | 78.3 | 81.8 |
| SE± | 0.81 | 2.63 | 7.03 | 7.26 |
| **Sowing Methods (P)** | | | | |
| Dibbling | 22.1 | 55.7 | 72.4 | 76.3 |
| Drilling | 22.9 | 56.3 | 82.7 | 86.8 |
| SE± | 0.81 | 2.63 | 7.03 | 7.26 |
| **Weed Control (W)** | | | | |
| Pendimethalin at 2.0kg/ha | 22.5 | 53.5 | 78.2 | 80.3 |
| fluazifop-butyl at 2.0 kg/ha | 22.7 | 58.0 | 81.4 | 84.8 |
| Hoe weeding at 3, 6 & 9 WAS | 21.7 | 56.6 | 69.7 | 75.3 |
| Weedy check | 23.1 | 55.8 | 81.0 | 85.7 |
| SE± | 1.14 | 3.72 | 9.94 | 10.27 |
| **Interaction** | | | | |
| V *P | NS[3] | NS | NS | NS |
| V*W | NS | NS | NS | NS |
| P*W | NS | NS | NS | NS |
| V*P*W | NS | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = Significant at 5% level of probability.

Table 18: Interaction between weed control and sowing methods of soybean on plant height 6 WAS at Samaru

| **Sowing Methods** | | |
|---|---|---|
| Treatment | Dibbling | Drilling |
| **Weed control method** | | |
| Pendimethalin at 2.0kg a.i/ha | 48.2ab | 43.7c |
| fluazifop-butyl at 2.0kg a.i/ha | 44.8bc | 53.2a |
| Hoe weeding | 49.6ab | 54.4a |
| Weedy check | 46.5bc | 54.1a |
| SE± | 2.08 | |

Means followed by same letter(s) are statistically similar at 5% level of probability using DMRT

### 4.3.5: Canopy Spread

Table 19 shows the effect of crop variety, sowing method and weed control treatment on canopy spread at 6 and 9WAS in Samaru and Bagauda. At Samaru, variety TGX 1448-2E had wider canopy than TGX 1987-10F at both sampling periods. However, the effect of variety was not significant on canopy cover at Bagauda. In both locations, sowing method did not influence canopy spread. The effect of weed control treatments on canopy spread was significant at 6WAS in Samaru and 9WAS in Bagauda. At Samaru, pendimethalin gave lower canopy spread than all the other treatments, including the weedy check. In Bagauda, fluazifop-butyl at 2.0kg a.i/ha gave wider canopy than all others except pendimethalin at 2.0kg a.i/ha, which in turn was greater than the weedy check. The interactions among the treatment factors were not significant in both sampling periods and locations.

Table 19: Influence of crop variety, sowing method and weed control treatments on canopy spread in soybean during the wet season of 2016 at Samaru and Bagauda

| Treatments | Canopy spread[1] | | | |
|---|---|---|---|---|
| | Samaru | | Bagauda | |
| | 6WAS[2] | 9WAS | 6WAS | 9WAS |
| **Variety (V)** | | | | |
| TGX 1448-2E | 38.4a | 54.5a | 35.9 | 57.7 |
| TGX 1987-62F | 35.3b | 50.5b | 35.4 | 54.8 |
| SE± | 1.60 | 2.07 | 1.29 | 3.75 |
| **Sowing Methods** | | | | |
| Dibbling | 35.8 | 51.3 | 36.5 | 58.3 |
| Drilling | 37.9 | 53.7 | 34.8 | 54.2 |
| SE± | 1.64 | 2.07 | 1.29 | 3.75 |
| **Weed Control Method(W)** | | | | |
| Pendimethalin at 2.0kg/ha | 33.0b | 50.6 | 34.3 | 58.1ab |
| fluazifop-butyl at 2.0kg/ha | 37.6a | 51.8 | 36.8 | 65.9a |
| Hoe weeding at 3,6 & 9 WAS | 39.4a | 65.0 | 36.7 | 54.3bc |
| Weedy check | 37.3a | 52.5 | 34.8 | 46.7c |
| SE± | 2.32 | 2.90 | 1.29 | 3.74 |
| **Interactions** | | | | |
| V *P | NS[3] | NS | NS | NS |
| V*W | NS | NS | NS | NS |
| P*W | NS | NS | NS | NS |
| V*P*W | NS | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = Significant at 5% level of probability.

### 4.3.6 Shoot dry weight

The effects of crop variety, sowing method and weed control treatment on total dry weight of soybean plant at Samaru and Bagauda are presented in Tables 20 and 21. The effect of crop variety on shoot dry weight was not significant at all the sampling periods in both locations. Similarly, effect of sowing method on shoot dry weight was not significant at Samaru. However, weed control method influenced shoot dry weight at 6 and 12WAS in Samaru. In this location and at 6WAS, hoe weeding at 3 and 6WAS increased shoot dry weight over the other treatments, except fluazifop-butyl at 2.0kg a.i/ha, which was similar to the least and highest values. At 9 and 12WAS, higher shoot dry weight was achieved by hoe weeding, followed by pendimethalin at 9WAS and the weedy check at both periods. The least shoot weight was obtained by fluazifop-butyl at 2.0kg a.i/ha. In Bagauda, sowing method influenced shoot dry weight at 3 and 6WAS, and dibbling resulted in greater value than drilling in both cases. The effect of weed control treatments on shoot dry weight of soybean was not significant throughout the sampling period in this location.

There was significant interaction of variety and weed control treatments at Bagauda at 9WAS (Table 22). With TGX 1448-2E, hoe weeding resulted in higher shoot dry weight than all the other treatments. However, with TGX 1987-10F, weed control method did not influence shoot dry weight. On the other hand, variety did not influence shoot dry weight of soybean

When used in conjunction with each of the weed control treatments except hoe weeding at 3 and 6WAS in which TGX 1448-2E gave higher dry weight than the other variety.

Table 20: Influence of crop variety, sowing method and weed control treatments on shoot dry weight in soybean during the wet season of 2016 at Samaru

| | Shoot Dry weight[1](g) | | | |
|---|---|---|---|---|
| Treatments | 3WAS[2] | 6WAS | 9WAS | 12WAS |
| **Variety (V)** | | | | |
| TGX 1448-2E | 4.9 | 14.2 | 35.5 | 42.7 |
| TGX 1987-10F | 4.9 | 14.5 | 34.8 | 41.0 |
| SE± | 0.470 | 1.060 | 4.120 | 3.710 |
| **Sowing Methods (W)** | | | | |
| Dibbling | 5.3 | 15.4 | 35.1 | 41.9 |
| Drilling | 4.6 | 13.7 | 35.2 | 42.2 |
| SE± | 0.470 | 1.660 | 4.120 | 3.710 |
| **Weed Control Method (W)** | | | | |
| Pendimethalin at 2.0 kg/ha | 4.9 | 11.7b | 29.8b | 35.6c |
| fluazifop-butyl at 2.0 kg/ha | 4.9 | 15.1ab | 28.7c | 33.6c |
| Hoe weeding at 3, 6 & 9 WAS | 5.2 | 19.1a | 49.2a | 55.9a |
| Weedy check | 4.7 | 12.1b | 32.9b | 42.3b |
| SE± | 0.660 | 2.340 | 5.830 | 5.250 |
| **Interaction** | | | | |
| V *P | NS[3] | NS | NS | NS |
| V*W | NS | NS | NS | NS |
| P*W | NS | NS | NS | NS |
| V*P*W | NS | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = Significant at 5% level of probability.

Table 21: Influence of crop variety, sowing method and weed control treatments on shoot dry weight in soybean during the wet season of 2016 at Bagauda

| Treatments | Shoot Dry weight[1](g) 3WAS[2] | 6WAS | 9WAS | 12WAS |
|---|---|---|---|---|
| **Varieties (V)** | | | | |
| TGX 1448-2E | 3.6 | 5.0 | 31.4 | 37.9 |
| TGX 1987-10F | 4.2 | 5.4 | 30.6 | 38.0 |
| SE± | 0.450 | 0.550 | 4.570 | 4.290 |
| **Sowing methods (W)** | | | | |
| Dibbling | 4.5a | 5.9a | 32.4 | 39.6 |
| Drilling | 3.4b | 4.4b | 29.6 | 36.4 |
| SE± | 0.450 | 0.550 | 4.270 | 4.200 |
| **Weed Control (W)** | | | | |
| Pendimethalin at 2.0kg/ha | 3.6 | 5.1 | 29.9 | 37.2 |
| fluazifop-buty at 2.0kg/ha | 3.6 | 4.8 | 29.1 | 35.9 |
| Hoe weeding at 3, 6 & 9 WAS | 4.7 | 5.7 | 37.1 | 43.3 |
| Weedy check | 3.8 | 5.0 | 28.0 | 35.4 |
| SE± | 0.640 | 0.780 | 6.470 | 6.070 |
| **Interaction** | | | | |
| V *P | NS[3] | NS | NS | NS |
| V*W | NS | NS | * | NS |
| P*W | NS | NS | NS | NS |
| V*P*W | NS | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = Significant at 5% level of probability.

Table 22: Interaction between weed control methods and Varieties of soybean on shoot dry weight (g) 9 WAS at Bagauda

| **Varieties** | | |
|---|---|---|
| Treatment | TGX 1448-2E | TGX 1987-10F |
| **Weed control (W)** | | |
| Pendimethalin at 2kg a.i/ha | 27.3b | 32.5b |
| Fluazifop-butyl at 2kg a.i/ha | 24.4b | 33.93ab |
| Hoe weeding 3&6WAS | 48.2a | 25.95b |
| Weedy check | 25.9b | 30.15b |
| SE± | 5.28 | |

Means followed by same letter(s) are statistically similar at 5% level of probability using DMRT

### 4.3.7 Leave area index (LAI)

The effects of crop variety, sowing method and weed control treatments on leave area index (LAI) at Samaru and Bagauda are presented in Tables 23 and 24. At Samaru, the effect of variety was only significant at 9 and 12WAS, in which TGX 1448-2E recorded higher LAI than TGX 1987-10F (Table 23). In this location, sowing method significantly influenced (LAI) throughout the sampling period and drilling method of sowing resulted in greater (LAI) than dibbling. The effect of weed control treatments shows that there was high significant difference in (LAI) among the treatments at 6 - 12WAS Fluazifop-butyl at 2kg a.i/ha gave higher LAI than the other treatments at 6WAS. Hoe weeding recorded higher leave area index at 9 and12WAS compared to other weed control treatments. The application of 2.0kg a.i/ha of fluazifop-butyl gave higher LAI than the weedy check at 12WAS. At Bagauda, variety did not influence LAI, while sowing did throughout the sampling periods. Drilling gave higher LAI than dibbling at 3, 9 and 12WAS, while the reverse was true at 6WAS. At 9WAS, all the weed control treatments gave similar LAI and each was higher than by the weedy check. Fluazifop-butyl at 2kg a.i/ha gave higher LAI than pendimethalin, which together with hoe weeding had an edge over the weedy check, being the least, while the weedy check constantly recorded the lowest leave area index.

The interaction of variety and weed control treatments was significant in Bagauda at 9WAS (Table 25). Crop variety did not influence LAI under all the weed control treatments, except with hoe weeding at 3 and 6WAS. With TGX 1448-2E, the two herbicides treatments and hoe weeded control gave similar LAI, and each was higher than by the weedy check. With TGX 1087-10F, the treatments with pendimethalin and Fluazifop-butyl each at 2kg a.i/ha resulted in greater LAI than the hoe weeded control and the weedy check.

Table 23: Influence of crop variety, sowing method and weed control treatments on leave area index (LAI) in soybean during the wet season of 2016 at Samaru

| Treatments | Leave area index[1] | | | |
|---|---|---|---|---|
| | 3WAS[2] | 6WAS | 9WAS | 12WAS |
| **Variety (V)** | | | | |
| TGX 1448-2E | 0.7 | 3.6 | 10.4a | 13.6a |
| TGX 1987-10F | 0.8 | 3.3 | 8.8b | 11.4b |
| SE± | 0.08 | 0.37 | 1.11 | 1.07 |
| **Sowing Methods (W)** | | | | |
| Dibbling | 0.3b | 1.6b | 5.3b | 8.6b |
| Drilling | 1.1a | 5.3a | 13.9a | 16.3a |
| SE± | 0.08 | 0.37 | 1.11 | 1.07 |
| **Weed Control Methods (W)** | | | | |
| Pendimethalin at 2.0kg/ha | 0.7 | 3.2b | 8.1b | 10.6bc |
| Fluazifop-butyl at 2.0kg/ha | 0.71 | 3.5a | 9.4b | 12.7b |
| Hoe weeding at 3,6 & 9 WAS | 0.8 | 4.2b | 13.8a | 16.8a |
| Weedy check | 0.8 | 2.8b | 7.1b | 9.7c |
| SE± | 0.11 | 0.52 | 1.57 | 1.51 |
| **Interactions** | | | | |
| V *P | NS[3] | NS | NS | NS |
| V*W | NS | NS | NS | NS |
| P*W | NS | NS | NS | NS |
| V*P*W | NS | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = Significant at 5% level of probability.

Table 24: Influence of crop variety, sowing method and weed control treatments on leave area index (LAI) in soybean during the wet season of 2016 at Bagauda

| | LAI[1] | | | |
|---|---|---|---|---|
| Treatments | 3WAS[2] | 6WAS | 9WAS | 12WAS |
| TGX 1448-2E | 0.5 | 0.2 | 29.3 | 34.5 |
| TGX 1987-10F | 0.6 | 0.1 | 25.5 | 30.8 |
| SE± | 0.05 | 0.04 | 3.34 | 2.34 |
| **Sowing methods (P)** | | | | |
| Dibbling | 0.3b | 0.2a | 14.5b | 22.3b |
| Drilling | 0.8a | 0.1b | 40.3a | 42.9a |
| SE± | 0.05 | 0.04 | 3.34 | 2.30 |
| **Weed Control Methods (W)** | | | | |
| Pendimethalin at 2.0kg/ha | 0.5 | 0.1 | 29.5a | 31.6b |
| Fluazifop-butyl at 2.0 | 0.5 | 0.2 | 32.4a | 39.2a |
| Hoe weeding at 3,6 & 9 WAS | 0.5 | 0.1 | 28.6a | 34.3ab |
| Weedy check | 0.7 | 0.2 | 19.1b | 25.4c |
| SE± | 0.07 | 0.05 | 4.73 | 3.31 |
| **Interactions** | | | | |
| V *P | NS[3] | NS | NS | NS |
| V*W | NS | NS | * | NS |
| P*W | NS | NS | NS | NS |
| V*P*W | NS | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = Significant at 5% level of probability.

Table 25:Interaction between weed control methods and sowing methods of soybean on Leave area index( LAI) at 9WAS in Bagauda

| | Varieties | |
|---|---|---|
| Treatments | TGX 1448-2E | TGX 1987-10F |
| **Weed Control (W)** | | |
| Pendimethalin at 2.0 kg a.i/ ha | 31.2a | 27.8a |
| Fluazifop-butyl at 2.0 kg a.i/ ha | 28.8a | 36.0a |
| Hoe weeding at 3, 6 & WAS | 37.7a | 19.5b |
| Weedy check | 19.3b | 18.8b |
| SE± | 3.86 | |

Means followed by same letter(s) are statistically similar at 5% level of probability using DMRT

### 4.3.8 Crop growth rate (CGR)

The effects of crop variety, sowing method and weed control treatment on crop growth rate (CGR) in Samaru and Bagauda are presented in Tables 26 and 27. Throughout the sampling periods in both locations, there were no significant differences recorded due to crop variety, sowing method and weed control treatments on crop growth rate.

Similarly, the interactions of variety sowing and weed control methods were not significant throughout the period of sampling in both locations.

### 4.3.9 Relative growth rate (RGR)

The effects of crop variety, sowing method and weed control treatment and on relative growth rate (RGR) of soybean in Samaru and Bagauda are presented in Tables 28 and 29. There was no significant effect of crop variety, sowing methods and weed control treatment at all the sampling periods at both locations.

The interactions of variety, sowing method and weed control treatments on CGR were not significant throughout the sampling periods in both locations.

Table 26: Influence of crop variety, sowing method and weed control treatments on crop growth rate (CGR) in soybean during the wet season of 2016 at Samaru

| Treatments | Crop growth rate[1] | | |
|---|---|---|---|
| | 3-6WAS | 6-9WAS | 9-12WAS |
| **Variety (V)** | | | |
| TGX 1448-2E | 3.10 | 7.09 | 2.39 |
| TGX 1987-10F | 3.18 | 6.78 | 2.07 |
| SE± | 0.31 | 0.78 | 0.22 |
| **Sowing methods (P)** | | | |
| Dibbling | 3.26 | 6.69 | 2.12 |
| Drilling | 3.02 | 7.19 | 2.34 |
| SE± | 2.14 | 0.78 | 0.33 |
| **Weed Control Methods (W)** | | | |
| Pendimethalin at 2.0kg a.i/ha | 2.07 | 6.21 | 1.93 |
| Fluazifop-butyl at 2.0kg a.i/ha | 3.43 | 4.51 | 1.64 |
| Hoe weeding at 3,6 & 9 WAS | 4.63 | 10.61 | 2.25 |
| Weedy check | 2.43 | 6.97 | 3.12 |
| SE± | 0.19 | 1.02 | 0.31 |
| **Interactions** | | | |
| V *P | NS[2] | NS | NS |
| V*W | NS | NS | NS |
| P*W | NS | NS | NS |
| V*P*W | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = Significant at 5% level of probability

Table 27: Influence of crop variety, sowing method and weed control treatments on crop growth rate (CGR) in soybean during the wet season of 2016 at Bagauda

| Treatments | Crop growth rate[1] | | |
|---|---|---|---|
| | 3-6WAS | 6-9WAS | 9-12WAS |
| **Varieties (V)** | | | |
| TGX 1448-2E | 0.47 | 8.80 | 2.17 |
| TGX 1987-10F | 0.39 | 8.42 | 2.46 |
| SE± | 0.04 | 0.83 | 0.22 |
| **Sowing methods (P)** | | | |
| Dibbling | 0.51 | 8.82 | 2.38 |
| Drilling | 0.35 | 8.41 | 2.24 |
| SE± | 0.04 | 0.83 | 0.22 |
| **Weed Control Methods (W)** | | | |
| Pendimethalin at 2.0 kg a.i/ha | 0.57 | 8.19 | 2.45 |
| Fluazifop-butyl at 2.0 kg a.i/ha | 0.40 | 8.13 | 2.26 |
| Hoe weeding at 3,6,9 &12 WAS | 0.34 | 10.46 | 2.08 |
| Weedy check | 0.41 | 7.67 | 2.46 |
| SE± | 0.06 | 1.17 | 0.31 |
| **Interactions** | | | |
| V *P | NS[2] | NS | NS |
| V*W | NS | NS | NS |
| P*W | NS | NS | NS |
| V*P*W | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = Significant at 5% level of probability.

Table 28: Influence of crop variety, sowing method and weed control treatments on Relative growth rate (RGR) in soybean during the wet season of 2016 at Samaru

| Treatments | Relative growth rate[1] | | |
|---|---|---|---|
| | 3-6WAS | 6-9WAS | 12WAS |
| **Variety (V)** | | | |
| TGX 1448-2E | 2.41 | 3.32 | 3.38 |
| TGX 1987-10F | 2.46 | 3.24 | 3.33 |
| SE± | 0.08 | 0.08 | 0.05 |
| **Sowing methods (P)** | | | |
| Dibbling | 2.48 | 3.29 | 3.36 |
| Drilling | 2.39 | 3.26 | 3.35 |
| SE± | 0.08 | 0.08 | 0.05 |
| **Weed Control Methods (W)** | | | |
| Pendimethalin at 2.0kg a.i/ha | 2.15 | 3.09 | 3.19 |
| Fluazifop-butyl at 2.0 kg a.i/ha | 2.52 | 3.12 | 3.16 |
| Hoe weeding at 3,6 & 9 WAS | 2.78 | 3.64 | 3.64 |
| Weedy check | 2.29 | 3.26 | 3.43 |
| SE± | 0.12 | 0.12 | 0.17 |
| **Interactions** | | | |
| V *P | NS[2] | NS | NS |
| V*W | NS | NS | NS |
| P*W | NS | NS | NS |
| V*P*W | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = Significant at 5% level of probability.

Table 29: Influence of crop variety, sowing method and weed control treatments on relative growth rate (RGR) during the wet season of 2016 at Bagauda

| Treatments | Relative growth rate[1] | | |
|---|---|---|---|
| | 3-6WAS | 6-9WAS | 9-12WAS |
| **Variety(V)** | | | |
| TGX 1448-2E | 1.26 | 3.25 | 3.25 |
| TGX 1987-10F | 3.29 | 3.26 | 3.29 |
| SE± | 0.07 | 0.08 | 0.05 |
| **Sowing methods (P)** | | | |
| Dibbling | 1.41 | 3.28 | 3.31 |
| Drilling | 1.13 | 3.22 | 3.23 |
| SE± | 0.07 | 0.08 | 0.05 |
| **Weed Control Methods (W)** | | | |
| Pendimethalin at 2.0kg a.i/ha | 1.31 | 3.23 | 3.27 |
| fluazifop-butyl at 2.0kg a.i/ha | 1.21 | 3.15 | 3.19 |
| Hoe weeding at 3,6 & 9 WAS | 1.27 | 3.42 | 3.38 |
| Weedy check | 1.29 | 3.21 | 3.24 |
| SE± | 0.10 | 0.11 | 0.08 |
| **Interactions** | | | |
| V *P | NS[2] | NS | NS |
| V*W | NS | NS | NS |
| P*W | NS | NS | NS |
| V*P*W | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = Significant at 5% level of probability.

### 4.3.10: Number of days to first flowering

The effects of crop variety, sowing methods and weed control treatments on number of days to first flowering in Samaru and Bagauda are presented in Table 30. Days to first flowering was not significantly influenced by crop variety, sowing methods and weed control treatments in both locations. The Interaction of the above factors on the number of days to first flowering was also not significant in this location.

### 4.3.11: Number of days to 50% flowering

The influence of crop variety, sowing methods and weed control treatment on the number of days to 50% flowering of soybean at Samaru and Bagauda is shown in Table 31. None of the above factors was observed to significantly influence the number of days to 50% flowering in the two locations. Also, there was no significant interaction of factors on days to 50% flowering at both locations.

### 4.3.12: Seed weight per plant (g)

The effects of crop variety, sowing method and weed control treatment on seed weight per plant at Samaru and Bagauda are presented in Table 32. None of these factors was found to significantly influence seed weight per plant of soybean in both locations.

The interactions of variety, sowing method and weed control treatment were also not significant on seed weight in both locations.

Table 30: Effects of variety, sowing method and weed control treatments on number of days to 1st flowering during in soybean the wet season of 2016 at Samaru and Bagauda

| Treatments | Days to 1st flowering[1] | |
|---|---|---|
| **Variety (V)** | **Samaru** | **Bagauda** |
| TGX 1448-2E | 49.63 | 50.4 |
| TGX 1987-62F | 50.8 | 50.1 |
| SE± | 0.43 | 0.16 |
| **Sowing Methods (P)** | | |
| Dibbling | 50.2 | 49.9 |
| Drilling | 50.3 | 50.6 |
| SE± | 0.43 | 0.16 |
| **Weed Control Method (W)** | | |
| Pendimethalin at 2.0 **kg a.i/ha** | 50.4 | 50.3 |
| Fluazifop-butyl at 2.0 **kg a.i/ha** | 51.3 | 49.3 |
| Hoe weeding at 3,6 & 9 WAS | 49.1 | 50.3 |
| Weedy check | 50.2 | 51.3 |
| SE± | 0.61 | 0.61 |
| **Interactions** | | |
| V *P | NS[2] | NS |
| V*W | NS | NS |
| P*W | NS | NS |
| V*P*W | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = Significant at 5% level of probability.

Table 31: Influence of crop variety, sowing method and weed control treatments on number of days to 50% flowering in soybean during the wet season of 2016 at Samaru and Bagauda

| Treatment | Days to 50% flowering[1] | |
|---|---|---|
| **Variety (V)** | Samaru | Bagauda |
| TGX 1448-2E | 58.3 | 59.9 |
| TGX 1987-62F | 58.6 | 60.1 |
| SE± | 0.62 | 0.56 |
| **Sowing Methods (P)** | | |
| Dibbling | 58.2 | 60.3 |
| Drilling | 58.7 | 59.7 |
| SE± | 0.62 | 0.56 |
| **Weed Control Method(W)** | | |
| Pendimethalin at 2.0kg a.i/ha | 58.0 | 59.3 |
| fluazifop-butyl at 2.0 kg a.i/ha | 58.3 | 54.6 |
| Hoe weeding at 3,6 & 9 WAS | 59.6 | 60.7 |
| Weedy check | 58.0 | 60.3 |
| SE± | 0.88 | 0.79 |
| **Interactions** | | |
| V *P | NS[2] | NS |
| V*W | NS | NS |
| P*W | NS | NS |
| V*P*W | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = Significant at 5% level of probability.

Table 32: Influence of crop variety, sowing method and weed control treatments on seed weight per plant in soybean during the wet season of 2016 at Samaru and Bagauda

| | Seed weight per plant[1] (g) | |
|---|---|---|
| **Variety (V)** | **Samaru** | **Bagauda** |
| TGX 1448-2E | 13.5 | 14.5 |
| TGX 1987-62F | 12.3 | 14.8 |
| SE± | 1.00 | 1.79 |
| **Sowing Methods (P)** | | |
| Dibbling | 15.1 | 15.2 |
| Drilling | 10.7 | 14.1 |
| SE± | 1.00 | 1.26 |
| **Weed Control Method (W)** | | |
| Pendimethalin at 2.0kg a.i/ha | 12.1 | 17.2 |
| Fluazifop-butyl at 2.0 kg a.i/ha | 11.3 | 13.9 |
| Hoe weeding at 3,6 & 9 WAS | 18.5 | 15.7 |
| Weedy check | 9.7 | 11.8 |
| SE± | 1.42 | 1.79 |
| **Interactions** | | |
| V *P | NS[2] | NS |
| V*W | NS | NS |
| P*W | NS | NS |
| V*P*W | NS | NS |

Means followed by same letter(s) within a treatment group in a column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = Significant at 5% level of probability.

### 4.3.13: 100 Seed weight

Crop variety in both locations and weed control treatment in Bagauda significantly affected 100 – seed weight (Table 33). In both locations TGX 1987-10F gave heavier seeds than TGX 1448 -2E in the two locations. Sowing methods did not significantly influence 100 – seed weight in the two locations. In Bagauda, the hoe weeded control gave greater 100 – seed weight than all the herbicide treatments and the weedy check, which are similar values.

The interaction of weed control treatments and sowing method on 100 – seed weight was significant at Samaru (Table 34). Sowing by dibbling resulted in greater 100 – seed weight by drilling when applied together with Pendimethalin at 2.0kg a.i/ha, Fluazifop-butyl at 2.0kg a.i/ha and the weedy check. However, with the hoe weeding, sowing method did not influence 100 – seed weight on the other hand, Fluazifop-butyl at 2.0kg a.i/ha resulted in lower 100 – seed weight than each of the other weed control treatments including the weedy check. With drilling, hoe weeding at 3 and 6 WAS and Fluazifop-butyl at 2.0kg a.i/ha resulted in greater 100 – seed weight than the weedy check

Table 33: Influence of cropvariety, sowing method and weed control treatments on 100 seed weight in soybean during the wet season of 2016 at Samaru and Bagauda

| **Variety (V)** | 100 seed weight (g)Samaru | Bagauda |
|---|---|---|
| TGX 1448-2E | 14.5b | 14.4b |
| TGX 1987-10F | 15.7a | 15.2a |
| SE± | 0.29 | 0.29 |
| **Sowing Methods (P)** | | |
| Dibbling | 15.3 | 14.9 |
| Drilling | 14.9 | 14.7 |
| SE± | 0.29 | 0.29 |
| **Weed Control Method (W)** | | |
| Pendimethalin at 2.0 kg a.i/ha | 14.9 | 14.8b |
| Fluazifop-butyl at 2.0 kg a.i/ha | 14.9 | 14.4b |
| Hoe weeding at 3,6 & 9 WAS | 16.1 | 15.6a |
| Weedy check | 14.5 | 14.4b |
| SE± | 0.41 | 0.42 |
| **Interactions** | | |
| V *P | NS[2] | NS |
| V*W | NS | NS |
| P*W | * | NS |
| V*P*W | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = Significant at 5% level of probability.

Table 34: Interaction between weed control methods and sowing methods of soybean on 100 seed weight at Samaru

| | Sowing methods[1] | |
|---|---|---|
| Treatments | Dibbling | Drilling |
| **Weed Control (W) kg a.i/ha** | | |
| Pendimethalin at 2.0kg a.i/ha | 15.3a | 14.4bc |
| fluazifop-butyl at 2.0kg a.i/ha | 13.8c | 15.0ab |
| Hoe weeding at 3, 6 & 9 WAS | 15.0a | 15.4a |
| Weedy check | 14.9ab | 13.8c |
| SE± | 0.35 | |

Means followed by same letter(s) are statistically similar at 5% level of probability using DMRT.

### 4.3.14: Grain yield (kg/ha)

The effects of crop variety, sowing method and weed control treatment at Samaru and Bagauda on soybean grain yield are presented in Table 35. The effect of variety and sowing method in both locations were not significant. At Samaru, Hoe weeding at 3, 6, and 9 WAS significantly produced the highest grain yield (1166kg/ha) than other weed control treatments. While the least grain yield was obtained from the weed check (680). The effect of weed control treatment on grain yields was also significant at Bagauda. Hoe weeding at 3, 6, and 9 and WAS produced the highest grain yield (1034kg/ha), which was comparable with the application of fluazifop-butyl at 2.0kg a.i/ha (985kg/ha). The least grain yield was obtained from the weed check (621kg/ha), follow by Pendimethalin applied at 2.0kg a.i/ha (712kg/ha) at both locations.

The interactions of crop variety, sowing method and weed control treatments on soybean grain yield were not significant in both Samaru and Bagauda.

### 4.3.15: Haulm yield (g)

The effects of crop variety, sowing method and weed control treatment on soybean haulm yields are presented in Table 36. None of the treatment factors showed any significant influence on haulm yield in both Samaru and Bagauda. In the same vein, none of the factors interactions on this parameter was significant in the two locations.

Table 35: Influence of crop variety, sowing method and weed control treatments on grain yield during the wet season of 2016 at Samaru and Bagauda

| Treatments | Grain yield of soybean(kg/ha) | | |
|---|---|---|---|
| **Varieties (V)** | Samaru | Bagauda | combined |
| TGX 1448-2E | 870 | 910 | 890 |
| TGX 1987-10F | 888 | 766 | 827 |
| SE± | 837.01 | 89.2 | 73.4 |
| **Sowing methods (P)** | | | |
| Dibbling | 837 | 798 | 817 |
| Drilling | 921 | 879 | 899 |
| SE± | 84.9 | 89.2 | 73.4 |
| **Weed control methods (W)** | | | |
| Pendimethalin at 2.0 kg a.i/ha | 730c | 712b | 720 |
| Fluazifop-butyl at 2.0kg a.i/ha | 940b | 985a | 962 |
| Hoe weeding at 3,6 & 9 WAS | 1166a | 1034a | 1099 |
| Weedy check | 680c | 621b | 651 |
| SE± | 120.0 | 126.2 | 103.8 |
| **Interactions** | | | |
| V *P | NS[2] | NS | NS |
| V*W | NS | NS | NS |
| P*W | NS | NS | NS |
| V*P*W | NS | NS | NS |

Means followed by same letter(s) within a treatment group of any column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, 3. NS =Not significant at 5% level of probability, * = Significant at 5% level of probability.

Table 36: Influence of crop variety, sowing method and weed control treatments on haulm yield during the wet season of 2016 at Samaru and Bagauda

| Treatments | Haulm yield[1] (g) | |
|---|---|---|
| **Variety (V)** | Samaru | Bagauda |
| TGX 1448-2E | 1525.0 | 1392 |
| TGX 1987-10F | 1373.9 | 1171 |
| SE± | 126.85 | 63.0 |
| **Sowing Methods (P)** | | |
| Dibbling | 1300 | 1418 |
| Drilling | 1599 | 1146 |
| SE± | 126.9 | 63.0 |
| **Weed control methods (W)** | | |
| Pendimethalin at 2.0kg a.i/ha | 1164 | 1111 |
| Fluazifop-butyl at 2.0kg a.i/ha | 1531 | 1417 |
| Hoe weeding at 3,6 & 9 WAS | 1842 | 1433 |
| Weedy check | 1261.2 | 1167 |
| SE± | 126.85 | 89.0 |
| **Interactions** | | |
| V *P | NS[2] | NS |
| V*W | NS | NS |
| P*W | NS | NS |
| V*P*W | NS | NS |

Means followed by same letter(s) within a treatment group in a column are statistically similar at 5% level of probability using DMRT, 2. WAS = Week after sowing, s3. NS =Not significant at 5% level of probability,* = Significant at 5% level of probability.

### 4.3.16: Correlation among weeds and crop growth and yield parameters of soybean

The correlation matrix among weed parameters, crop growth and yield components and grain yield of soybean at Samaru and Bagauda are shown in Tables 37 and 38, respectively .At Samaru, soybean grain yield was highly significant and positively correlated to crop plant height, shoot dry weight and 100 grain weight .The association between grain yield and 100 seed weight was positive but not highly significant and negatively correlated with weed cover score, weed density and weed dry matter at both locations. Weed density, weed dry weight and weed cover score were highly significant and positively associated with each other at both locations. At Bagauda, there was a positive correlation among the grain yield and crop vigour, plant height, canopy spread but none of the association was positive. 100 seed weight was positively and significantly correlated with grain yield. In both locations, it was observed that weed density, weed dry matter and weed cover score were significant and negatively correlated to other growth and yield parameters such as plant height canopy spread and crop vigour.

Table 37: Simple correlation matrix among weeds and crop growth and yield parameters during 2016 wet season at Samaru

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.00 | | | | | | | | | | |
| 2 | 0.274* | 1.00 | | | | | | | | | |
| 3 | -0.502** | -0.164 | 1.00 | | | | | | | | |
| 4 | -0.497** | -0.153 | 0.011 | 1.00 | | | | | | | |
| 5 | 0.324* | 0.142 | -0.263* | 0.022 | 1.00 | | | | | | |
| 6 | 0.283* | 0.228 | -0.189 | -0.155 | 0.916** | 1.00 | | | | | |
| 7 | 0.336* | 0.248 | -0.275 | -0.234 | 0.908** | 0.924** | 1.000 | | | | |
| 8 | 0.361* | 0.353* | -0.434** | -0.228 | 0.589** | 0.494** | 0.494** | 1.00 | | | |
| 9 | -0.487** | -0.178 | 0.564** | 0.239 | -0.352 | -0.313* | -0.283 | -0.537** | 1.00 | | |
| 10 | 0.143 | 0.012 | -0.344* | -0.168 | 0.443** | 0.425** | 0.496** | 0.237 | -0.242 | 1.00 | |
| 11 | 0.414** | -0097 | -0.403** | -0.245 | 0.295 | 0.201 | 0.233 | 0.029 | -0.439** | 0.278 | 1.00 |

*Significant at 5% level of probability (r = 0.282)
** Significant at 1% level of probability (r = 0.365),
1 Grain yield/kg/ha, 5 Total dry matter9 Weed density, 2 Plant height, 6 Crop growth weight, 10 Grain weight/plot, 3 Weed dry matter 7 Relative growth rate, 11 100 grain weight, 4 Weed cover score 8 Leave area index

Table 38: Simple correlation matrix among weeds and crop growth and yield parameters during 2016 wet season at Bagauda

| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 1.00 | | | | | | | | | | |
| 2 | 0.073 | 1.00 | | | | | | | | | |
| 3 | -0.006 | -0.191 | 1.00 | | | | | | | | |
| 4 | -0.030 | -0.029 | -0.273 | 1.00 | | | | | | | |
| 5 | -0.175 | 0.042 | -0.211 | 0.184 | 1.00 | | | | | | |
| 6 | -0.084 | 0.107 | -0.247 | 0.139 | 0.954** | 1.00 | | | | | |
| 7 | -0.166 | 0.033 | -0.253 | 0.159 | 0.905** | 0.926** | 1.00 | | | | |
| 8 | 0.271 | 0.256 | -0.484** | 0.068 | 0.271 | -0.395** | 0.387** | 1.00 | | | |
| 9 | -0.302* | 0.137 | 0.252 | 0.027 | 0.049 | -0.007 | 0.091 | -0.484** | 1.00 | | |
| 10 | 0.108 | 0.300* | -0.429** | 0.046 | 0.195 | 0.196 | 0.061 | 0.098 | -0.129 | 1.000 | |
| 11 | 0.038 | -0.061 | -0.012 | 0.057 | 0.020 | 0.010 | -0.302* | -0.137 | -0.400** | 0.06 | 1.00 |

*Significant at 5% level of probability (r = 0.282)

** Significant at 1% level of probability (r = 0.365)

1 Grain yield/kg/ha 5 Total dry matter 9 Weed density, 2 Plant height, 6 Crop growth weight10 Grain weight/plot, 3 Weed dry matter, 7 Relative growth rate, 11 100 grain weight 4 Weed cover score 8 Leave area index

## 4.4Path Analysis

### 4.4.1 Direct and indirect effect of some soybean growth and yield character to grain yield

A study of direct and direct effect of the different growth and yield character s of soybean to grain yield in 2016 wet season at Samaru and Bagauda are shown in Tables 39 and Table 40. The highest direct effect on yield was by 100-seed weight, followed by haulm yield at Samaru (Table 39). The least direct effect was by shoot dry weight (sdwt), which had a negative value. The highest indirect effect was by shoot dry weight via crop growth rate (CGR), followed by haulm yield via 100-seed weight, while the least was by CGR via shoot dry weight. All the indirect effect via shoot dry weight was negative.

In Bagauda, (Table 40) the highest direct effect on yield was by 100-seed weight, followed by haulm yield at Samaru (Table 40). The least direct effect was by shoot dry weight (sdwt), which had a negative value. Also, the highest indirect effect was by shoot dry weight via crop growth rate (CGR), followed by haulm yield via 100-seed weight, while the least was by CGR via shoot dry weight. All the indirect effect via shoot dry weight was negative.

The highest individual contribution to seed yield in Samaru was 100-seed weight, followed by shoot dry weight (Table 41). The least contribution was by plant height. The highest joint contribution to yield was by 100-seed weight plus CGR. The least joint contribution was by CGR and plant height followed by 100-seed weight and shoot dry weight, which had negative values.

In Bagauda, the highest individual contribution to seed yield was shoot dry weight, followed by haulm yield (Table 42). The least individual contribution to yield was by LAI. The highest joint contribution was by haulm yield plus LAI, The least joint contribution was by 100-seed weight plus haulm yield, followed by CGR plus LAI

Table 39: Direct and indirect effects of different yield characters to yield of soybean during the wet season of 2016 at Samaru

| Direct and Indirect contributions | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 100-seed weight | Haulm yield | CGR | Dry matter | Plant height | LAI | Total corr |
| 100-seed weight | **0.6777** | 0.1320 | 0.0741 | -0.1425 | -0.0063 | 0.0079 | 0.743O |
| haulm | 0.2155 | **0.4152** | 0.0616 | -0.1198 | 0.0255 | 0.0958 | 0.6940 |
| CGR | 0.1362 | 0.0693 | **0.3688** | -0.4425 | 0.0150 | 0.1360 | 0.2830 |
| Shoot dry weight | 0.1999 | 0.1029 | 0.3378 | **-0.4831** | 0.0093 | 0.1619 | 0.3290 |
| Pltht | -0.0657 | 0.1611 | 0.0841 | -0.0686 | **0.0658** | 0.0972 | 0.2740 |
| LAI | 0.0196 | 0.1445 | 0.1822 | -0.2840 | 0.0232 | **0.2754** | 0.3610 |

Table 40: Direct and indirect effects of different yield characters to yield of soybean during the wet season of 2016 at Bagauda

| Direct and Indirect contributions | | | | | | | |
|---|---|---|---|---|---|---|---|
| | 100-seed weight | Haulm | CGR | Dry matter | Plant height | LAI | Total correlation |
| 100-seed weight | **0.085657** | -0.03124 | 0.004493 | -0.01245 | -0.00726 | -0.00119 | 0.038 |
| Haulm yield | -0.00591 | **0.452766** | 0.012582 | 0.015567 | 0.003928 | 0.028067 | 0.507 |
| CGR | 0.000857 | 0.012677 | **0.449345** | -0.59405 | 0.012738 | 0.034431 | -0.084 |
| Shoot dry matter | 0.001713 | -0.01132 | 0.428675 | **-0.62269** | 0.005 | 0.023622 | -0.175 |
| Pltht | -0.00523 | 0.014941 | 0.04808 | -0.02615 | **0.119042** | 0.022315 | 0.173 |
| LAI | -0.00117 | 0.14579 | 0.177491 | -0.16875 | 0.030475 | **0.087166** | 0.271 |

Table 41: Percentage contribution of different growth character to yield of soybean during the 2016 wet season at Samaru

| **Parameters** Individual contribution | **%Contribution** |
|---|---|
| s100-seed weight | 35.9 |
| Haulm | 17.2 |
| CGR | 13.6 |
| Dry matter | 23.3 |
| Plant height | 0.4 |
| LAI | 17.5 |
| | |
| Combined Contributions | |
| 100 seed weight and Haulm yield | 17.9 |
| 100 seed weight and CGR | 10.0 |
| 100 seed weight and dry matter | -19.3 |
| 100 seed weight and plant height | -0.8 |
| 100 seed weight and LAI | 1.0 |
| Haulm yield and CGR | 5.1 |
| Haulm yield and Dry matter | -9.9 |
| Haulm yield and plant height | 2.1 |
| Haulm yield and LAI | 7.9 |
| CGR and dry matter | -32.6 |
| CGR and plant height | 1.1 |
| CGR and LAI | 7.0 |
| Dry matter and plant height | -0.9 |
| Dry matter and LAI | -15.6 |
| plant height and LAI | 1.2 |
| Residual | 17.4 |
| Total | 100 |

Table 42: Percentage contributions of different growth characters to yield of soybean during the wet season of 2016 at Bagauda

| **Parameters** Individual contribution | **%Contribution** |
|---|---|
| 100gw | 0.7 |
| Haulm | 20.4 |
| CGR | 20.1 |
| Dry matter | 38.7 |
| Plant height | 1.4 |
| LAI | 0.7 |
| | |
| **Combined** | |
| 100 seed weight and haulm yield | -0.5352 |
| 100 seed weight and CGR | 0.076979 |
| 100 seed weight and dry matter | -0.21335 |
| 100 seed weight and plant height | -0.1244 |
| 100 seed weight and LAI | -0.02046 |
| Haulm yield and CGR | 1.139308 |
| Haulm yield and dry matter | 1.409665 |
| Haulm yield and plant height | 0.355729 |
| Haulm yield and LAI | 2.541599 |
| CGR and dry matter | -53.3864 |
| CGR and plant height | 1.144709 |
| CGR and LAI | 2.522397 |
| Dry matter and plant height | -0.62266 |
| Dry matter and LAI | -2.94184 |
| Plant height and LAI | 0.531275 |
| Residual | 15.74691 |
| Total | 100 |

**4.5Gross Margin Analysis**

The result of Gross Margin (GM) analysis shows that the highest gross returns of ₦270378.00 were achieved by sowing soybean TGX 1978-10F at 266666 plants/ha, while the least return of ₦6930.00 was achieved by sowing TGX 1448-2E, at the same 266666population(Table 43). Revenue was calculated by multiplying ₦11500 price per bag obtained from Bagauda market in Kano State by numbers of bags as per treatments used. Costs of production which included land preparation, seed procurement, fertilizer and herbicide applications, weeding and harvesting were computed. These added up to ₦6246.00. The gross margin is given by the differences between the total revenue (TR) per hectare and total variable cost (TVC) per hectare.

GM = TR (income/ha) – TVC (cost/ha)

It can be seen from the above equation that any increase in TR will result in increase in GM, provided TVC is constant (Table 43).

**T**able43**: Cost** benefit ratio of soybean cultivation under rain feed at Samaru and Bagauda

| **Treatments** | **Yields (kg/ha)** | **Yields per bag** | **Price per bag ₦** | **Total cost of production ₦** | **Revenue ₦/ha** | **Profit ₦/ha** |
|---|---|---|---|---|---|---|
| W1P1V1 | 1180 | 11 | 11500 | 6870 | 126500 | 119630 |
| WIPIV2 | 1208 | 12 | 11500 | 6870 | 13800 | 6930 |
| W1P2V1 | 935 | 9 | 11500 | 6870 | 103500 | 96630 |
| W1P2V2 | 1210 | 12 | 11500 | 6870 | 138000 | 131130 |
| **W**2P1V1 | 1509 | 15 | 11500 | 6870 | 172500 | 165630 |
| W2P1V2 | 1132 | 11 | 11500 | 6870 | 126500 | 119630 |
| **W**2P2V1 | 1782 | 18 | 11500 | 6870 | 207000 | 200130 |
| **W**2P2V2 | 1840 | 18 | 11500 | 6870 | 207000 | 200130 |
| **W**3P1V1 | 1765 | 18 | 11500 | 5622 | 207000 | 201378 |
| W3P1V2 | 1670 | 17 | 11500 | 5622 | 195500 | 189878 |
| W3P2V1 | 1985 | 20 | 11500 | 5622 | 230000 | 224378 |
| W3P2V2 | 2352 | 24 | 11500 | 5622 | 276000 | 270378 |
| W4P1V1 | 1567 | 16 | 11500 | 5121 | 184000 | 178879 |
| W4P1V2 | 1129 | 11 | 11500 | 5121 | 126500 | 121379 |
| **W**4P2V1 | 873 | 9 | 11500 | 5121 | 103500 | 98379 |
| W4P2V2 | 1300 | 13 | 11500 | 5121 | 149500 | 144379 |

# CHAPTER FIVE

## 5.0 DISCUSSION

### 5.1 Preamble

To achieve high yield in soybean production requires good agronomy practices. The essential aspects of soybean production practices that need attention include; good varietal selection, correct sowing method, and effective and timely weed control among others. The better performance of soybean observed during the cropping season of 2016 in Samaru compared to Bagauda in the same cropping season can be attributed to the differences in climatic and soil conditions in the two sites.

The early rains recorded in Samaru (Appendice1) allowed early sowing and encouraged early crop establishment and also the development of critical phases of the crop before the rain stopped. This really improved better growth and yield performance at Samaru than at Bagauda. Soybean is a worm weather crop that does well in a well-drained soil which has adequate moisture and temperature within the range of 18-35$^{0c}$ (Odeleye*et al*. 2007). The relative humidity that was moderately high in Samaru (75.0-80.4%) was another important climatic factor that might be counted in favour of better performance of soybean at Samaru compared to what was obtained at Bagauda, where the condition was drier and the relative humidity lower with average of 10.0-46.8%. In addition to this, the better crop performance at Samaru could also be due to the higher available phosphorous content of the experimental site at Samaru (10.34mgkg$^{-1}$) compared to Bagauda with (2.75mgkg-$^{1}$) (Appendix 1).

Phosphorus is an important nutrient that is required in large quantity, especially for leguminous crops such as soybean (Dozomeku*el al., 2006*). The lack or inadequate phosphorus may lead to stunted growth, suppression of pod formation and grain filling. This assertion corroborates the findings of Adeosun (2000) who reported that low levels of soil

nutrients such as available P, total N could make crops unable to optimally utilise the nutrient elements thereby, leading to reduction in growth and yield of soybean.

Higher weed cover score and weed density were recorded in Samaru compared to Bagauda. This may be due to high rain that fell less than an hour after glyphosate was applied during land preparation at Bagauda. The rain might have leached the herbicide beyond the action zone of the soil, which might reduce the efficiency and efficacy of the herbicide on weeds. This is in support of the report by Das (2008), who observed that heavy rain fall washed away both foliar and soil- active herbicides and reduced their efficacy and efficiency. Moderately good seed yield and yield attributes were achieved at both locations. This may be as a result of adequate moisture and longer and high light intensity during the critical growth stages of the crop plants.

## 5.2 Effects of Variety on Weeds and Crop Growth and Yield

All the weed control treatments generally reduced weed cover score and weed dry weight throughout the cropping period, compared to the weedy check in both locations, with a littleexemption. The variety TGX 1448-2E produced taller crops with more number of leaves and wider canopy cover, which could help to supressed weeds and enhance more assimilate production for pod formation than variety TGX 1987-10F. This can therefore, be attributed to the inherent genetic make-up of the variety, which was expressed during growth. This collaborate the findings of Wilcox (1980), who reported that soybean varieties had varying genetic and phenotypic traits. At Samaru and Bagauda, weedy check had significant higher weed cover scores and weed dry matter than all other weed control treatments. The effect of weed control treatment was significant at 2WAS at Samaru and 12WAS at Bagauda .At Samaru variety TGX 1987-10F recorded higher weed cover score and produces more weed dry matter than variety TGX 11448-2E. This may be due to the fact that variety TGX 1987-

10F has a slender stem and it is less robust, features that can inhibit early canopy formation and prevent closure to smother weeds. This observation agreed with the finding of Harder *et al*. (2007), who reported that crop growth attributes such leave area index; plant height, canopy cover, among others, were superior characters that can help to supress weed growth and reduce competition with crop. The response of variety to canopy spread was significant in both Samaru and Bagauda in which TGX 1448-2E significantly had more canopy cover at 6 and 9 WAS. This fact buttressed the findings of Joshi *et al;* (2013), who reported that significant differences exist among soybean genetic make-up, which are exhibited in their phenotypic expression. Also, variety has significant effect on the LAI, CGR, number of seeds per pod, shoot dry weight, 100 grain weight and grain yield. But at Bagauda, the effect of variety was not pronounced with respect to shoot dry weight, LAI and CGR. At Samaru, variety TGX 1448-2E produced the heaviest 100 seed weight and highest grain yield compared to TGX 1987-10F.

### 5.3 Effects of Sowing Method on Weed and Crop Growth and Yield

The effect of sowing methods on weed was significant in both locations. It was observed that dibbling method of sowing soybean had heavier weed dry weight and more weed cover score at both locations especially at 9WAS sampling period. Drilling method of sowing produced less weed dry weight and weed cover score which revealed that sowing soybean by drilling method, help to stimulate early and effective canopy formation as well as closure for weed control. This collaborate the findings of Dougherty (1969), who reported that shading of weed by early formation of canopy by soybean planted by drilling method helps to control weed and improved yield of crop plant.

The result of this research showed that the drilling method of sowing soybean gave significantly heavier dry biomass and increase yield in both Samaru and Bagauda. The

biomass was more in drilled soybean because there were more plants on the ridges which result to more yield and increase dry biomass. This is in line with the findings of Olufajo (1990), who reported that yield and yield attributes of soybeans increase with increase in plant population per unit area. Drilled soybeans can out-yield dibbled soybean, but care need to be taken to ensure that the seeds are placed at a uniform sowing depth. Some potential gains from drilling may be offset by inconsistent sowing depth.

### 5.4 The Effect of Weed Management on Weeds and Crop Growth and Yield

Hoe weeded plots gave significantly lower weeds cover scores and weed dry matter than other weed control treatments. This may due to complete uprooting of the weed during hoe weeding periods. This corroborates the findings of Das (2008), who reported that soybean yields were low under weed infestation. Weed at the critical growth period such as pod filling is detrimental and it can cause competitions for environmental factors such as nutrient, sunlight, water and space, leading to high yield reduction in soybean. In both locations, Pendimethalin at 2.0kg a.i/ha resulted in lower weed cover score and weed dry weight than fluazifop-butyl at 2.0 kg a.i/ha. This may be due to the suppressive effect of Pendimethalin on noxious and aggressive annual weeds like *rottboelliacochinchinesis* and *Ancathospermushispidium* dominant during the trial. This collaborate the findings of Anon (1994) who reported that Pendimethalin at 1.5 – 2.0 kg a.i/ha gave total control of grass weed seedlings. Many researchers have reported reduction in weed dry matter production due to herbicide applications in various leguminous crop Reddy, **(**2002) ; Ishaya, 2004 ;) Growth parameter on varieties of soybean such as stand count, plant height, crop vigour scores, shoot dry weight, leaf area index (LAI) crop growth rate (CGR), relative growth rate (RGR), days to first, and 50% flowering were significantly influence by weed control treatments. In both Samaru and Bagauda, hoe weeding, plot treated with the application of 2.0kg a.i/ha of

fluazifop-butyl applied as post emergency and weeding check had significantly higher crop emergence count or stand count at 3 WAS than the plots treated with 2.0kg a.i/ha of Pendimethalin (Table 18). The canopy spread was significantly enhanced by all the weed control treatment compare to the weedy check in both locations. This is because growth factor such as nutrient, water, light and space are more available in a weed free farm, which encourage good leave formation both in the number of leaves and the size of the leave. This observation is in line with the findings of Conner et al. (2004), who reported more leaves in sesame crop resulting from application of 2.0kg a.i/ha of Pendimethalin plus metholachlor at 1.5kg a.i/ha. In both Samaru and Bagauda, 6 and 9 WAS, weedy check recorded more crop vigour than other weed control treatments. This is because of the phototoxic effect of the herbicide on the treated plots and root injury in hoe weeded plots. However, the weedy check recorded the least crop vigour score in all the sampling periods and in both locations. This was due to unchecked weed competition for resources that lead to lower crop vigour. The yield parameters such as grain weight, grain yield were increased considerably under Pendimethalin herbicide and hoe weeding. The good performance of soybean under hoe weeding and herbicide as compare to the weedy check could be attributed to better weed control that was provided by the treatments.

## 5.5 Interactions

The interaction showed that that took place between the weed control treatments and sowing methods revealed that the combination of weed control treatment with sowing methods had significant influence on plant height in which higher plants were recorded when hoe weeding was combined with drilling method of sowing. This may be as a result of good weed control ability of hoe weeding couple with early canopy cover of the drilled crop that culminate into effective weed management. In this case, weed competition with crop plant was reduced.

Thus, there was adequate growth and development. On the other hand, drilling method of sowing with each weed control treatment helped to reduce the weed and suppressed compared to weedy check. Close spacing help to reduced weed competition and increased effective use of growth factors. Grichar, *et al*. (2004) reported that efficient weed control in a narrow spacing of soybean than the wider spacing.

Variety TGX 1448-2E planted by drilling method produced significantly wider canopy cover. This may be attributed to the fact that variety TGX 1448-2E is taller and robust when planted with drilling method which encourages canopy cover.

**5.6Correlations and Path Analysis**

The correlation matrix shows a significant relationship between grain yield and growth parameters which include plant height, canopy cover, crop vigour, crop growth rate, relative growth rate, 100 seed weight, grain weight and total dry weight which influence the vegetative growth and photosynthetic ability of the crop in both Samaru and Bagauda shows the importance of these yield component to soybean yield. The result revealed that an increase in any of these parameters would invariably contribute to grain yield. The highly significant and positive correlation ($p=0.01$) exhibited between soybean yield and growth characters such as leaf area index, canopy spread in both location was probably due to the fact that these vegetative attributes directly determine the extent of photosynthesis and the amount of assimilates that were available for crop plant growth and grain yield production.

The path analysis and the percentage contribution revealed that among the growth and yield characters selected, dry matter production and haulm weight made the highest positive contribution of 38.7% and 20.4% respectively to soybean yield.

This shows that these characters were most critical determinants of yield in soybean and thus constitute important characters that should be considered by breeders during breeding

programmes. The other growth and yield parameters assessed made their highest indirect contribution through plant height and seed yield. This also buttresses their importance for yield in soybean production.

### 5.7Economic Analysis

Economic analysis was carried out using the prevailing market prices for inputs at sowing and for outputs at the time the crop was harvested. All costs and benefits were calculated on hectare basis in naira. The following concepts used in the partial budget analysis are defined as Mean grain yield is the average yield (t/ha) of each treatment. The average yield was adjusted downwards by 10%. The adjusted yields represent the potential yield from the farmer's field using the same treatments. The gross field benefit was calculated by multiplying the field price by the adjusted yield. The net benefits were calculated by subtracting the total costs that vary from the gross field benefits for each treatment.

### 5.8 Cost Analysis

The main aims of cost analysis of the soybean production enterprise were to determine the cost and returns of operations and corresponding level of profit. The cost is made up of all the expenses incurred during the production processes. The revenue was the amount of money realised from the sales of soybean obtained per the treatment imposed. The outcome of the gross margin analysis indicated the range of ₦6930.00 – ₦270378.00 the lower profit achieved is attributed to the lower yield obtained from the combination of weed control treatment, sowing method and variety which was not adapted to the environment and as a result, did not performed very well.

The result of the cost analysis (CA) analysis in this work shows that soybean production in the study area is an economically profitable enterprise. The positive average gross margin

(GM) obtained in this study is a clear pointer that a good input – output relationship exist for soybean cultivation under rain fed production. Additional profit can be obtained from the sales of dry haulms at a time when it values is very high due to scarcity and high demand.

# CHAPTER SIX

## 6.0 Summary and Conclusion

Field experiment was conducted during rainy season of 2016 at Samaru located in latitude 11$^{o}$ 11'N and longitude 07o 38'E 686 metres above sea level in the Northern Guinea Savannah and at Bagauda located 11$^{'}$37N, 8$^{o}$ 23$^{'}$E, 500 metres above sea level in the Sudan Savannah ecological zone of Nigeria to study the performance of soybean varieties as influenced by sowing method and weed control treatments. The experiment consist of two varieties of soybean (TGX 1448-E and TGX 1987-10F), two sowing method and four weed control treatments. The treatments were laid out in a split plot design with sowing method and weed control treatments on the main plot while varieties were assigned to the sub-plot. Weed density and weed dry weight were significantly decreased by the weed control treatments. The hoe weeded plot recorded higher crop vigour, plant height, canopy cover and crop growth rate.

The yield parameters such as total dry weight, 100 seed weight, and grain yield weight were significant. The hoe weed was observed to significantly increase growth and yield parameters. The variety TGX 1448-2E recorded less weed cover and weed dry weight. It produces the tallest plant and it was more vigour crop with wider canopy and had the most grain yield at both locations. The drilling method of sowing recorded less weed dry weights, weed cover score and produced significant more vigorous crop with wider canopy and heavier total dry weight. There was positive and significant relationship between soybean yield and growth parameter such as height, crop vigour, canopy cover, total dry weight 100 seed weight as well as grain yield weight. However, there was negative and significant association between grain yield weight and weed cover scores and also weed dry weight. In conclusion, the result from the study shows that hoe weeding at 3,6 and 9WAS, fusillade

applied as post emergence at 2.0kg a.i/ha and drilling method of sowing resulted in effective weed control and recorded the highest grain yield in both locations. Variety TGX 1448-2E performed better than the TGX 1987-10F during the rainy season of 2016 at Samaru and Bagauda.

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## APPENDICES

Appendix I: Mean rainfall (mm), mean temperature ($^0$C), mean sunshine hours, mean relative humidity (%) and number of rainy days in 2016 wet season at Samaru.

| Month | Rain fall (mm) | Temperature $^0$C | | Relative humidity (%) | | Sunshine hours day$^{-1}$ | Rainy days |
|---|---|---|---|---|---|---|---|
| | | Max | min | 10.00am | 4.00pm | | |
| June | 4.4 | 31 | 23 | 76 | 65 | 7 | 14 |
| July | 7.1 | 31 | 23 | 80 | 71 | 5 | 10 |
| August | 8.7 | 31 | 22 | 82 | 74 | 6 | 16 |
| September | 11.5 | NA | 25 | 77 | NA | 6 | 15 |
| October | 00 | 33 | 18 | 58 | 53 | 8 | 00 |

NA= Not available

Source: IAR Metrological unit, Samaru-Zaria, Kaduna

## APPENDIX II

Mean rainfall (mm), mean temperature ($^0$C), mean sunshine hours, mean relative humidity (%) and number of rainy days in 2016 wet season at Bagauda.

| Month | Rain fall (mm) | Temperature $^0$C | | Relative humidity (%) | | Sunshine hours day$^{-1}$ | Rainy days |
|---|---|---|---|---|---|---|---|
| | | Max | min | 10.00am | 4.00pm | | |
| June | 5.0 | 29 | 30 | 49 | 36 | 00 | 11 |
| July | 6.2 | 28 | 28 | 56 | 47 | 00 | 11 |
| August | 7.5 | 30 | 21 | 60 | 52 | 4 | 10 |
| September | 3.5 | 35 | 30 | 50 | 38 | 5 | 4 |
| October | 0.6 | 36 | 29 | 43 | 34 | 5 | 2 |

Source: Bagauda metrological unit Kano

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|---|---|---|
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