INFLUENCE OF POULTRY MANURE AND WEED CONTROL METHODS ON THE PERFORMANCE OF GROUNDNUT *(Arachis hypogaea* L.) VARIETIES UNDER RAINFED AND IRRIGATED CONDITIONS

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A DISSERTATION SUBMITTED TO THE SCHOOL OF POST GRADUATE STUDIES AHMADU BELLO UNIVERSITY, ZARIA, IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF DOCTOR OF PHILOSOPHY IN AGRONOMY.

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NIGERIA.

MARCH, 2015

DECLARATION

I hereby declare that the work in this dissertation titled “Influence of Poultry Manure and Weed Control Methods on the Performance of Groundnut *(Arachis hypogaea* L.) Varieties under Rainfed and Irrigated Conditions” was performed by me in the Department of Agronomy, under the supervision of Dr. (Mrs.) A.A. Mukhtar, Dr. B.A. Babaji and Dr. D.I. Adekpe. The information derived from the literature has been duly acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for another Degree or Diploma at this or any other institution.

Usman IBRAHIM		
Name of Student	Signature	Date

The above declaration is confirmed by me

Dr. (Mrs.) A.A. Mukhtar
Chairman Supervisory Committee

CERTIFICATION

This dissertation entitled "Influence of Poultry Manure and Weed Control Methods on the Performance of Groundnut *(Arachis hypogaea* L.) Varieties under Rainfed and Irrigated Conditions" by Usman IBRAHIM meets the regulation governing the award of the degree of Doctor of Philosophy in Agronomy in the Department of Agronomy, Faculty of Agriculture, Ahmadu Bello University, Zaria and is approved for its contribution to knowledge and literary presentation.

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DEDICATION

This work is dedicated to Allah and the most important people in my life; Ibrahim, Fatima, Fatima, Bilkis, Maryam, Abdurrahman and Ibrahim.

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ABSTRACT

Field trials were conducted during the 2012 and 2013 rainy seasons at the Teaching and Research Farm of Samaru College of Agriculture, Ahmadu Bello University Zaria and in 2012/2013 and 2013/2014 dry seasons at the Irrigation Research Station, Kadawa of the Institute for Agricultural Research, Kadawa. The treatments consisted of three levels of poultry manure (0, 1.5 and 3 tonnes ha^{-1}), five weed control methods which included three rates of post emergence herbicide (0.054 kg a.i.ha^{-1}, 0.108 kg a.i ha^{-1} and 0.162 kg a.i ha^{-1} of Haloxyfop-R-methyl ester), weedy check, and hoe weeding at 3 and 6 weeks after sowing (WAS) and three varieties of groundnut (SAMNUT 11, SAMNUT 22 and SAMNUT 23). The treatments were laid out in a split-plot design with factorial combinations of the weed control methods and poultry manure occupying the main plot while the varieties were allocated to the subplots. The treatments were replicated three times. The results from the study revealed that application of 3.0 tonnes ha^{-1} poultry manure significantly increased growth parameters such as plant height, shoot dry weight, number of branches, and number of leaves, crop growth rate and relative growth rate. Days to 50% flowering was reduced by the application of 3.0 tonnes ha^{-1} poultry manure. Application of 3.0 tonnes ha^{-1} poultry manure improved the crop vigour score of groundnut plant and increased weed control efficiencies. Application of poultry manure increased pod weight $plot^{-1}$, 100 kernel weight and pod yield ha^{-1}. However, a further increase from 1.5 tonnes ha^{-1} to 3.0 tonnes ha^{-1} resulted in significant increase in haulms production at the expense of the yield characters. Among the evaluated weed control methods, two hoe weeding resulted in significant increase in all the growth parameters considered in this work, while days to 50% flowering was significantly reduced by two hoe weeding. Similarly, two hoe weeding resulted in highest crop vigour and highest weed control efficiency. Other weed control parameters such as crop injury, weed cover score, weed dry weight were significantly reduced by the same treatments. All the yield parameters were significantly increased by two hoe weeding. Production of SAMNUT 11 resulted in the highest growth and yield parameters and lowest weed infestation. Pod yield ha^{-1} was positively and highly correlated with number of branches, number of leaves, plant height, canopy spread, number of pods, pod weight and 100 kernel weight but was negatively correlated with haulm yield. Pod weight had the highest direct contribution which was followed by 100 kernel weight, number of pods, number of branches, plant height and canopy spread in that order, while number of leaves had the lowest direct contribution. The combined effect of pod weight and 100 kernel weight gave the highest combined contribution while the combined contribution of number of branches and number of pods and the combined contribution from number of branches and number of leaves ranked second. The least combined contribution was from number of leaves and number of pods; and plant height and canopy spread that resulted in negative values. The profitability analysis showed that the combinations of 1.5 tonnes ha^{-1} of poultry manure, two hoe weeding and SAMNUT 11 gave the highest net farm income. It can be concluded that application of 1.5 tonnes ha^{-1} of poultry manure, two hoe weeding and use of SAMNUT 11 resulted in highest pod yield and profitability of groundnut in the study area.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Groundnut Production

Groundnut (*Arachis hypogaea* L.) is one of the most important oil seed crops in the world. It contains 50% oil and 25 % protein and is a rich source of dietary fiber, minerals and vitamins (Anon., 2002). Groundnut is grown on 32.4 million hectare worldwide, with a total production of 45.3 million tonnes and an average productivity of 1.4 tonnes ha^{-1}. Developing countries constitute 97% of the global area and 94% of the global production of this crop (FAO, 2013). In Nigeria, the estimated land area to groundnut production in 2013 was 2,720,970 ha with a total production of 2,474.53 tonnes (NAERLS and FDAE, 2013). Groundnut is mainly produced in the northern parts of the country and the major producing states are Nassarawa, Niger, Kano, Jigawa, Katsina, Benue, Taraba, Gombe, Adamawa and Zamfara states. Between 2010 and 2012, these states recorded marginal increase in the production of groundnut due to availability of new improved varieties and improved crop management systems (NAERLS and FDAE, 2013).

Traditionally in Nigeria, groundnut is being grown during rainy season. Environmental factors for successful groundnut production found during the rainy season also prevail during the dry season in the savanna, while moisture requirements can be adequately met by the supply of water through irrigation (Mukhtar, 2009). The major groundnut producing areas are located in the Sudan and northern Guinea savanna ecological zone where the soil and agro-climatologically conditions are favorable (Misari *et al.*, 1980). Groundnut cultivation under irrigation is uncommon, although in parts of Africa irrigated groundnut has been long produced on a few large scale irrigation scheme such as that at Wad medina in Sudan, where edible groundnut are grown for export (Anon., 2002).

1.2 Economic Importance and Utilization

Groundnut has contributed immensely to the development of the Nigerian economy. From 1956 to 1967, groundnut products including cake and oil accounted for about 70% of total Nigerian export earnings, making it the country's most valuable single export crop ahead of other cash crops like cotton (*Gossypium* spp.), oil palm (*Elaeis guineensis*), cocoa (*Theobroma cacao*) and rubber (*Hevea brasiliensis*) (Harkness *et al.*, 1976). Up till 1969 Nigeria was the third largest exporter of groundnut, after India and China. Presently, it provides significant sources of cash through the sales of seed, cakes, oil and haulms. The groundnut oil is composed of mixed glycerides, and contains a high proportion of unsaturated fatty acids, in particular Oleic acid (50-56%) and Linoleic acid (18-30%). The stable oil is preferred by the deep-frying industries since it has a smoke point of 229.4^{o}C compared to 193.5^{o}C for soybean oil. The oil is also used to make margarine and mayonnaise (Hui, 1996). Groundnut plays an important role in the diets of rural populations, particularly children, because of its high contents of protein, fat and carbohydrate. It is also rich in calcium, potassium, phosphorus, magnesium and vitamin E. Protein meal, a by-product of oil extraction, is an important ingredient in livestock feed. Groundnut haulm is nutritious and widely used for feeding livestock. Groundnut is also important in the confectionary industry where products such as snack nuts, sauce, flour, peanut butter and cookies are made from high quality nuts of the crop. In the northern Guinea and Sudan savanna zones of Nigeria, apart from being consumed whole, edible groundnuts are processed into or included as ingredient in a wide range of other products, which include groundnut paste that is fried to obtain groundnut cake (*kuli kuli)*, salted groundnut (*gyada mai gishiri)*, a gruel or porridge made with millet and groundnut (*kunun gyada)*, groundnut candy *(kantun gyada)* and groundnut soup (*miyar gyada)*. Groundnut haulms are important products often equal in value to the pod in the sudano-sahelian zone. In such areas haulms provide substantial cash income for small holder farmers. The shells are used as fuel by some local oil factories or they are sometimes spread on the field as a soil amendment ((Anon., 2002).

1.3 Constraints to Groundnut Production

Groundnut pod yield from farmers fields under rainfed conditions are low, averaging 910 kg ha^{-1} (NAERLS and FDAE, 2013) when compared to the potential yield of 3,000 kg ha^{-1}. According to Ahmed *et al.* (2010), the main problems limiting production of groundnut include non-availability of seed of improved varieties for a particular ecology, poor soil fertility, inappropriate crop management practices, inadequate weed management, pest and diseases. Other problems include high labour demand for groundnut production, lack of mechanization and market constraints. The above listed constraints have contributed immensely to low yield of the crop which discourages farmers from cultivating the crop but rather prefer to grow other food crops like maize, especially in Nigeria.

1.4 Justification for the Study

The use of organic manure is on the increase because of scarcity and high cost of chemical fertilizers and its negative effects on the environment. Poultry manure is an excellent source of plant nutrients, as it contains high nitrogen, phosphorous, potassium and other essential nutrients (Mitchell and Donald, 2012). In contrast to mineral fertilizers, poultry manure adds organic matter to soil, which improves soil structure, nutrient retention, aeration, soil moisture holding capacity and water infiltration (Mitchell and Donald, 2012). To obtain maximum economic value of plant nutrients in poultry manure, the manure should be applied to match nutrient needs of crops. It is essential to avoid wastage by ensuring that only the required quantities of poultry manure are applied to the crop. However, rates varying within the range of 3- 10 tonnes ha^{-1} have been reported by various researchers (Ahmed *et al.,* 2010; Mubarak, 2004; Yanduraju *et al.*, 1980). There is the need to determine the appropriate rate of poultry manure for optimum groundnut yield.

Effective weed control method is essential for profitable groundnut production. According to Akobundu (1987), weeds may account for 30 to 40 percent of potential yield losses in groundnut. Hoe weeding which is the most widely and predominant method of weed control in groundnut throughout the tropics is expensive, labour intensive and the availability of labour is often scarce, particularly at the peak of the season when it is needed most. Hoe weeding occasionally may damage pegs and roots and therefore reduce crop yield. It is ideal to evaluate the performance of this post emergence herbicide in the control of weeds with a view to reduce cost, labour demand and avoid damages to pegs in groundnut production.

The adoption of appropriate varieties for a particular ecology is very vital in groundnut production. Farmers using improved varieties have derived significant yield gains of 23%, 43% and 31% over local varieties in Mali, Niger and Nigeria, respectively (ICRISAT, 2011). In line with this, it is necessary to determine the most appropriate and adaptable variety suitable for each of the ecological zones where groundnut is produced.

Generally in the Guinea Savanna, groundnut is traditionally produced during the rainy season. There is however, the need to increase groundnut production which may be achieved through irrigation farming. Unfortunately, the dry season in Samaru does not allow for groundnut production because of low temperature which affects germination, growth and development of the crop (Yayock, 1978; Tanimu, 1982; Ntare *et al.,* 1988; Mukhtar, 2009). In the Sudan Savanna however, the rainy season is short and with the recent change in climatic conditions it is more uncertain to predict rainfall pattern making it difficult to grow high yielding long maturing groundnut varieties because of uncertainty in rainfalls. The Sudan Savanna also has the required soil, sunshine and temperature for groundnut production, there is the need to grow groundnut during the dry seasons to supplement rainy season production (Mukhtar, 2009).

In Nigeria, the establishments of oil mills and poultry farms, which consume a great bulk of the crop, are also on the increase. There is the need by Government to relocate the African Groundnut Council to Kano in Nigeria so that the country can return to its position among the leading producing countries in the world, thus reducing the country's dependence on crude oil exportation. In view of these, it is important to evolve an integrated approach involving combination of improved varieties, herbicide and fertilizer that could prove effective in the production of groundnut in both wet and dry seasons.

1.5 Objectives of the Study

The objectives of the study therefore are to evaluate,

1. The effect of poultry manure on the performance of groundnut under rainfed condition at Samaru and irrigated condition at Kadawa.
2. The effect of weed control methods on weed infestation and performance of groundnut under rainfed condition at Samaru and irrigated condition at Kadawa.
3. To determine the best adaptable and highest yielding variety under rainfed condition at Samaru and irrigated condition at Kadawa.
4. The Profitability of poultry manure and weed control methods on yield of three varieties of groundnut under rainfed condition at Samaru and irrigated condition at Kadawa.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Poultry Manure

Poultry manure, if properly handled, is the most valuable of all manures produced by livestock. It has historically been used as a source of plant nutrients and for soil amendment. Two basic types of poultry wastes are generally produced: broiler litter and caged layer manure. Broiler litter, for the purposes of fertilization, includes all floor-type birds such as broilers, pullets, and floor layers. Bedding material such as wood shavings or peanut hulls is used to absorb liquids. Caged layer manure is usually free from litter material and generally has higher moisture content. Both types of waste usually contain feathers and some wasted feed (Mitchell and Donald, 2012). Chemical analysis of either type of manure varies due to moisture, temperature (more N will be lost at higher temperatures), amount and kind of bedding, amount of soil picked up while a house is cleaned, number of batches consecutively reared, and conditions under which the manure was stored and handled prior to spreading (Mitchell and Donald, 2012).

Poultry manure is an important resource for crop production and soil fertility sustainability. It is a source of almost all essential plant nutrients. It also provides an excellent source of organic matter when added to soil, restoring some organic matter depleted by many agricultural activities (Cooke, 1972). He further asserted that that poultry dropping retain and supply some nutrients for plant growth and development and the carbon containing compounds are food for small animal and micro-organisms. Poultry dropping often improves the structure of the soil. This structural improvement increases the water holding capacity of the soil, aeration and drainage, which enhances good root growth. Poultry manure is managed primarily for its nitrogen (N) value. However, N availability from poultry manure is the most difficult of the three primary nutrients to predict. About one-third of the total N in poultry manure is in the ammonium N form (NH_4-N) and the rest is in organic form. The amount of N available for plant uptake is ammonium nitrogen plus the amount of organic nitrogen that mineralizes during the growing season (Mitchell and Donald, 2012). The ammonium N fraction is subject to conversion to ammonia gas (NH_3) and atmospheric loss (volatilization). When manure has a strong ammonia odor or is spread on the surface of a soil and not incorporated, significant N will be lost to the atmosphere. Losses typically range from 15 to 20 percent of the ammonium fraction (5 to 7 percent of total N) when poultry manure is surface applied. If poultry manure is spread as a liquid or slurry, as much as 25 percent of the ammonium N could be lost within 7 days after spreading when the weather is hot and dry, and manure is not soil-incorporated. In quantifying the amount of N to be applied using poultry manure, ammonium N loss should be deducted from the total amount to be applied (Mitchell and Donald, 2012).

The organic N fraction gradually becomes available for crop uptake as the manure decomposes. Mineralization rates can range from 40 to 90 percent depending on environmental conditions. For poultry manure, it is assumed that 60 percent of the organic N (40% total N) may be released during the first year following application. Therefore, around 70 percent of the total N in poultry manure will be available to the crop the same year it is applied (Mitchell and Donald, 2012). The phosphorus (P) and potassium (K) fractions are considered to be about 75 percent as effective as commercial fertilizers during the first year of application (Mitchell and Donald, 2012).

2.2 Effect of poultry Manure on Growth and Yield of Groundnut

Poultry manure, not only supply nutrients but also improved soil conditions to produce higher yields. Mubarak (2004) reported an increase of 10% shelling percentage, 100 % kernel weight, 32% pod yield ha^{-1} when poultry manure was applied to groundnut at the rate of 5 tonnes ha^{-1}.

Bedry (2007) reported that application of 5 tonnes ha^{-1} of farm yard manure and 3 tonnes ha^{-1} of poultry manure increases post harvest soil organic carbon and available calcium contents in Faba bean. Ahmed *et al.* (2010) reported highest dry matter accumulation, kernel yield and oil content when groundnut was fertilized with 3 tonnes ha^{-1} of poultry manure. Yanduraju *et al*. (1980) reported a significant increase in plant height, number of branches, dry weight, number of pods, pod weight and shelling percentage of groundnut with the use of 10 tonnes ha^{-1} of poultry manure in poor soil in Malaysia and the check where poultry manure was not applied managed to survive and concluded that the application of poultry manure can greatly improve the soil nutrients. Das (2008) reported that application of farm yard manure and poultry manure increased post harvest soil organic C. and available Ca contents. Application of poultry manure has been found to decrease the adsorption capacity and increased the soluble P and phosphorous desorption (Reddy and Guri, 1989). Nwoku (2011) reported that application of poultry manure increased the available P content of the soil and concluded that application of essential nutrients which are available in poultry manure will increase the growth and yield of groundnut.

2.3 Effect of Weed on Growth and Yield of Groundnut

All groundnut varieties are susceptible to weed infestation. The spreading type offers a measure of competition against weeds after they completely cover the ground, but weeds that are able to grow above the canopy cover cause serious competition problem in the crop. Groundnut yield is as high as 3,000 kg ha^{-1} in the USA, the yield in tropical Africa is only 800kg ha^{-1}. One of the reasons for this poor yield is weed infestation (Akobundu, 1987). Uncontrolled weed growth has been reported to cause yield reduction of 50-80 percent in groundnut (Paulo *et al.,* 2001). Reduction of pod yield owing to competition with weeds depends on the duration of the crop, weed competition in general and the stages of crop growth in particular. When groundnut competes with weeds at 4- 8 weeks after sowing (WAS), the reduction in pod yield was substantial (Ishaq, 2007). Several studies have shown that the productivity of groundnut is reduced considerably when weed competition occurs during the early stage of the crop. Rao (2004) revealed that the critical period of weed competition was between 2 and 8 WAS. Yield components affected by weed competition are number of pods plant $^{-1}$, number of filled pod and mean kernel weight. Generally the reduction in number of pods plant^{-1} by weed interference is directly related to the adverse effect of uncontrolled weed growth in groundnut. The slow early growth in groundnut makes the crop very susceptible to early weed interference. In general, weed competition in groundnut is more severe for the first 6 weeks from sowing. Rao (2004) reported 25 - 75% yield reduction in groundnut due to weed competition in India. In Ghana and Nigeria, 54% and 60% yield losses have been reported in groundnut, respectively (Akobundu, 1987).

2.4 Weed Control Methods in Groundnut

According to Akobundu (1987) two weeding at 3 and 6 WAS were necessary for most legumes but groundnut may require additional weeding depending on location and because of its inability to develop canopy cover as fast as the other legumes. Ahmed *et al.* (2010) found that groundnut plant height was increased by about 70% compared to weedy check. Weeding twice had the highest plant height. Weed decrease the number of branches, the higher number of branches was obtained when the crop was weeded twice. This is attributed to vigorous plant with less competition for light, nutrients and free space in weed free environment. Weeding facilitates plant to have more resources for growth (Mubarak, 2004).

Yadava and Kaura (2007) reported that weed control in groundnut led to increased number of branches plant^{-1} as compared to non weeded plants. Increase in weeding frequencies led to increased leaf area index, which is due to better control of weeds. Reduced competition and increased availability of resources like nutrients, soil moisture and light paved way for higher leaf area. Effectiveness of weed control is largely dependent on the weed species prevalent, its life cycle and method of propagation. Since mechanical or cultural method alone does not ensure weed free condition, the use of herbicides in combination with cultural methods may be adopted. In areas where agricultural labour is scarce and costly, herbicides may be used as pre- and post-emergence application to control weeds (Rao, 2004).

The yield of groundnut can be improved to 20–30% by minimizing the crop-weed competition particularly at early stage of groundnut. When groundnut fields were kept weed free for a period of the first six weeks after planting, there was significant increase in pod yield (Annadurai *et al.*, 2010). Pre-emergence application of pendimethalin/metolachlor at the rate of 0.75kg a.i ha^{-1} or alachlor at the rate of 1.0 kg a.i ha^{-1} or pre-planting incorporation of fluchloralin at the rate of 0.75 kg a.i ha^{-1} controlled weeds effectively (Rao, 2004). Post- emergence spray of quizalofop ethyl 5 E.C at the rate of 0.05 kg a.i ha^{-1} or fluazifop-p-butyl 28 E.C. at the rate of 0.25 kg a.i ha^{-1} at 20 days after sowing took care of later flush of weeds (Rao, 2004).

Jhala *et al.* (2010) studied the effect of weed management practices and Rhizobium inoculation on growth and yield of groundnut and observed that minimum weed dry matter accumulation (70 kg ha^{-1}) with higher weed control efficiency (90.70%) was recorded under an integrated method i.e. pendimethalin at 1.0 kg a.i ha^{-1} + hand weeding at 30 DAS, which also resulted in maximum pod yield of 1,773.50 kg ha^{-1}. This treatment was comparable to fluchloralin applied at 1.0 kg ha^{-1} combined with hand- weeding at 30 DAS. Weedy conditions in the unweeded control treatment reduced pod yield by 29.90 - 35.95 % as compared to the integrated method. Significant higher pod yield was obtained with Rhizobium inoculation than the mean value of all treatments without inoculation. For most agronomical parameters examined, Rhizobium inoculation and weed control treatments were independent in their effect.

Chemical weed control has generally been superior to hand weeding but crop yields have been identical. For example, weed control with alachlor and fluorodifen was reported to be superior to hoe weeding. Oxyflorfen (0.15 - 0.25 kg a.i ha^{-1} as pre-emergence) fluchloralin (1.0 kg a.i. ha^{-1} as pre-plant incorporation) or pendimethalin (0.75 -1.5 kg a.i ha^{-1} as pre-emergence) or imazethepyrin (0.1- 0.15 kg a.i ha^{-1} as early post- emergence) were all effective in weed control (Anon., 1994) and further recommended the addition of 1.5 kg a.i ha^{-1} of bentazone as post-emergence herbicides for weed control in groundnut**.**

2.5 Haloxyfop –R- methyl (0.108 kg a.i. ha^{-1})

Haloxyfop–R-methyl **(**Gallant super) belongs to the family aryloxyphenoxypropionic acid herbicides. The IUPAC name of the herbicide is methyl (2R)-2-[4-[[3-chloro-5-(trifluoromethyl)-2-pyridinyl] oxy] phenoxy] propanoate with a molecular formula; $C_{16}H_{13}ClF_3NO_4$. It is a selective, systemic, and post-emergence herbicide for weed control in broad leaf crops like cotton, groundnut, cowpea, potato and vegetables. The herbicide is absorbed by roots and foliage and hydrolysed to Haloxyfop-P, which is translocated to the meristematic tissues of the treated plants, and inhibits their growth. Haloxyfop-R-acts by competitively binding to the Acetyl-Co A-carboxylase (ACCase) that catalyzes the biosynthesis of fatty acids. The available formulation in Nigeria contains 0.108kg Haloxyfop-R-methyl ester as the active ingredient per liter formulated as an emulsifiable concentrate (E.C.). Higher rate is used for large plants and the rate varies from 0.5l ha^{-1} to 1.5 l ha^{-1} in as spray volume of 200-300 l ha^{-1} (Anon., 2013).

2.6 Groundnut Varieties

Botanically cultivated groundnut (*Arachis hypogaea* L.) can be classified into two sub species each containing two botanical types, which differs mainly in their branching patterns. Sub species hypogaea is divided in to var. hypogaea (Virginia) and var. hirsuta. Subspecies fastigiata is divided in to var.fastigiata (Valencia) and var. vulgaris (Spanish). Plants of the botanical variety hypogaea are bold- seeded, spreading (runner) to upright (erect bunch) in growth habit, having alternate branching, lack inflorescence on the main stem, possess appreciable fresh seed dormancy, flowers are longer and mature later than those of subspecies fastigiata . Virginias are generally longer season, taking up to 150 days to reach maturity. In Virginia varieties, many more branches are formed and the maximum leaf area plant $^{-1}$ is larger. Besides being late maturing, the plants become taller and bushier than Spanish or Valencia types (Anon., 2002). Variety hirsute has been used only to a little extent. Plants of the subspecies *fastigiata* are small seeded, upright, have sequential branching and inflorescences in the main-stem leaf axils, possess little fresh seed dormancy, and are of shorter duration than those of the species *hypogaea* typically completing their cycle in 90 to 110 days (Anon., 2002).

2.7 Growth and Yield of Groundnut

Environment and genotype interact to determine how a crop grows and how in turn, growth determines yield. The key factor affecting growth and yield of groundnut in semi arid regions such as the Sudan savanna is the availability of moisture during the cropping seasons (Nautiyal *et al.*, 1999). In an experiment with two cultivars (Florunner and Pronto), Auma (1988) observed that the cultivar Florunner had higher CGR, pod production rate and dry matter partitioning than cultivar Pronto (Anon., 2002).

Improved varieties are much more efficient at partitioning assimilates to the seeds than the old land races. The difference in yield and yield attributes of groundnut were associated with differences in their genetic compositions. Tanimu and Ado (1995) observed genotypic differences among varieties of groundnut as regards their response to variation in the environment and they conclude that it could be possible to select specific genotypes for specific environments. At Samaru, SAMNUT 12 produced significantly more pod yield than SAMNUT 18 (Tanimu, 1982). In an irrigation trial, to evaluate the performance of three groundnut varieties under different basin size and plant population in Kadawa, Mukhtar (2009) found significant differences in pod yield among the varieties: SAMNUT 23, SAMNUT 21 and SAMNUT 11 evaluated.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Experimental Site

Field trials were conducted during the 2012 and 2013 rainy seasons at Teaching and Research Farm of Samaru College of Agriculture, Ahmadu Bello University Zaria (Latitude 11° $11^{'}$ N, Longitude 07° $38^{'}$ E, and 686 meters above sea level) located in the northern Guinea Savanna ecological zone of Nigeria and in 2012/2013 and 2013/2014 dry seasons at the Irrigation Research Station of the Institute for Agricultural Research, Kadawa (Latitude, 11° $39^{'}$ N, Longitude 08° $27^{'}$ E, 500 meter above sea level) located in the Sudan Savanna ecological zone of Nigeria.

3.2. Poultry Manure Analysis

Samples of poultry manure, obtained from livestock section of Samaru College of Agriculture, used for the experiment were analyzed in the laboratory to determine their chemical properties (Appendix 1).

3.3 Soil Sampling and Analysis

Soil samples were taken randomly at 0 – 30 cm soil depths from the experimental sites before establishing each trial. A tubular auger was used to take the samples. The composite sample was analyzed in the laboratory to determine their physical and chemical properties using standard procedures as described by Black (1968). The results are shown in Appendix 2.

3.4 Determining the Rates of Poultry Manure Used In the Experiment

The fertilizer requirement of groundnut in the Savanna according to IAR recommendation cited by Mukhtar (2009) is given as N =20 kg, P=23.6 kg and K=24.9 kg ha^{-1}, and from the poultry manure analysis in 2012 wet season (Appendix I), the nutrient content was used to calculate the poultry manure needed to satisfy the inorganic fertilizer recommendation using the assumption of Michelle and Donald (2012) that about 70 % of the total N will be available in the first year; therefore additional 30 % was added to satisfy N demand. Based on this, 1.5 tonnes ha^{-1} will give 20kg N ha^{-1} and 3.0 tonnes ha^{-1} will give 40 kg N ha^{-1}. These manure rates (1.5 and 3.0 tonnes ha^{-1}) were used in both years and locations.

3.5 Meteorological Data

Data on rainfall distribution, temperature, sunshine and relative humidity for 2012, and 2013 wet seasons in Samaru and 2012/2013 and 2013/2014 dry seasons in Kadawa were collected and are shown in Appendix III.

3.6 Treatments and Experimental Design

The treatments consisted of three levels of poultry manure (0, 1.5 and 3 tonnes ha^{-1}), five weed control methods which included three rates of post emergence herbicide (0.054 kg a.i.ha^{-1}, 0.108kg a.i ha^{-1} and 0.162kg a.i ha^{-1} of Haloxyfop-R-methyl ester), weedy check, and hoe weeding at 3 and 6 weeks after sowing (WAS) and three varieties of groundnut (SAMNUT 11, SAMNUT 22 and SAMNUT 23). The treatments were laid out in a split- plot design with factorial combinations of the weed control methods and poultry manure occupying the main plot while the varieties were allocated to the subplots. The treatments were replicated three times.

3.7 Cultural Practices

3.7.1 Land preparation and layout

The land was harrowed twice to obtain a fine tilth and ridged at a spacing of 75cm apart. It was then marked out into 135 plots with 1.0m spacing between main plots and 0.5m spacing between sub plots. The gross and net plot sizes were 18.0 m^2 (4.5m x 4m) and 6.0 m^2 (1.5m x 4m), respectively. There were 6 ridges in gross plot and 2 ridges in net plot.

3.7.2 Application of poultry manure

The poultry manure was applied three weeks before sowing as per treatments. It was uniformly spread on the ridges and lightly incorporated into soils with a manual hoe.

3.7.3 Sowing

The seeds were sown on 4^{th} July in 2012 and 4^{th} June 2013 rainy seasons. During the dry seasons, the seeds were sown on the 6^{th} of March, 2013 and 4^{th} of January 2014, respectively. The seeds were dressed with APRON STAR 42 WS (Thiamethoxam: 200 g/kg, Mefenoxam: 200 g/kg and Difenoconazole**:** 20 g/kg) at the rate of 2.5 kg of groundnut seed per 10 kg of APRON STAR. The groundnut seed was sown at inter and intra row spacing of 75cm x 23cm respectively. Two seeds were sown per hole.

3.7.4 Irrigation

At Kadawa, irrigation was carried out using furrow method and water was supplied at 10 days intervals, and was stopped a week before harvesting each variety.

3.7.5 Weed control

Weed control was carried out as per treatments as follows: at 3 WAS Haloxyfop-R-methyl ester was applied as post-emergence at the following rates 0.054 kg a.i.ha^{-1}, 0.108 kg a.i.ha^{-1} and 0.162kg a.i.ha^{-1}, using a knapsack sprayer with a spray volume of 200 l ha^{-1}. Hoe weeding at 3 and 6 WAS was also employed only to the hoe weeded control plot. Weedy check did not receive any form of weed control throughout the period of the experiment.

3.7.6 Harvesting and processing

Harvesting was done when the crop reached physiological maturity i.e. when most leaves turned brown and the groundnut pod had a pronounced brown colour. The plants in the net plots were harvested by digging out the whole plant including the pods with a hand hoe and picking up the remaining pods from the soil. Thereafter, pods were detached from the haulms and allowed to dry for seven days under the sun. The dried pods for each net plot were then weighed using E2000 mettler balance and the value recorded on par plot basis.

3.8 Varietal Description

SAMNUT 11 is a late maturing variety (130-150 days), erect bunch with protein and oil content of 21.08% and 51.05%, respectively. It has a pod yield potential of 2,800-3500kg ha^{-1} and is adapted to northern Guinea savanna ecological zone of Nigeria.

SAMNUT 22 is a medium maturing variety (110-120 days), semi erect in habit with protein and oil content of 19.60% and 51.35%, respectively. It has a pod yield potential of 2,500kg ha^{-1} and is adapted to all the zones in the Guinea savanna.

SAMNUT 23 is an early maturing variety (90-100 days), semi erect in habit with protein and oil content of 18.96% and 52.53%, respectively. It has a pod yield potential of 2,000kg ha^{-1} and is adapted to Sudan and Sahel savanna ecology.

3.9. Assessment of Weed Parameters

3.9.1 Weed composition

At 3 weeks after sowing (WAS) the common weed species at the sites were identified and classified as described by Akobundu and Agyaku (1998). The relative Frequency (RF) of the weed species was used to quantify the weed species as suggested by Das (2008). This was calculated using the formula:

$$RF = \frac{\text{No of occurrence of a species}}{\text{Total number of occurrence of all the species}} \times 100$$

3.9.2 Crop vigour

Crop vigour score was assessed at 6, 9 and 12 WAS by visual observation using a scale of 1-9 where 9 represented plots with most vigorous crop and 1 represented completely dead plants. In this observation, plant height, greenness of foliage, canopy spread, leaf size and stem thickness were used in assessing the crop vigour. The values obtained were recorded on par plot basis.

3.9.3 Crop injury

Visual observation was used to assessed the crop injury score using a scale of 1-9 at 6, 9 and 12 WAS. Where 1 represented the least injured plants while 9 represented the most injured. Crop injury was assessed based on leaf necrosis, burnt and stunted growth of the crop. The values obtained were recorded on par plot basis.

3.9.4. Weed cover

Weed cover score was assessed at 6, 9 and 12 WAS by visual observation using a scale of 1-9. Where 1 represents no weed cover and 9 represent complete weed cover. The values obtained were recorded on par plot basis.

3.9.5 Weed dry weight (g)

Weed weight samples were taken from $0.75m^2$ quadrat at 6, 9 and 12 WAS. The samples were cleared free of soil and oven dried at 70^o C to constant weight for dry matter determination using E2000 electronic mettler balance. The weights were recorded in grams for each plot.

3.9.6 Weed control efficiency (W.C.E.) (%) at harvest

This was calculated using the formula:

W.C.E.

$$= \frac{\text{Weed dry weight in weedy check} - \text{Weeds dry weight per treatment}}{\text{Weed dry weight in weedy check}} \; x\ 100$$ (Das, 2008)

3.10 Assessment of Growth Characters

Assessment of growth characters were done at 6, 9 and 12 WAS. Five plants were randomly selected and tagged in each plot for sampling. In each sample the following parameters were measured, averaged and recorded on per plot basis:

3.10.1 Plant height plant^{-1} (cm)

Plant height was measured *in situ* using a meter rule from the ground level to the terminal leaflet; the mean obtained was recorded on per plot basis. This was done at 6, 9 and 12 WAS.

3.10.2 Canopy spread (cm)

Canopy spread was measured by taking the diameter of the open canopy using a meter rule and the mean obtained was recorded on per plot basis. This was done at 6, 9 and 12 WAS.

3.10.3 Shoot dry weight plant^{-1} (g)

Two plants were randomly selected in each gross plot. The shoot sample was packed in an electronic oven at 70^0C for 48 hours as suggested by Sharma and Mehta (1991). Dried shoot weight was measured using E2000 electronic mettler balance. The mean of dry matter plant^{-1} was recorded on per plot basis. This was done at 6, 9 and 12 WAS.

3.10.4 Number of branches plant^{-1}

Number of branches was obtained by counting the total number of branches of five tagged plants. The mean obtained was recorded on per plot basis and this was done at 6, 9 and 12 WAS.

3.10.5 Number of leaves plant^{-1}

Number of leaves was obtained by counting the total number of leaves of five tagged plants. The mean obtained was recorded on per plot basis and this was done at 6, 9 and 12 WAS.

3.10.6 Days to 50% flowering

Days to 50% flowering were recorded by daily observation and counting the days from the time of sowing to when about 50% of the plants in each plot flowered and was recorded on per plot basis.

3.10.7 Crop growth rate (g m^{-2} wk^{-1})

This was calculated using the relation CGR = $\frac{W_2 - W_1}{t_2 - t_1}$ as suggested by Radford (1967) where W_2 and W_1 are dry shoot weights taken at two respective time interval t_2 and t_1, respectively.

3.10.8 Relative growth rate (g $g^{-1}$$wk^{-1}$)

This is dry weight increment per unit plant weight per unit time. This is computed using the formula described by Radford (1967)

$$RGR = \frac{\log_e w2 - \log_e w1}{t2 - t1}$$

where w_2 and w_1 refer to total dry weight per plant at time t_2 and t_1, respectively.

3.11. Assessment of Yield Components

3.11.1 Number of pods $plant^{-1}$

Number of pods per plant was determined by counting the total number of filled pods from the five randomly selected plants in each plot, and mean number per plant computed and recorded. This was done at harvest.

3.11.2 Pod weight $plant^{-1}$ (g)

Pod weight per plant was determined by measuring the weight of the total number of pods from the five randomly selected plants in each plot using E2000 electronic mettler balance and the mean weight per plant computed and recorded on per plot basis.

3.11.3 Pod weight plot^{-1} (kg)

Pod weight per plot was determined by measuring the weight of the total number of pods in each net plot using E2000 electronic mettler balance and the value was recorded on per plot basis.

3.11.4 One hundred kernel weight (g)

One hundred kernels were randomly counted from each net plot, weighed and the value was recorded on per plot basis.

3.11.5 Pod yield hectare^{-1} (kg)

The pod yield per net plot was extrapolated to per hectare basis and the value obtained was then recorded.

3.11.6 Shelling percentage

This is the proportion of seed to pod on weight basis expressed as percentage and was calculated using the formula below, the value obtained was recorded.

$$\frac{\text{Weight of seed}}{\text{Weight of pod}} X100$$

3.11.7 Haulm yield hectare^{-1} (kg)

The haulm yield per net plot weighed was extrapolated to per hectare and the value obtained was recorded as haulm yield ha^{-1}.

3.11.8 Harvest index

This is the ratio of the seed yield to the total dry matter at harvest. It was obtained by using the formula HI =

$$\frac{\text{Grain yield from sample}}{\text{Total dry matter of sample}} X100$$

3.12 Statistical Analysis

Data collected were subjected to Analysis of Variance (ANOVA) using general linear model GLM of the Statistical Analysis System package (SAS, 2003) and the means were separated using the Duncan's Multiple Range Test using Critical Difference at 5% probability level (Duncan, 1955). Regression was done to determine the optimum poultry manure rate for pod yield. The strength of relationship between growth and yield parameters was studied using matrix of correlation coefficient (Little and Hills, 1978). The direct, indirect, individual and combined contributions of growth and yield components to total pod yield were determined using path analysis (Dewey and Lu, 1959). The profitability of groundnut production was determined using farm net income. The farm net income is the difference between the total revenue and the total cost expressed as: FNI= TR-TC. Where FNI= Farm net income, TR= Total revenue and TC= Total cost. The revenue from groundnut was obtained as a product of farm gate price of one kg of the crop and the yield measured in kg ha^{-1}. Farm gate price of ₦100 kg^{-1} was used in computing the revenue for pod yield at Samaru and ₦125 kg^{-1} at Kadawa. ₦50 kg^{-1} was used as farm gate price for haulm yield at Samaru and ₦60 kg^{-1} at Kadawa. The total revenue is the summation of the revenue from the pod and that of the haulm. Total variable cost is the summation of all the cost incurred for each treatment. Total cost is total variable cost and total fixed cost.

CHAPTER FOUR

4.0. RESULTS

4.1 Weed Composition

The major weeds in the study area were identified and classified as grasses, broad leaves and sedges. According to the survey 58.81% of the weeds on the field used for the trial at 3 WAS in 2012 wet season were grasses, 22.82% were broad leaves, while 18.36% were sedges (Table 1). Similarly at 3WAS in 2013 wet season, 56.97% were grasses, 22.18% were broad leaves while 20.85% were sedges as shown in Table 2. In 2012 wet season at Samaru *Panicum maximum*, *Cynodon dactylon* and *Rottboellia cochinchinenses* were the major species that had the highest relative frequencies, while in 2013 wet season, *Rottboellia cochinchinenses, Echinochloa obtusiflora, Dactyloctenium aegyptium, Setaria megaphylla, Eleusine indica* and *Digitaria horizontalis* were the major grasses that infested the field. Other grass family members moderately infested the field. In 2012, *Paspalum scrobiculatum* had low infestation and also in 2013 *Panicum maximum* and *Cynodon dactylon* had low infestation. Similarly *Ipomoea triloba* and *Ageratum conyzoides* had high infestation in both years while the other broad leaves had moderate infestation. *Acanthospermum hispidum and Leucas martinicensis* (Jacq) were the sedges that had the lowest and highest infestation in 2012 and 2013 wet seasons, respectively. Other sedges showed moderate infestation in both years of the study.

A similar survey carried out during the dry seasons indicated that in 2012 dry season, 47.97% of the weeds were grasses, 32.38% were broadleaves and 19.65% of the weeds were sedges (Table 3). The relative weed frequencies in 2013 dry season was 44.8% for grasses, 32.23% for broad leaves and 22.97 % for sedges as shown in Table 3. *Digitaria horizontalis* and *Hackelochloa granularis* had the highest infestation in 2012 dry season. The other grasses were moderately present except *Dactyloctenium aegyptium*, which had low relative frequency. The only species in 2013 that had high infestation was *Hackelochloa granularis. Eleusine indica*, *Panicum maximum*, *Dactyloctenium aegyptium and Eragrostis tenella* had low infestations. The highly infested broad leaves weeds were *Ipomoea triloba* and *Vernonia galamensis* in 2012, while *Amaranthus spinosus* and *Cleome rutidosperma* D.C. highly infested the plot in 2013. Other identified broadleaves in both years at Kadawa moderately infested the experimental sites. *Kyllinga squamulata* was the only sedge in 2012 that highly infested the experimental sites. Other sedges in both years were moderately present.

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Table 1: Weed composition and relative frequency of occurrence at 3WAS at Samaru during the 2012 wet season.

Weed composition	Relative frequency (%)
Grasses	
Digitaria horizontalis willd	4.96
Eleusine indica Gaertn.	5.03
Panicum maximum Jacq.	8.93
Rottboellia cochinchinenses (Lour.) Clayton	6.58
Paspalum scrobiculatum Linn.	0.65
Dactyloctenium aegyptium (Linn.) P. Beauv.	5.44
Setaria megaphylla (Steud.) Dur and Schinz	5.20
Cynodon dactylon (Linn.) Pers.	7.31
Axonopus compressus (Sw.) P. Beauv.	4.71
Echinochloa obtusiflora Stapf.	5.69
Acroceras zizanioides Dandy	4.31
Total Grasses	**58.81**
Broad leaves	
Commelina benghalensis L.	4.63
Amaranthus spinosus Linn.	4.14
Ipomoea triloba Linn.	7.96
Ageratum conyzoides Linn.	6.09
Total Broad leaves	**22.82**
Sedges	
Cyperus esculentus Linn.	4.96
Cyperus difformis Linn.	6.09
Acanthospermum hispidum DC.	1.14
Leucas martinicensis (Jacq.)	2.60
Hydrolea palustris (Aubl.)	3.57
Total Sedges	**18.36**

Table 2: Weed composition and relative frequency of occurrence at 3WAS at Samaru during the 2013 wet season.

Weed composition	Relative frequency (%)
Grasses	
Digitaria horizontalis willd	6.24
Eleusine indica Gaertn.	6.29
Panicum maximum Jacq.	1.13
Rottboellia cochinchinenses (Lour.) Clayton	8.28
Paspalum scrobiculatum Linn.	2.99
Dactyloctenium aegyptium (Linn.) P. Beauv.	6.68
Setaria megaphylla (Steud.) Dur and Schinz	6.50
Cynodon dactylon (Linn.) Pers.	0.48
Axonopus compressus (Sw.) P. Beauv.	5.91
Echinochloa obtusiflora Stapf.	7.12
Acroceras zizanioides Dandy	5.35
Total Grasses	**56.97**
Broad leaves	
Commelina benghalensis L.	4.16
Amaranthus spinosus Linn.	4.59
Ipomoea triloba Linn.	7.85
Ageratum conyzoides Linn.	5.58
Total Broad leaves	**22.18**
Sedges	
Cyperus esculentus Linn.	0.45
Cyperus difformis Linn.	3.35
Acanthospermum hispidum DC.	7.69
Leucas martinicensis (Jacq.)	5.36
Cyperus iria Linn.	4.00
Total Sedges	**20.85**

Table 3: Weed composition and relative frequency of occurrence (%) at 3WAS at Kadawa during the 2012 and 2013 dry seasons.

Weed composition	2012	2013
Grasses		
Digitaria horizontalis willd	7.10	5.55
Eleusine indica Gaertn.	5.99	3.03
Panicum maximum Jacq.	3.91	2.28
*Hackelochloa granularis (*Linn.) O.Ktze.	7.88	9.06
Dactyloctenium aegyptium (Linn.) P. Beauv.	2.01	2.96
Cynodon dactylon (Linn.) Pers.	5.22	6.89
Axonopus compressus (Sw.) P. Beauv.	6.20	7.12
Eragrostis tenella (Linn.)	4.03	1.42
Chloris pilosa Schumach.	5.63	0
Brachiaria lata Schumach.	0.00	6.49
Total Grasses	**47.97**	**44.80**
Broad leaves		
Physalis angulata Linn.	5.08	5.84
Amaranthus spinosus Linn.	6.79	7.80
Ipomoea triloba Linn.	7.89	4.73
Cleome rutidosperma DC.	4.55	8.22
Vernonia galamensis (Cass.) Leas.	8.07	5.64
Total Broad leaves	**32.38**	**32.23**
Sedges		
Cyperus rotundus Linn.	5.89	6.32
Cyperus difformis Linn.	4.72	5.01
Kyllinga squamulata Thonn. ex Vahl	7.86	0.00
Laportea aestuans Linn.	1.18	7.52
Sclerocarpus africanus Jacq.ex Murr.	0	4.12
Total Sedges	**19.65**	**22.97**

4.2 Crop Vigour Score

4.2.1 Crop vigour score (6 WAS)

The effect of poultry manure and weed control methods on crop vigour score of three groundnut varieties at 6 WAS is presented in Table 4. Application of 3.0 tonnes $ha^{-1}$of poultry manure resulted in significantly highest crop vigour score, which was followed by application of 1.5 tonnes $ha^{-1}$and the control gave the least in that order. The effect of weed control methods on crop vigour at 6 WAS was significant during the wet seasons and also in 2012 dry season. In 2012 wet season, two hoe weeding resulted in significantly highest crop vigour score while, the applications of all the herbicide rates and the weedy check gave significantly the lowest crop vigour score. In 2013 wet season, application of 0.054 kg a.i. ha^{-1} of Haloxyfop-R-methyl had crop vigour score that were similar to all the other weed control methods. During the 2012 dry season, the result showed that application of 0.054 kg a.i. ha^{-1} of Haloxyfop-R-methyl and the weedy check were comparable to all the other weed control methods. The varieties evaluated did not exhibit significant differences among themselves with respect to crop vigour score and there were no significant interactions among the factors.

4.2.2 Crop vigour score (9 WAS)

The effect of poultry manure and weed control methods on crop vigour score of three groundnut varieties at 9 WAS is presented in Table 5. The effect of poultry manure on weed cover score was significant in 2012 and 2013 wet and dry seasons, respectively and showed that application of 3.0 tonnes $ha^{-1}$of poultry manure resulted in significantly the highest crop vigour score over the application of 1.5 tonnes ha^{-1} and the control that gave similar crop vigour score. The effect of weed control methods at 9 WAS on crop vigour score was significant. In 2012 wet season the applications of all the herbicide rates resulted in similar crop vigour score which were significantly higher than the weedy check. Two hoe weeding had the significantly highest crop

Table 4: Effect of poultry manure and weed control methods on crop vigour score of three groundnut varieties at 6 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	5.44c	4.74c	5.09c	5.85c	5.70c	5.77c
1.5	5.84b	5.14b	5.49b	6.22b	6.06b	6.14b
3.0	6.76a	6.06a	6.41a	6.59a	6.27a	6.43a
S.E. ±	0.097	0.062	0.080	0.101	0.062	0.082
Weed control methods (W)						
Weedy check	5.26b	5.56a	5.41	5.76ab	5.06	5.41
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	5.27b	4.57ab	4.92	5.77ab	5.07	5.42
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	5.02b	4.32b	4.67	5.52b	4.82	5.17
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	4.93b	4.23b	4.58	5.43b	4.73	5.08
Two hoe weeding at 3 and 6 WAS	6.93a	6.23a	6.58	7.43a	6.73	7.08
S.E.±	0.124	0.576	0.700	0.624	0.760	0.700
Varieties (V)						
SAMNUT 11	6.08	5.38	5.73	6.58	5.88	6.23
SAMNUT 22	6.04	5.34	5.69	6.50	5.84	6.19
SAMNUT 23	6.02	5.32	5.67	6.50	5.82	6.17
S.E±	0.073	0.060	0.076	0.074	0.042	0.043
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

Table 5: Effect of poultry manure and weed control methods on crop vigour score of three groundnut varieties at 9 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	6.31b	5.61	5.96	5.14	5.26b	5.20
1.5	6.49b	5.79	6.14	5.41	5.44b	5.43
3.0	7.13a	6.43	6.78	5.78	6.08a	5.93
S.E. ±	0.108	0.645	0.377	0.645	0.209	0.427
Weed control methods (W)						
Weedy check	5.03c	5.33	5.18b	6.53	5.76b	6.14
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	6.30b	5.97	6.14a	6.47	6.77a	6.62
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	6.67b	5.60	6.14a	6.80	6.83a	6.82
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	6.96ab	6.26	6.61a	6.46	6.80a	6.63
Two hoe weeding at 3 and 6 WAS	7.26a	6.56	6.91a	7.76	7.06a	7.41
S.E.±	0.139	0.703	0.421	0.701	0.267	0.484
Varieties (V)						
SAMNUT 11	6.85a	6.92a	6.88a	7.21a	6.51a	6.86a
SAMNUT 22	6.61b	6.01b	6.31b	7.12b	6.42b	6.77b
SAMNUT 23	6.60b	5.90b	6.25b	7.10b	6.40b	6.75b
S.E±	0.083	0.067	0.075	0.013	0.026	0.030
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

vigour , though was comparable to the application of 0.054 kg a.i. ha^{-1} of Haloxyfop-R-methyl of while the weedy check gave the significantly lowest crop vigour. Also in the wet seasons combined and in 2013 dry season, applications of all the herbicide rates and two hoe weeding resulted in similar crop vigour score, which were significantly higher than the weedy check. The varieties used exhibited significant differences among themselves with respect to crop vigour score. The results which were consistent indicated that SAMNUT 11 had significantly the highest crop vigour score than SAMNUT 22 and SAMNUT 23 and there was no significant difference between SAMNUT 22 and SAMNUT 23. There were no significant interactions among the factors throughout the period of experimentation.

4.2.3 Crop vigour score (12WAS)

The effect of poultry manure and weed control methods on crop vigour score of three groundnut varieties at 12 WAS is presented in Table 6. Application of 3.0 tonnes $ha^{-1}$of poultry manure resulted in significantly highest crop vigour score, which was followed by application of 1.5 tonnes ha^{-1} and the control gave the least in that order. The effect of weed control methods on crop vigour score at 12 WAS during the wet seasons indicated that two hoe weeding resulted in significantly highest crop vigour score while the weedy check gave significantly the lowest crop vigour score. The applications of all the rates of the herbicide resulted in similar crop vigour score which were significantly higher than the weedy check. During the dry seasons, applications of all herbicide rates and the weedy check were similar in terms of crop vigour score and were significantly lower than the crop vigour score recorded for two hoe weeding. The varieties evaluated showed that SAMNUT 11 had the significantly highest weed cover score, which was followed by SAMNUT 22 while SAMNUT 23 gave the least value for weed cover score in 2012 wet season and the combined.

Table 6: Effect of poultry manure and weed control methods on crop vigour score of three groundnut varieties at 12 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	6.44c	5.74c	6.09c	5.81c	5.39c	5.60c
1.5	6.84b	6.14b	6.49b	6.85b	5.79b	6.32b
3.0	7.76a	7.06a	7.41a	7.25a	6.71a	6.98a
S.E. ±	0.074	0.064	0.070	0.099	0.067	0.083
Weed control methods (W)						
Weedy check	. 5.06c	5.36c	5.21c	7.56b	6.86b	7.21b
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	7.07b	6.37b	6.72b	7.57b	6.87b	7.22b
0.108kg a.i. ha^{-1} Haloxyfop – R –methyl ester	7.04b	6.38b	6.71b	7.58b	6.88b	7.23b
0.162kg a.i. ha^{-1} Haloxyfop – R –methyl ester	7.08b	6.34b	6.71b	7.54b	6.84b	7.19b
Two hoe weeding at 3 and 6WAS	7.93a	7.23a	7.58a	8.43a	7.73a	8.08a
S.E.±	0.096	0.067	0.082	0.220	0.073	0.147
Varieties (V)						
SAMNUT 11	6.98a	6.82a	6.90a	7.58	6.78	7.18
SAMNUT 22	6.44b	6.34b	6.39b	7.54	6.84	7.19
SAMNUT 23	6.02c	6.32b	6.17c	7.52	6.82	7.17
S.E±	0.027	0.037	0.032	0.053	0.057	0.055
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P Xv	NS	NS	NS	NS	NS	NS
W Xv	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

but in 2013 wet season the weed cover score for both SAMNUT 22 and SAMNUT 23 were similar and significantly lower to that of SAMNUT11. There were no significant interactions among the factors at this sampling stage.

4.3. Crop Injury Score

4.3.1 Crop injury score (6 WAS).

The effect of poultry manure and weed control methods on crop injury score of three groundnut varieties at 6 WAS is presented in Table 7. Application of 3.0 tonnes ha^{-1} of poultry manure resulted in significantly lowest crop injury score which was followed by the application of 1.5 tonnes $ha^{-1}$and the control resulted in significantly highest crop injury score.

The effect of weed control methods on crop injury was significant at 6 WAS. Two hoe weeding resulted in significantly lowest crop injury score over all the other weed control methods in 2012 wet season and the combined. Also in 2012 wet season application of 0.054 kg a.i. ha^{-1} and the weedy check resulted in similar crop injury score, which were significantly; lower when compared to the application of 0.108 kg a.i. ha^{-1} and 0.162 kg a.i. ha^{-1} of the herbicide. In 2013 wet season applications of all the herbicide rates were similar in term of crop injury but higher than both the weedy check and two hoe weeding. The results from 2012 dry season and the combined showed that two hoe weeding resulted in significantly lowest crop injury score over the other weed control methods. In 2013 dry season, the weedy check, application of 0.054 kg a.i. ha^{-1} and 0.108 kg a.i. ha^{-1} of the herbicide were comparable to both application of 0.162 kg a.i. ha^{-1} of the herbicide and two hoe weeding. The varieties evaluated did not exhibit any significant differences among themselves with respect to the crop injury score. There were no significant interactions among the factors throughout the period of experimentation in both years and locations.

Table 7: Effect of poultry manure and weed control methods on crop injury score of three groundnut varieties at 6 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

Treatments	Wet Season (Samaru)			Dry season (Kadawa)		
	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	3.56a	4.26a	3.91a	3.15a	3.30a	3.23a
1.5	3.16b	3.86b	3.51b	2.78b	2.94b	2.86b
3.0	2.24c	2.94c	2.59c	2.41c	2.73c	2.57c
S.E. ±	0.060	0.037	0.016	0.063	0.039	0.016
Weed control methods (W)						
Weedy check	3.74b	3.44b	3.59b	3.24a	3.94ab	3.59a
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	3.73b	4.43a	4.08a	3.23a	3.93ab	3.58a
0.108kg a.i. ha^{-1} Haloxyfop – R –methyl ester	3.98a	4.68a	4.33a	3.48a	4.18ab	3.83a
0.162kg a.i. ha^{-1} Haloxyfop – R –methyl ester	4.07a	4.77a	4.42a	3.57a	4.27a	3.92a
Two hoe weeding at 3 and 6WAS	2.07c	2.77b	2.42c	1.57b	2.27b	1.92b
S.E.±	0.077	0.359	0.141	0.389	0.671	0.453
Varieties (V)						
SAMNUT 11	2.92	3.62	3.27	2.42	3.12	2.77
SAMNUT 22	2.96	3.66	3.31	2.46	3.16	2.81
SAMNUT 23	2.98	3.68	3.33	2.48	3.18	2.83
S.E±	0.046	0.390	0.172	0.358	0.702	0.484
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P Xv	NS	NS	NS	NS	NS	NS
W Xv	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant.

4.3.2 Crop injury score (9 WAS)

The effect of poultry manure and weed control methods on crop injury score of three groundnut varieties at 9 WAS is presented in Table 8. Application of 3.0 tonnes ha^{-1} of poultry manure resulted in significantly lowest crop injury score compared to the application of 1.5 tonnes ha^{-1} of poultry manure and the control that had similar crop injury score except in 2013 dry season where there was no significant difference among the poultry manure rates. Also In the dry seasons combined the application of 1.5 tonnes ha^{-1} of poultry manure was similar to both the control and the application of 3.0 tonnes ha^{-1} of the poultry manure.

The effect of weed control methods on crop injury score was significant but inconsistent. In 2012 wet season, the application 0.108 kg a.i. ha^{-1} of Haloxyfop-R-methyl ester was comparable to all the other herbicide rates and two hoe weeding, while the weedy check had the significantly lowest crop injury score. In the wet seasons combined applications of 0.054 kg a.i. ha^{-1} and 0.108 kg a.i. ha^{-1} of the herbicide were similar to all the other weed control methods. Similarly, in 2013 dry season all the herbicide rates were similar to two hoe weeding and the weedy check.

The varieties evaluated also exhibited significant difference among themselves with respect to crop injury score at 9 WAS only in 2013 wet season and the combined. During these periods SAMNUT 11 had the significantly lowest crop injury score compared to SAMNUT 22 and SAMNUT 23 that has similar crop injury score. There were no significant interactions among the factors at this sampling period.

Table 8: Effect of poultry manure and weed control methods on crop injury score of three groundnut varieties at 9 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

Treatments	Wet Season (Samaru)			Dry season (Kadawa)		
	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	2.69a	3.39a	3.04a	3.86a	3.74	3.80a
1.5	2.51a	3.21a	2.90a	3.59a	3.56	3.57ab
3.0	1.87b	2.57b	2.22b	3.22b	2.92	3.07b
S.E. ±	0.119	0.174	0.147	0.125	0.377	0.251
Weed control methods (W)						
Weedy check	3.97a	3.67	3.82a	1.47	3.24a	2.35
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	2.70b	3.03	2.86ab	1.53	2.23ab	1.88
0.108kg a.i. ha^{-1} Haloxyfop – R –methyl ester	2.33bc	3.40	2.86ab	2.2	2.17ab	2.18
0.162kg a.i. ha^{-1} Haloxyfop – R –methyl ester	2.04c	2.74	2.39b	2.54	2.90ab	2.72
Two hoe weeding at 3 and 6WAS	1.74c	2.44	2.09b	1.24	1.94b	1.59
S.E.±	0.154	0.774	0.464	0.771	0.390	0.581
Varieties (V)						
SAMNUT 11	2.15	2.08b	2.12b	1.88	2.58	2.23
SAMNUT 22	2.39	2.99a	2.69a	1.79	2.49	2.14
SAMNUT 23	2.40	3.10a	2.75a	1.90	2.60	2.25
S.E±	0.092	0.074	0.083	0.010	0.077	0.044
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P Xv	NS	NS	NS	NS	NS	NS
W Xv	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.3.3 Crop injury score (12 WAS)

The effect of poultry manure and weed control methods on crop injury score of three groundnut varieties at 12 WAS is presented in Table 9. Application of 3.0 tonnes ha^{-1} of poultry manure resulted in significantly lowest crop injury score, which was followed by the application of 1.5 tonnes ha^{-1} while the control resulted in significantly the highest crop injury score.

The effect of weed control methods at 12 WAS was significant on crop injury score. In the wet seasons, the weedy check gave significantly highest crop injury score while two hoe weeding resulted in significantly lowest crop injury score, all the herbicide rates applied resulted in similar crop injury score. In the dry seasons, application of all the rates of the herbicide and the weedy check resulted in similar crop injury score, which were significantly higher than the crop injury recorded when two hoe weeding, was carried out.

The varieties evaluated also showed significant differences with respect to crop injury score only during the wet seasons. In 2012 wet season and the combined SAMNUT 23 had significantly the highest crop injury score, which was followed by SAMNUT 22, while SAMNUT11 had the least crop injury score. In 2013 wet season both SAMNUT 23 and SAMNUT 22 had similar crop injury score that were significantly higher than that of SAMNUT11. There were no significant interactions among the factors for crop injury score at this sampling period.

Table 9: Effect of poultry manure and weed control methods on crop injury score of three groundnut varieties at 12WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Seasons(Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	2.56a	3.26a	2.91a	3.19a	3.61a	3.40a
1.5	2.16b	2.86b	2.51b	2.15b	3.21b	2.68b
3.0	1.24c	1.94c	1.59c	1.75c	2.29c	2.02c
S.E. $\pm$	0.036	0.026	0.031	0.036	0.029	0.033
Weed control methods (W)						
Weedy check	3.94a	3.64a	3.79a	1.44a	2.14a	1.79a
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	1.93b	2.63b	2.28b	1.43a	2.13a	1.78a
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	1.96b	2.62b	2.29b	1.42a	2.12a	1.77a
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	1.92b	2.66b	2.29b	1.46a	2.16a	1.81a
Two hoe weeding at 3 and 6 WAS	1.07c	1.77c	1.42c	0.57b	1.27b	0.92b
S.E.$\pm$	0.094	0.050	0.072	0.049	0.215	0.132
Varieties (V)						
SAMNUT 11	2.02c	2.18b	2.10c	1.42	2.22	1.82
SAMNUT 22	2.56b	2.66a	2.61b	1.46	2.16	1.81
SAMNUT 23	2.98a	2.68a	2.83a	1.48	2.18	1.83
S.E$\pm$	0.010	0.024	0.012	0.021	0.025	0.023
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P Xv	NS	NS	NS	NS	NS	NS
W Xv	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.4 Weed Cover Score

4.4.1 Weed cover score (6 WAS)

The effect of poultry manure and weed control methods on weed cover score of three groundnut varieties at 6 WAS is presented in Table 10. The results which were consistent during the wet seasons showed that both the control and application of 1.5 tonnes ha^{-1} of poultry manure resulted in significantly lowest weed cover score over the application of 3.0 tonnes ha^{-1} that resulted in significantly the highest weed cover score. In 2012 wet season the application of 1.5 tonnes ha^{-1} of poultry manure was similar to both the control and application of 3.0 tonnes ha^{-1} of the manure.

The effect of weed control methods at 6 WAS was significant on weed cover score. In 2012 wet season and the combined, two hoe weeding resulted in significantly lowest weed cover score, which was followed by the application of 0.162kg a.i.ha-^{1}, while the application of 0.108kg a.i.ha^{-1} and 0.054 kg a.i.ha-^{1}of Haloxyfop-R-methyl ester and the weedy check resulted in similar weed covers, which produced significantly the highest weed cover scores. In 2013 wet season, the weedy check had the significantly highest weed cover score while two hoe weeding had the lowest weed cover score and the applications of the different herbicide rates resulted in similar weed cover score, which was significantly lower when compared to weed cover score in the weedy check but higher than in two hoe weeding. During the dry seasons all the herbicide rates applied and weedy check resulted in significantly highest weed cover score over two hoe weeding; which resulted in significantly lowest weed cover score. The varieties evaluated did not exhibit any significant differences among themselves with respect to weed cover score. There were no significant interactions among the factors at this sampling period.

Table 10: Effect of poultry manure and weed control methods on weed cover score of three groundnut varieties at 6WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	4.33a	4.85a	4.59a	4.68a	5.20	4.94
1.5	4.11a	4.63a	4.42a	4.46ab	4.98	4.72
3.0	3.60b	4.12b	3.86b	3.95b	4.47	4.21
S.E. ±	0.124	0.144	0.134	0.223	0.322	0.273
Weed control methods (W)						
Weedy check	4.74a	5.26a	5.00a	5.06a	5.08a	5.07a
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	4.89a	4.41b	4.65a	4.21a	4.23a	4.22a
0.108kg a.i. ha^{-1} Haloxyfop – R –methyl ester	4.78a	4.3b	4.54a	4.1a	4.12a	4.11a
0.162kg a.i. ha^{-1} Haloxyfop – R –methyl ester	3.67b	4.19b	3.93b	3.99a	4.11a	4.05a
Two hoe weeding at 3 and 6WAS	2.00c	2.52c	2.26c	2.32b	2.34b	2.33b
S.E.±	0.160	0.180	0.170	0.480	0.500	0.490
Varieties (V)						
SAMNUT 11	4.09	4.56	4.33	4.36	4.28	4.32
SAMNUT 22	4.07	4.50	4.29	4.30	4.32	4.31
SAMNUT 23	4.05	4.54	4.30	4.34	4.36	4.35
S.E±	0.043	0.033	0.038	0.062	0.053	0.058
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P Xv	NS	NS	NS	NS	NS	NS
W Xv	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.4.2 Weed cover score (9 WAS)

The effect of poultry manure and weed control methods on weed cover score of three groundnut varieties at 9 WAS is presented in Table 11. The effect of poultry manure was only significant during the wet seasons and the results showed that both the control and application of 1.5 tonnes ha^{-1} of poultry manure resulted in significantly highest weed cover score over the application of 3.0 tonnes ha^{-1} that resulted in significantly the lowest weed cover score.

The effect of weed control methods at 9 WAS was significant on weed cover score. The results in the wet seasons indicated that the weedy check had significantly the highest weed cover score, while the application of and 0.108 kg a.i.$ha^{-1}$of Haloxyfop-R-methyl ester was similar to applications of 0.054 kg a.i.ha^{-1} and 0.162 kg a.i.$ha^{-1}$of Haloxyfop-R-methyl ester and two hoe weeding gave the lowest significant value for weed cover score. In the dry seasons, applications of the different rates of the herbicide had similar weed cover score that were significantly lower than the weedy check but higher than two hoe weeding. The varieties evaluated did not exhibit any significant differences among themselves with respect to weed cover score. Similarly, there were no significant interactions among the factors.

4.4.3 Weed cover score (12 WAS)

The effect of poultry manure and weed control methods on weed cover score of three groundnut varieties at 12 WAS is presented in Table 12. In 2013 wet and dry seasons, application of 1.5 tonnes ha^{-1} of poultry manure was similar to both the control and application of 3.0 tonnes ha^{-1} of poultry manure. The control resulted in significantly the highest weed cover score, which was similar to application of 1.5 tonnes ha^{-1} of poultry manure while the application of 3.0 tonnes ha^{-1} of poultry manure resulted in significantly lowest weed cover score in all except in 2012 wet season and the combined where the application of the different rates of the manure did not result in significant difference.

The effect of weed control methods at 12 WAS was significant on weed cover score. In 2012 wet season, both the weedy check and application of 0.054 kg a.i.ha^{-1} of Haloxyfop-R-methyl ester had the highest weed cover score and were significantly higher than the weed cover score obtained when 0.108 kg a.i.ha^{-1} Haloxyfop-R-methyl ester was applied, which was followed by the application of 0.162 kg a.i.ha^{-1} of the herbicide and two hoe weeding in that order. In 2013 wet season and the combined, the weedy check and the different rates of herbicide had similar weed cover score were significantly higher than two hoe weeding that resulted in significantly lowest weed cover score. In 2013 dry season and the combined, the weedy check, applications of 0.054 kg a.i.ha^{-1} and 0.108 kg a.i.ha^{-1} of the herbicide had significantly the highest weed cover score, while application of 0.162 kg a.i.ha^{-1} was similar to weedy check, applications of 0.054 kg a.i.ha^{-1} and 0.108 kg a.i.ha^{-1} of the herbicide and two hoe weeding.

The varieties used exhibited significant differences among themselves with respect to weed cover score at 12 WAS, the results in the wet seasons and in 2013 dry season indicated that SAMNUT 11 had significantly the lowest weed cover score than SAMNUT 22 and SAMNUT 23 which had similar weed cover scores. In 2012 dry season and the combined both SAMNUT 11 and SAMNUT 22 had similar weed cover score, which were significantly higher than the weed cover score recorded in SAMNUT 23. There were no significant interactions among the factors at this sampling period.

Table 11: Effect of poultry manure and weed control methods on weed cover score of three groundnut varieties at 9 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	5.09a	5.61a	5.35a	5.44	5.96	5.70
1.5	4.89a	5.41a	5.15a	5.24	5.76	5.50
3.0	4.20b	4.72b	4.46b	4.55	5.07	4.81
S.E. ±	0.137	0.157	0.147	0.498	0.328	0.413
Weed control methods (W)						
Weedy check	7.30a	7.82a	7.56a	7.62a	7.64a	7.63a
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	5.04b	5.56b	5.30b	5.36b	5.38b	5.37b
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	4.89bc	5.41bc	5.15bc	5.21b	5.23b	5.22b
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	4.37c	4.89c	4.63c	4.69b	4.71b	4.70b
Two hoe weeding at 3 and 6 WAS	2.04d	2.56d	2.30d	2.36c	2.38c	2.37c
S.E.±	0.178	0.198	0.188	0.668	0.518	0.593
Varieties (V)						
SAMNUT 11	4.97	5.49	5.23	5.29	5.31	5.30
SAMNUT 22	4.91	5.43	5.17	5.23	5.25	5.24
SAMNUT 23	5.00	5.52	5.26	5.32	5.34	5.33
S.E±	0.049	0.058	0.054	0.069	0.059	0.064
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P Xv	NS	NS	NS	NS	NS	NS
W Xv	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

Table 12: Effect of poultry manure and weed control methods on weed cover score of three groundnut varieties at 12 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	7.62	8.14a	7.88	7.97a	8.49a	8.23a
1.5	7.59	7.81ab	7.70	7.64a	8.16ab	7.90a
3.0	7.53	6.05c	6.79	5.88b	6.40b	6.14b
S.E. $\pm$	0.163	0.683	0.423	0.420	0.620	0.520
Weed control methods (W)						
Weedy check	8.11a	8.63a	8.37a	8.43a	8.45a	8.44a
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	7.93a	8.45a	8.19a	8.25a	8.27a	8.26a
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	7.48b	8.30a	7.84a	7.80a	8.82a	8.31a
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	6.89c	7.41a	7.15a	7.21a	7.23ab	7.22ab
Two hoe weeding at 3 and 6 WAS	5.33d	5.85b	5.59b	5.65b	5.67b	5.66b
S.E.$\pm$	0.210	0.730	0.470	0.530	0.753	0.642
Varieties (V)						
SAMNUT 11	6.00b	6.52b	6.26b	7.23b	7.14b	7.19b
SAMNUT 22	6.98a	7.50a	7.24a	7.29b	7.32a	7.31b
SAMNUT 23	7.02a	7.54a	7.28a	7.94a	7.36a	7.65a
S.E$\pm$	0.073	0.093	0.083	0.093	0.041	0.067
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P Xv	NS	NS	NS	NS	NS	NS
W Xv	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.5 Weed Dry Weight (g)

4.5.1 Weed dry weight (6 WAS)

The effect of poultry manure and weed control methods on weed dry weight of three groundnut varieties at 6 WAS is presented in Table 13. The control gave significantly the highest weed dry weight, which was followed by the application of 1.5 tonnes ha^{-1} while the application of 3.0 tonnes ha^{-1} of poultry manure resulted in significantly least weed dry weight.

The effect of weed control methods at 6 WAS was significant on weed dry weight. The results which were consistent throughout the trials except in 2012 wet season indicated that two hoe weeding resulted in significantly lowest weed dry, which was followed by the application of 0.162kg a.i.ha^{-1}, while the application of 0.108kg a.i.ha^{-1} and 0.054 kg a.i.ha-^{1}of Haloxyfop-R-methyl ester resulted in similar weed dry weight, which were significantly lower than that of the weedy check that had the highest weed dry. In 2012 wet season, application of 0.054 kg a.i.ha^{-1} was comparable to the applications of 0.108kg a.i.ha^{-1} and 0.162kg a.i.ha^{-1}.

The varieties evaluated also exhibited significant differences among themselves. In the wet seasons, SAMNUT 23 had significantly the highest weed dry weight, which was followed by SAMNUT 22 and SAMNUT 11 in that order. In 2013 dry season SAMNUT 11 had significantly the highest weed dry weight $plant^{-1}$, which was followed by SAMNUT 22 and SAMNUT 23 in that order. In the dry season combined SAMNUT 22 had similar weed dry weight with both SAMNUT 22 and SAMNUT 23. There were no significant interactions among the factors.

Table 13: Effect of poultry manure and weed control methods on weed dry weight (g) of three groundnut varieties at 6 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	4.29a	5.00a	4.65a	4.37a	5.54 a	5.02a
1.5	4.00b	4.67b	4.33b	4.08b	5.16 b	4.68b
3.0	3.51c	4.09c	3.80c	3.93c	4.53c	4.10 c
S.E. ±	0.055	0.054	0.054	0.068	0.067	0.067
Weed control methods (W)						
Weedy check	6.64a	7.75a	7.20a	6.96a	7.57a	7.27a
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	3.69bc	4.31b	4.06b	4.13b	4.13b	4.13b
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	3.57c	4.17b	3.98b	4.01b	4.27b	4.14b
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	3.81b	3.45c	3.26c	3.59c	3.29c	3.44c
Two hoe weeding at 3 and 6 WAS	1.94d	2.27d	2.11d	2.26d	2.09d	2.18d
S.E.±	0.076	0.092	0.084	0.094	0.114	0.104
Varieties (V)						
SAMNUT 11	3.75c	4.37c	4.06c	4.27	4.67a	4.47a
SAMNUT 22	3.89b	4.54b	4.21b	4.31	4.35b	4.33ab
SAMNUT 23	4.16a	4.86a	4.51a	4.38	4.19c	4.28b
S.E±	0.035	0.044	0.039	0.043	0.054	0.049
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P Xv	NS	NS	NS	NS	NS	NS
W Xv	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.5.2 Weed dry weight (9 WAS)

The effect of poultry manure and weed control methods on weed dry weight of three groundnut varieties at 9 WAS is presented in Table 14. Application of 3.0 tonnes ha^{-1} of poultry manure resulted in significantly lowest weed dry weight, which was followed by the application of 1.5 tonnes ha^{-1} while the control resulted in significantly the highest weed dry weight throughout the wet seasons. However, during the dry season and the combined application of and 3.0 tonnes ha^{-1} of poultry manure resulted in significantly lowest weed dry weight when compared to both the control and application of 1.5 tonnes ha^{-1} of the manure, except in 2012 dry season where there was no significant difference in weed dry weight among the manure rates.

The effect of weed control methods at 9 WAS was significant on weed dry weight. Weedy check resulted in significantly highest weed dry weight, which was followed by the application of 0.054 kg a.i.ha^{-1}, 0.108kg a.i.ha^{-1} and 0.162kg a.i.$ha^{-1}$of Haloxyfop-R-methyl ester, respectively; while two hoe weeding resulted in the least weed dry weight .In 2013 wet season applications of all the herbicide rates gave similar results while in 2012 dry season, application of 0.162kg a.i.$ha^{-1}$of Haloxyfop-R-methyl ester was similar to application of 0.108kg a.i.ha^{-1} of the herbicide and two hoe weeding. The varieties evaluated exhibited significant differences among themselves with respect to weed dry weight. In 2013 wet season and combined SANMUT 23 had significantly highest weed dry weight than SAMNUT 22 and SAMNUT 11 that had similar weed dry weight. In 2013 dry season SANMUT 11 had significantly lowest weed dry weight than SAMNUT 22 and SAMNUT 23 that had similar weed dry weight. Also in the dry seasons combined weed dry weight in SAMNUT 22 was similar to that in SAMNUT 11 and SAMNUT 23. There were no significant interactions among the factors.

Table 14: Effect of poultry manure and weed control methods on weed dry weight (g) of three groundnut varieties at 9 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	26.99a	31.50a	29.24a	27.49	34.86a	31.60a
1.5	25.17b	29.37b	27.26b	25.70	32.50a	29.60a
3.0	22.07c	25.76c	23.91c	24.75	28.50b	25.83b
S.E. ±	0.552	0.692	0.623	1.592	0.977	1.285
Weed control methods (W)						
Weedy check	48.78a	41.80a	45.29a	42.12a	60.97a	51.54a
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	37.10b	25.97b	31.53b	34.29b	43.87b	39.08b
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	29.22c	23.22bc	26.22c	23.54c	30.77c	27.15c
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	25.97d	20.47c	23.22d	18.79cd	24.06d	21.46d
Two hoe weeding at 3 and 6 WAS	14.30e	12.25d	13.28e	12.57d	17.87e	15.22e
S.E.±	0.827	1.040	0.934	2.388	1.466	1.927
Varieties (V)						
SAMNUT 11	24.57	27.51b	25.54b	23.89	34.68b	29.28b
SAMNUT 22	24.47	28.56b	26.51b	26.79	37.87a	32.33ab
SAMNUT 23	25.18	30.55a	28.37a	27.50	38.14a	32.82a
S.E±	0.480	0.603	0.542	1.385	0.850	1.118
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P Xv	NS	NS	NS	NS	NS	NS
W Xv	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.5.3 Weed dry weight (12 WAS)

The effect of poultry manure and weed control methods on weed dry weight of three groundnut varieties at 12 WAS is presented in Table 15. Application of 3.0 tonnes ha^{-1} of poultry manure resulted in significantly lowest weed dry weight, which was followed by the application of 1.5 tonnes ha^{-1} of poultry while the control resulted in significantly the highest weed dry weight except in 2012 dry season where the application of 1.5 tonnes ha^{-1} of poultry manure was similar to both the control and application of 3.0 tonnes ha^{-1} of the manure.

The effect of weed control methods at 12 WAS was significant on weed dry weight. In the wet seasons, the results indicated that the weedy check resulted in significantly highest weed dry weight, which was followed by the application of 0.054 kg a.i.ha^{-1}, 0.108kg a.i.ha^{-1} and 0.162kg a.i.ha^{-1} of Haloxyfop-R-methyl ester, respectively while two hoe weeding resulted in the least weed dry weight. However, in the dry seasons, applications of all the herbicide rates had similar values for weed dry weight. The varieties evaluated did not show any significant differences with respect to weed dry weight. Similarly, there were no significant interactions among the factors.

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Table 15: Effect of poultry manure and weed control methods on weed dry weight (g) of three groundnut varieties at 12 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	23.18a	27.05a	38.89a	26.61a	29.94a	28.28a
1.5	21.62b	25.23b	25.12b	23.61ab	27.92b	25.31b
3.0	18.96c	22.12c	23.42c	22.07b	24.48c	22.19c
S.E. ±	0.358	0.450	0.404	1.034	0.634	0.834
Weed control methods (W)						
Weedy check	41.89a	35.90a	38.89a	36.22a	41.71a	38.97a
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	33.27b	27.30b	30.28b	20.90b	23.84b	22.37b
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	27.52c	21.30c	24.41c	20.26b	23.09b	21.68b
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	20.00d	14.30d	17.15d	19.62b	22.34b	20.98b
Two hoe weeding at 3 and 6 WAS	12.30e	10.30e	11.30e	10.86c	12.12c	11.49c
S.E.±	0.537	0.676	0.607	1.551	0.952	1.252
Varieties (V)						
SAMNUT 11	21.45	23.51	22.48	21.77	24.45	23.11
SAMNUT 22	21.42	23.53	22.48	21.74	24.48	23.11
SAMNUT 23	21.49	23.54	22.52	21.81	24.51	23.16
S.E±	0.312	0.391	0.352	0.899	0.552	0.726
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P Xv	NS	NS	NS	NS	NS	NS
W Xv	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant.

4.6 Weed Control Efficiency (%)

The effect of poultry manure and weed control methods on weed control efficiency of three groundnut varieties is presented in Table 16. Application of 3.0 tonnes ha^{-1} of poultry manure resulted in significantly highest weed control efficiency while the application of 1.5 tonnes ha^{-1} resulted in significantly lowest weed control efficiency. The effect of weed control methods on weed control efficiency indicated that two hoe weeding resulted in significantly highest weed control efficiency which was followed by the application of 0.162kg a.i. ha^{-1}, 0.108kg a.i. $ha^{-1}$and 0.054 kg a.i. ha^{-1} of Haloxyfop-R-methyl ester, respectively. The varieties evaluated exhibited significant differences among themselves with respect to weed control efficiency. In 2012 wet season SAMNUT 11 and SAMNUT 22 had similar weed control efficiency which was higher than that of SAMNUT 23. Also in 2013 dry season SAMNUT 22 and SAMNUT 23 had similar weed control efficiency, which was lower than that of SAMNUT 11. In the other years, in both locations SAMNUT 11 had significantly the highest weed control efficiency which was followed by SAMNUT 22 and then SAMNUT 23 in that order.

The significant interaction of weed control methods and poultry manure indicated that the weed control efficiency increased with increase in poultry manure rates except in two hoe weeding where further increase in poultry manure rates did not result in significant increase in weed control efficiency. Two hoe weeding resulted in significant increase in weed control efficiency over the use of the herbicide as shown in Table 17.

Table 16: Effect of poultry manure and weed control methods on weed control efficiency (%) of three groundnut varieties at harvest at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Seasons (Samaru)			Dry seasons (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	0.00c	0.00c	0.00c	0.00b	0.00c	0.00c
1.5	6.74b	6.76b	6.75b	6.51b	6.76b	6.32b
3.0	18.22a	18.22a	18.22a	9.96a	18.24a	18.25a
S.E. ±	0.551	0.693	0.622	0.592	0.977	0.785
Weed control methods (W)						
Weedy check	0.00e	0.00e	0.00e	0.00e	0.00e	0.00e
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	23.94d	37.87d	30.91d	18.58d	28.05d	24.17d
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	40.09c	44.44c	42.10c	46.48c	49.86c	47.32c
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	46.76b	51.02b	48.73b	55.38b	60.54b	58.36b
Two hoe weeding at 3 and 6 WAS	70.68a	70.69a	70.68a	70.15a	70.69a	70.47a
S.E.±	0.827	1.043	0.934	2.388	1.466	1.927
Varieties (V)						
SAMNUT 11	2.42a	9.95a	9.97a	13.12a	9.07a	10.79a
SAMNUT 22	2.82a	6.51b	6.55b	2.58b	0.71b	1.49b
SAMNUT 23	0.00b	0.00c	0.00c	0.00c	0.00b	0.00c
S.E±	0.395	0.596	0.496	0.320	0.348	0.334
Interactions						
P x W	*	NS	NS	NS	NS	NS
P Xv	NS	NS	NS	NS	NS	NS
W Xv	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. * Significant interaction at 5% level of probability. NS – Not Significant

Table 17: Interaction of poultry manure and weed control methods on weed control efficiency (%) of groundnut at Samaru during the 2012 wet season.

Weed control methods	**Poultry manure (tonnes ha^{-1})**		
	0	1.5	3.0
Weedy check	0.00h	0.00h	0.00h
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	27.87g	30.91f	44.58de
0.108kg a.i. ha^{-1} Haloxyfop – R –methyl ester	32.44f	42.10e	46.48cd
0.162kg a.i. ha^{-1} Haloxyfop – R –methyl ester	34.02f	48.73c	55.38b
Two hoe weeding at 3 and 6 WAS	57.69b	67.34a	70.15a
S.E. ±		1.346	

Means followed by the same letter are statistically the same using DMRT at 5% level of significance.

4.7 Plant Height (cm)

4.7.1 Plant height (6 WAS)

The effect of poultry manure and weed control methods on plant height of three groundnut varieties at 6 WAS is presented in Table 18. Application of 3.0 tonnes ha^{-1} of poultry manure produced significantly the tallest plants, which was followed by the application of 1.5 tonnes ha^{-1} while the control gave shortest plants. The effect of weed control methods on plant height was significant at 6 WAS. Two hoe weeding resulted in significantly tallest plants, while the weedy check produced the shortest plants. During the wet seasons, application of 0.054 kg a.i. ha^{-1} of Haloxyfop-R-methyl ester was similar to the applications of 0.108kg a.i. ha^{-1} and 0.162kg a.i.ha^{-1} of the herbicide. But in the dry seasons, applications of 0.054 kg a.i. ha^{-1} and 0.108kg a.i. ha^{-1} gave plants with similar height which were significantly shorter when compared with plants that received application of 0.162kg a.i.ha^{-1} of the herbicide except in the combined where all the herbicide rates were similar. The varieties evaluated also showed significant differences with respect to plant height during the wet season. The results which were consistent indicated that SAMNUT 22 was significantly taller than SAMNUT 23 and SAMNUT 11 which were at par. There were significant interactions among the factors throughout the period of experimentation in both locations.

4.7.2 Plant height (9 WAS)

The effect of poultry manure and weed control methods on plant height of three groundnut varieties at 9 WAS is presented in Table 19. Application of 3.0 tonnes ha^{-1} of poultry manure produced significantly tallest plants which were followed by the application of 1.5 tonnes ha^{-1} while the control resulted in shortest plants. The effect of weed control methods was significant at 9 WAS in both years of experimentation at the different locations.

Table 18: Effect of poultry manure and weed control methods on plant height (cm) of three groundnut varieties at 6 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	11.20c	10.68c	10.94c	6.76c	5.23c	6.00c
1.5	14.25b	17.23b	15.74b	9.96b	7.20b	8.58b
3.0	20.23a	20.23a	20.23a	16.24a	11.06a	13.65a
S.E. ±	0.449	0.395	0.422	0.192	0.210	0.186
Weed control methods (W)						
Weedy check	10.78c	11.38c	11.08c	6.33d	4.96d	5.65d
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	15.33b	16.22b	15.77b	10.53c	7.55c	9.04c
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	14.78b	15.60b	15.19b	11.09c	7.89c	9.49bc
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	16.21b	16.98b	16.60b	12.02b	8.47b	10.25b
Two hoe weeding at 3 and 6 WAS	19.04a	20.06a	19.54a	14.99a	10.29a	12.64a
S.E.±	0.580	0.592	0.586	0.290	0.300	0.295
Varieties (V)						
SAMNUT 11	15.14b	15.95b	15.55b	10.89	6.10	8.49
SAMNUT 22	16.28a	17.12a	16.67a	11.04	6.17	8.61
	15.26b	16.07b	15.66b			
SAMNUT 23				11.02	6.17	8.59
S.E±	0.171	0.173	0.172	0.178	0.183	0.181
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P Xv	NS	NS	NS	NS	NS	NS
W Xv	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

Table 19: Effect of poultry manure and weed control methods on plant height (cm) of three groundnut varieties at 9 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	17.95c	17.10c	17.53c	13.84c	9.59c	11.72c
1.5	23.82b	28.82b	26.33b	20.03b	13.40b	16.71b
3.0	30.61a	30.61a	30.61a	27.14a	17.77a	22.46a
S.E. $\pm$	0.648	0.683	0.666	0.331	0.362	0.347
Weed control methods (W)						
Weedy check	16.79c	17.63c	17.21c	12.63d	9.67d	11.15d
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	23.20b	24.56b	23.88b	19.36c	14.12c	16.74c
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	23.34b	24.64b	23.98b	19.51c	14.22c	16.86c
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	25.58b	26.86b	26.22b	21.86b	15.77b	18.82b
Two hoe weeding at 3 and 6 WAS	31.75a	33.86a	32.81a	28.34a	20.07a	24.20a
S.E.$\pm$	0.837	0.872	0.855	0.376	0.499	0.438
Varieties (V)						
SAMNUT 11	24.16	25.50	24.83	20.37	14.79	17.58
SAMNUT 22	24.41	25.87	25.14	20.63	14.96	17.80
SAMNUT 23	23.82	25.16	24.49	20.01	14.55	17.28
S.E$\pm$	0.359	0.396	0.378	0.322	0.216	0.269
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P Xv	NS	NS	NS	NS	NS	NS
W Xv	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

The results showed that two hoe weeding resulted in significantly tallest plants, while the weedy check produced the shortest plants when compared to all the treatments. In the wet seasons all the herbicide rates gave similar plant height, but in the dry seasons applications of 0.054 kg a.i. ha^{-1} and 0.054 kg a.i. ha^{-1} of the herbicide produced plants with similar height, which were significantly shorter than plants, which received 0.162 kg a.i. ha^{-1} of the herbicide. In both years and locations of the study, the different varieties evaluated did not show significant differences in plant height at this sampling period. Similarly, there were no significant interactions among the factors.

4.7.3 Plant height (12 WAS)

The effect of poultry manure and weed control methods on plant height of three groundnut varieties at 12 WAS is presented in Table 20. Application of 3.0 tonnes ha^{-1} of poultry manure produced significantly tallest plants, which was followed by the application of 1.5 tonnes ha^{-1} of the manure, while the control gave the shortest plant, except in 2012 wet season where the applications of both 3.0 tonnes ha^{-1} and 1.5 tonnes ha^{-1} of the manure produced plants with similar height. The effect of weed control methods on plant height of groundnut at 12 WAS was significant. The results showed that two hoe weeding resulted in significant tallest plant, while the weedy check produced the shortest plant. All the herbicide rates gave similar plant height. The varieties evaluated exhibited significant differences among themselves. The results showed that SAMNUT 11 was significantly taller than SAMNUT 22 and SAMNUT 23which were at par. There were no significant interactions among the factors.

Table 20: Effect of poultry manure and weed control methods on plant height (cm) of three groundnut varieties at 12 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	21.62b	20.61c	21.11c	22.70c	27.93c	25.31c
1.5	27.83a	33.11b	30.25b	28.75b	35.37b	32.06b
3.0	26.40a	36.40a	36.40a	38.21a	47.01a	42.61a
S.E. $\pm$	0.852	1.053	0.953	0.426	0.351	0.389
Weed control methods (W)						
Weedy check	19.69c	20.80c	20.24c	20.67c	27.37c	24.02c
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	27.05b	28.54b	27.80b	28.40b	37.60b	33.00b
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	28.00b	29.60b	28.80b	29.40b	38.92b	34.16b
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	30.00b	31.40b	30.70b	31.50b	40.70b	36.60b
Two hoe weeding at 3 and 6WAS	37.60a	39.84a	38.72a	39.48a	42.26a	45.87a
S.E.$\pm$	1.100	1.152	1.126	1.155	1.529	1.342
Varieties (V)						
SAMNUT 11	28.51a	30.07a	29.29a	30.93a	39.63	35.28a
SAMNUT 22	26.59b	28.19b	27.39b	29.41b	39.74	34.37b
SAMNUT 23	26.30b	27.86b	27.08b	29.71b	39.34	34.52b
S.E$\pm$	0.204	0.220	0.212	0.214	0.283	0.249
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P Xv	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant.

4.8 Canopy Spread (cm)

4.8.1 Canopy spread at (6 WAS)

The effect of poultry manure and weed control methods on canopy spread of three groundnut varieties at 6 WAS is presented in Table 21. In 2012 wet season and the combined application of 3.0 tonnes ha^{-1} of poultry manure produced plants with significantly widest spread, which was followed by the application of 1.5 tonnes ha^{-1} while the control resulted in the lowest canopy spread. However, in 2013 wet season, application of 1.5 tonnes ha^{-1} and 3.0 tonnes ha^{-1} were at par in terms of canopy spread and were significantly wider than the control. In 2012 dry season and the dry seasons combined, application of 3.0 tonnes ha^{-1} of poultry manure produced plants with significantly widest canopy spread while the application of 1.5 tonnes ha^{-1} was comparable to the control.

There were no significant differences on canopy spread with respect to weed control methods at this sampling period. The varieties used exhibited significant differences among themselves. The results in 2012 wet season and combined and 2012 dry season showed that SAMNUT 11 had significantly wider canopy, which was followed by SAMNUT 22 and SAMNUT 23 that had similar canopy spread. While in 2013 wet season the canopy spread for SAMNUT 11 and SAMNUT 22 were similar and higher than that of SAMNUT 23. In 2013 dry season and the combined the canopy spread for SAMNUT 22 were similar to that of the other two varieties. There were no significant interactions among the factors throughout the period of experimentation.

Table 21: Effect of poultry manure and weed control methods on canopy spread (cm) of three groundnut varieties at 6 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	17.02c	16.22b	16.62c	12.84b	7.52	10.18b
1.5	17.74b	21.45a	19.59b	13.63b	7.23	10.44b
3.0	20.81a	20.81a	20.81a	16.85a	7.94	12.40a
S.E. ±	0.230	0.312	0.271	0.292	0.281	0.287
Weed control methods (W)						
Weedy check	18.66	19.62	19.14	14.59	10.97	12.78
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	18.04	18.95	19.49	13.94	10.54	12.24
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	18.65	19.62	19.14	14.58	10.96	12.77
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	18.74	19.72	19.23	14.67	11.02	12.85
Two hoe weeding at 3 and 6WAS	18.54	19.55	19.04	14.46	10.89	12.68
S.E.±	0.397	0.472	0.435	0.453	0.354	0.403
Varieties (V)						
SAMNUT 11	19.17a	20.12a	19.65a	15.13a	11.32a	13.23a
SAMNUT 22	18.48b	19.51a	18.99b	14.40b	10.84ab	12.62ab
SAMNUT 23	17.92b	18.84b	18.38b	13.82b	10.35b	12.14b
S.E±	0.218	0.228	0.223	0.229	0.203	0.216
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.8.2 Canopy spread at (9 WAS)

The effect of poultry manure and weed control method on canopy spread of three groundnuts at 9 WAS is presented in Table 22. The result in 2012 wet season showed that application of 3.0 tonnes ha^{-1} of poultry manure produced plants with significantly widest spread while the application of 1.5 tonnes ha^{-1} of the manure and the control had similar canopy spread. In 2013 wet season and 2012 dry season and the combined, application of 3.0 tonnes ha^{-1} of poultry manure produced plants with significantly widest spread, which was followed by the application of 1.5 tonnes ha^{-1} of the manure while the control resulted in significantly lowest canopy spread. However, in the wet season combined and 2013 dry season both applications of 3.0 tonnes ha^{-1} of poultry manure and 1.5 tonnes ha^{-1} of poultry manure produced plants with similar canopy spread that were significantly wider than that in the control.

The effect of weed control methods on canopy spread was significant in 2012 wet season and the combined and 2012 dry season. The results show that two hoe weeding resulted in significantly highest canopy spread than the rest of the treatments. The weedy check and the different rates of the herbicide applied were similar with respect to canopy spread. In the dry seasons combined, the weedy check, application of 0.108 kg a.i. ha^{-1} and 0.162kg a.i. ha^{-1} of the herbicide were similar to both the application of 0.054 kg a.i. ha^{-1} and two hoe weeding.

The varieties used exhibited significant differences among themselves. During the wet seasons and in 2012 dry season and combined, the results which were consistent indicated that SAMNUT 11 had significantly the widest canopy spread while SAMNUT 22 and SAMNUT 23 had similar canopy spread but in 2012 dry season, SAMNUT 11 had significantly the widest canopy spread which was followed by SAMNUT 22 and SAMNUT 23 in that order. There were no significant interactions among the factors throughout the period of experimentation in both locations

Table 22: Effect of poultry manure and weed control methods on canopy spread (cm) of three groundnut varieties at 9 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	22.07b	21.03c	21.55b	15.07c	10.52b	12.79c
1.5	22.70b	26.72b	24.10b	17.07b	11.72a	14.40b
3.0	26.72a	27.44a	27.08a	21.72a	11.36a	16.54a
S.E. ±	0.281	0.309	0.295	0.241	0.153	0.197
Weed control methods (W)						
Weedy check	24.13b	25.38	24.65b	19.13b	10.69	14.91ab
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	23.46b	24.63	24.05b	18.46b	10.32	14.39b
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	24.13b	25.38	24.76b	19.13b	10.69	14.91ab
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	23.88b	25.27	24.48b	18.88b	10.64	14.76ab
Two hoe weeding at 3 and 6WAS	28.46a	24.95	26.71a	23.46a	10.48	16.97a
S.E.±	0.364	0.423	0.394	0.890	0.860	0.875
Varieties (V)						
SAMNUT 11	24.70a	25.93a	25.31a	19.79a	10.97a	15.60a
SAMNUT 22	23.71b	24.99b	24.35b	18.71b	10.50b	14.33b
SAMNUT 23	23.08b	24.27b	23.67b	18.08c	10.54b	14.11b
S.E±	0.278	0.297	0.288	0.109	0.141	0.125
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant.

4.8.3 Canopy spread at (12 WAS)

The effect of poultry manure and weed control methods on canopy spread of three groundnut varieties at 12WAS is presented in Table 23. In 2012 wet season and the dry seasons. Application of 1.5 tonnes ha^{-1} and 3.0 tonnes ha^{-1} of poultry manure were at par in terms of canopy spread and were significantly wider than the control. While in 2013 wet season and the combined, application of 1.5 tonnes ha^{-1} of poultry manure produced plants with significantly widest spread, which was followed by the application of 3.0 tonnes ha^{-1} while the control resulted in the lowest canopy spread.

The effect of weed control methods on canopy spread at 12 WAS was significant only in the wet season combined where two hoe weeding produced significantly widest canopy than the weedy check, but all the herbicide rates were similar in their actions with respect to canopy spread and were also comparable to both the weedy check and two hoe weeding.

The varieties used exhibited significant differences among themselves with respect to canopy spread. The results which were consistent indicated that SAMNUT 11 had the significantly widest canopy spread, which was followed by SAMNUT 22 and then SAMNUT 23 in that order. Except in 2013 wet season where there was no significant difference between SAMNUT 22 and SAMNUT 23 with respect to canopy spread. There were no significant interactions among the factors at this sampling period.

Table 23: Effect of poultry manure and weed control methods on canopy spread (cm) of three groundnut varieties at 12 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	35.55b	33.88c	34.72c	37.33b	45.92b	41.63b
1.5	37.54a	45.38a	41.46a	39.41a	48.48a	43.95a
3.0	37.70a	37.69b	37.70b	39.58a	48.68a	44.13a
S.E. +	0.386	0.516	0.451	0.493	0.504	0.499
Weed control methods (W)						
Weedy check	36.52	36.68	36.60b	38.06	50.40	44.23
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	36.95	38.41	37.68ab	38.35	51.67	45.01
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	37.17	38.58	38.22ab	38.80	51.36	45.08
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	37.74	38.99	37.88ab	39.03	51.76	45.40
Two hoe weeding at 3 and 6 WAS	39.25	39.28	39.27a	39.63	52.96	46.30
S.E.+	0.971	0.860	0.916	0.723	0.892	0.808
Varieties (V)						
SAMNUT 11	38.32a	40.38a	39.35a	40.24a	53.26a	46.75a
SAMNUT 22	36.81b	38.86b	37.83b	38.65b	51.17b	44.91b
SAMNUT 23	35.66c	37.71b	36.69c	37.44c	49.57c	43.51c
S.E+	0.298	0.421	0.360	0.316	0.180	0.248
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.9 Shoot Dry Weight Plant^{-1} (g)

4.9.1 Shoot dry weight plant^{-1} (6WAS)

The effect of poultry manure and weed control method on shoot dry weight plant^{-1} of three groundnut varieties at 6 WAS is presented in Table 24. Application of 3.0 tonnes ha^{-1} of poultry manure produced the highest shoot dry weight plant^{-1}, which was followed by application of 1.5 tonnes ha^{-1} while the control resulted in significantly the lowest shoot dry weight plant^{-1}. The trend was the same throughout the trials.

The effect of weed control methods was also significant with respect to shoot dry weight plant^{-1}. The result in 2012 wet season showed that the applications of 0.162kg ha^{-1} and 0.108kg ha^{-1} of Haloxyfop-R-methyl ester were similar to all the other treatments but in the 2013 wet season and combined only the application of 0.108kg ha^{-1} of the herbicide was similar to all the other treatments. In 2012 dry season two hoe weeding gave significantly the highest shoot dry weight plant^{-1}, which was followed by application of 0.162kg ha^{-1} and 0.108kg ha^{-1} of Haloxyfop-R-methyl ester were similar but significantly higher than the application of 0.054 kg ha^{-1} of the herbicide, while in 2013 dry season two hoe weeding and applications of all the herbicide rates had similar shoot dry weight that were significantly higher than that in the weedy check. In the dry seasons combined both the weedy check and the application of the lowest rate of the herbicide gave similar shoot dry weight that were significantly lower to the other treatments.

The varieties used exhibited significant differences with respect to shoot dry weight plant^{-1}. The results which were consistent indicated that SAMNUT 11 had significantly the highest shoot dry weight plant^{-1} than SAMNUT 22 and SAMNUT 23 which were at par. There were no significant interactions among the factors at this sampling period.

Table 24: Effect of poultry manure and weed control methods on shoot dry weight plant^{-1} (g) of three groundnut varieties at 6 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Seasons (Samaru)			Dry seasons (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	10.06c	9.59c	9.83c	5.06c	2.80c	3.93c
1.5	15.27b	18.46b	16.87b	10.27b	7.23b	8.75b
3.0	20.41a	20.41a	20.41a	15.41a	8.21a	11.81a
S.E. ±	0.562	0.234	0.398	0.281	0.078	0.180
Weed control methods (W)						
Weedy check	12.48b	13.23b	12.86b	7.48d	4.62b	6.05b
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	14.55b	15.36b	14.96b	9.55c	5.68a	7.62b
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	15.86ab	16.77ab	16.32ab	10.86b	6.39a	8.63a
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	15.63ab	16.59b	16.11b	10.63b	6.30a	8.46a
Two hoe weeding at 3 and 6WAS	17.72a	18.82a	18.27a	12.72a	7.41a	10.07a
S.E.±	0.725	0.747	0.736	0.363	0.820	0.592
Varieties (V)						
SAMNUT 11	16.40a	17.41a	16.91a	11.40a	6.71a	9.05a
SAMNUT 22	14.78b	15.64b	15.21b	9.78b	5.82b	7.80b
SAMNUT 23	14.56b	15.41b	14.99b	9.56b	5.71b	7.63b
S.E±	0.215	0.187	0.201	0.226	0.300	0.262
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant.

4.9.2 Shoot dry weight plant^{-1} (9WAS)

The effect of poultry manure and weed control methods on shoot dry weight plant^{-1} of three groundnut varieties at 9 WAS is presented in Table 25. During the wet seasons and 2013 dry season, application of 3.0 tonnes ha^{-1} of poultry manure produced plants with significantly highest shoot dry weight plant^{-1}, which was followed by the application of 1.5 tonnes ha^{-1} while the control resulted in lowest significant shoot dry weight plant^{-1}. The results in 2012 dry season and the combined showed similarity in shoot dry weight plant^{-1} when 1.5 tonnes ha^{-1} and 3.0 tonnes ha^{-1} were applied, while the control had the lowest shoot significant dry weight plant^{-1}.

The effect of weed control methods was significant on shoot dry weight plant^{-1} at 9 WAS. The results which were consistent indicated that two hoe weeding resulted in significantly highest shoot dry weight plant^{-1}, while the weedy check produced plants with lowest shoot dry weight plant^{-1}. Among the herbicides rate evaluated, applications of 0.054 kg a.i. ha^{-1} and 0.108kg a.i. ha^{-1} of the herbicide produced plants with similar shoot dry weight which were significantly lower when compared to the application of 0.162kg a.i.ha^{-1} of the herbicide. Except in 2013 dry season where the applications of of 0.054 kg a.i. ha^{-1} and 0.108kg a.i. ha^{-1} of the herbicide was similar to weedy check. The varieties used exhibited significant differences with respect to shoot dry weight plant^{-1}. During the wet seasons SAMNUT 11 had significantly the highest shoot dry weight plant^{-1} which was followed by SAMNUT 23 and SAMNUT 22 in that order. In 2013 dry season SAMNUT 11 had significantly the highest shoot dry weight plant^{-1} than SAMNUT 22 and SAMNUT 23 which produced similar shoot dry weight in the wet seasons. in 2012 dry season and the combined SAMNUT 11 had significantly highest shoot dry weight plant^{-1} than the other two varieties while SAMNUT 22 produced plants with higher shoot dry weight plant^{-1} than SAMNUT 23. There was no significant interaction among the factors at this sampling.

Table 25: Effect of poultry manure and weed control methods on shoot dry weight $plant^{-1}$ (g) of three groundnut varieties at 9 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	55.81c	53.19c	54.50c	24.59b	50.81c	37.70b
1.5	69.55b	75.40b	72.48b	40.05a	64.55b	52.30a
3.0	75.40a	84.09a	79.75a	35.70a	70.40a	53.05a
S.E. ±	1.550	1.652	1.601	1.550	1.175	1.663
Weed control methods (W)						
Weedy check	50.84d	53.99d	52.42d	45.84d	25.00dc	35.42d
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	58.81c	62.41c	60.61c	53.81c	29.21c	41.51c
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	61.40c	64.83c	63.11c	56.40c	30.42c	43.41c
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	72.43b	76.65b	74.54b	67.43b	36.33b	51.88b
Two hoe weeding at 3 and 6WAS	91.12a	96.59a	93.86a	86.12a	46.30a	66.21a
S.E.±	1.769	1.823	1.796	1.885	1.608	1.746
Varieties (V)						
SAMNUT 11	74.45a	78.81a	76.63a	69.45a	37.41a	53.43a
SAMNUT 22	60.66c	64.26c	62.46c	60.65b	32.81b	46.73b
SAMNUT 23	65.65b	69.61b	67.63b	55.66c	30.10b	42.90c
S.E±	1.370	1.324	1.347	1.280	1.088	1.084
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant.

4.9.3 Shoot dry weight plant^{-1} (12WAS)

The effect of poultry manure and weed control methods on shoot dry weight plant^{-1} of three groundnut varieties at 12 WAS is presented in Table 26**.** In 2012 wet season and the dry seasons, application of 3.0 tonnes ha^{-1} of poultry manure produced plants with significantly highest shoot dry weight plant^{-1}, which was followed by the application of 1.5 tonnes ha^{-1} while the control resulted in significantly lowest shoot dry weight plant^{-1}. In 2013 wet season, application of 3.0 tonnes ha^{-1} of poultry manure gave significantly highest shoot dry weight plant^{-1}, which was followed by the application of 1.5 tonnes ha^{-1} while the control resulted in the least shoot dry weight plant^{-1}. However, in the combined analysis for the wet seasons, application of 1.5 and 3.0 tonnes ha^{-1} of poultry manure, respectively were at par in terms of shoot dry weight plant^{-1} but were significantly higher than the control.

Effect of weed control methods was also significant on the shoot dry weight plant^{-1} of the crop. The results which were consistent indicated that two hoe weeding resulted in plants with significantly highest shoot dry weight plant^{-1}, while the weedy check produced plants with significantly lowest shoot dry weight plant^{-1}. Among the herbicide rates evaluated, application of 0.054 kg a.i. ha^{-1} and 0.108kg a.i. ha^{-1} of the herbicide produced plants with similar shoot dry weight plant^{-1} which were significantly lower than the application of 0.162kg a.i.ha^{-1} of the herbicide. The varieties also exhibited significant differences in their performance with respect to shoot dry weight plant^{-1}. SAMNUT 11 produced significantly the highest shoot dry plant^{-1}, which was followed by SAMNUT 22 and then SAMNUT 23 in that order. But in 2013, SAMNUT 23 produced higher shoot dry weight plant^{-1} than SAMNUT 22. There were no significant interactions among the factors throughout the period of experimentation**.**

Table 26: Effect of poultry manure and weed control methods on shoot dry weight plant^{-1} (g) of three groundnut varieties at 12 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	171.20c	163.16c	167.18b	179.77c	221.13c	200.44c
1.5	213.64b	258.17a	235.86a	224.22b	275.79b	250.00b
3.0	231.15a	231.15b	231.15a	242.70a	298.53a	270.62a
S.E. ±	4.199	4.875	4.981	5.012	6.265	5.672
Weed control methods (W)						
Weedy check	155.84d	165.50d	160.67d	163.63d	216.62d	190.12d
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	180.48c	191.53c	186.01c	189.50c	250.87c	220.19c
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	188.35c	198.87c	193.61c	197.77c	261.81c	229.79c
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	222.31b	235.26b	228.78b	233.42b	309.01b	271.22b
Two hoe weeding at 3 and 6WAS	279.52a	296.32a	287.92a	293.50a	388.53a	341.01a
S.E.±	5.421	5.280	5.088	5.692	7.535	6.613
Varieties (V)						
SAMNUT 11	228.03a	241.37a	234.70a	239.43a	316.96a	278.20a
SAMNUT 22	201.74b	213.93c	207.83b	211.82b	280.42b	246.12b
SAMNUT 23	186.13c	197.18b	191.66c	195.43c	258.72c	227.08c
S.E±	3.435	3.838	3.973	4.706	4.554	4.630
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant.

4.10 Number of Branches Plant^{-1}

4.10.1 Number of branches plant^{-1} (6WAS)

The effect of poultry manure and weed control methods on number of branches plant^{-1} of three groundnut varieties at 6 WAS is presented in Table 27. In 2012 wet and dry seasons and their combined, application of 3.0 tonnes ha^{-1} of poultry manure produced significantly highest number of branches plant^{-1}, which was followed by the application of 1.5 tonnes ha^{-1} while the control resulted in significantly lowest number of branches plant^{-1}. However, in 2013 wet and dry seasons, application of 1.5 tonnes ha^{-1} and 3.0 tonnes ha^{-1} were at par in terms of number of branches plant^{-1} and were significantly more than the control.

Effect of weed control methods was significant on number of branches plant^{-1}. Two hoe weeding resulted in significantly highest number of branches plant^{-1}, while the weedy check resulted in significantly lowest number of branches plant^{-1}. Among the herbicide rates evaluated, application of and 0.108 kg a.i. ha^{-1} of the herbicide was similar to both applications of 0.054 kg a.i. ha^{-1} and 0.162 kg a.i.ha^{-1} of the herbicide.

The varieties also exhibited significant differences in their performance with respect to number of branches plant^{-1}. SAMNUT 11 had significantly highest number of branches plant^{-1} than SAMNUT 22 and SAMNUT 23 that produced similar number of branches plant^{-1}. There were no significant interactions among all the factors throughout the period of experimentation**.**

Table 27: Effect of poultry manure and weed control methods on number of branches plant $^{-1}$ of three groundnut varieties at 6 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	13.92c	13.26b	13.58c	8.92c	4.63b	6.775c
1.5	18.77b	22.70a	20.73b	13.77b	9.35a	11.56b
3.0	23.15a	23.15a	23.15a	18.15a	9.57a	13.86a
S.E. $\pm$	0.525	0.575	0.519	0.473	0.518	0.4671
Weed control methods (W)						
Weedy check	13.11d	13.93d	13.52d	8.11d	4.97c	6.54d
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	17.26c	18.28c	17.77c	12.26c	7.14b	9.70c
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	18.41bc	19.50bc	18.95bc	13.41bc	7.75b	10.58bc
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	19.53b	20.66b	20.09b	14.53b	8.33b	11.43b
Two hoe weeding at 3 and 6 WAS	24.75a	26.15a	25.45a	19.75a	11.08a	15.41a
S.E.$\pm$	0.553	0.590	0.571	0.497	0.531	0.514
Varieties (V)						
SAMNUT 11	22.07a	23.88a	22.73a	17.07a	9.69a	13.38a
SAMNUT 22	16.92b	17.85b	17.38b	11.92b	6.93b	9.42b
SAMNUT 23	16.85b	17.87b	17.36b	11.92b	6.93b	9.42b
S.E$\pm$	0.429	0.475	0.496	0.351	0.297	0.341
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.10.2 Number of branches plant^{-1} (9 WAS)

The effect of poultry manure and weed control methods on number of branches plant^{-1} of three groundnut varieties at 9 WAS is presented in Table 28. In 2012 wet and dry seasons and their combined, application of 3.0 tonnes ha^{-1} of poultry manure produced significantly highest number of branches plant^{-1}, which was followed by the application of 1.5 tonnes ha^{-1} while the control resulted in significantly lowest number of branches plant^{-1}. However, in 2013 wet and dry seasons, application of 1.5 tonnes ha^{-1} and 3.0 tonnes ha^{-1} were at par in terms of number of branches plant^{-1} and were significantly more than the control.

Effect of weed control methods was significant on number of branches plant^{-1} at 9 WAS. The results showed that two hoe weeding resulted in plants with significantly highest number of branches plant^{-1}, while the weedy check produced plants with significantly lowest number of branches plant^{-1}. In 2012 wet season and the dry seasons, the application of 0.108 kg a.i. ha^{-1} was similar to the applications of 0.054 kg a.i. ha^{-1} and 0.162kg a.i.ha^{-1} of the herbicide in term of number of branches plant^{-1} produced in except in 2013 wet season and the combined where only the applications of 0.108kg a.i. ha^{-1} and 0.162kg a.i.ha^{-1} were similar and significantly higher than the application of 0.054 kg a.i. ha^{-1} of the herbicide.

The varieties also exhibited significant differences in their performance with respect to number of branches plant^{-1}. SAMNUT 11 had significantly the highest number of branches than that produced by SAMNUT 22 and SAMNUT 23, which were similar in number of branches produced. There were no significant interactions among all the factors.

Table 28: Effect of poultry manure and weed control methods on number of branches plant^{-1} of three groundnut varieties at 9 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	23.05c	21.97b	22.51c	18.05c	8.99b	13.52c
1.5	31.16b	37.67a	34.41b	26.16b	16.84a	21.50b
3.0	38.54a	38.54a	38.54a	33.54a	17.27a	25.41a
S.E. ±	0.939	0.875	0.907	0.845	0.788	0.816
Weed control methods (W)						
Weedy check	21.82d	23.19d	22.50d	16.82c	11.59c	14.21c
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	28.71c	30.42c	29.57c	25.71b	16.21b	20.96b
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	30.60bc	32.41b	31.50b	25.60b	17.20b	21.40b
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	32.40b	34.25b	33.33b	27.40b	17.13b	22.27b
Two hoe weeding at 3 and 6 WAS	41.06a	43.40a	42.21a	36.06a	29.70a	32.88a
S.E.±	0.954	0.932	0.943	0.859	0.839	0.849
Varieties (V)						
SAMNUT 11	36.65a	38.82a	37.73a	31.65a	17.41a	24.53a
SAMNUT 22	28.11b	29.67b	28.85b	23.11b	12.84b	17.97b
SAMNUT 23	27.98b	29.69b	28.84b	22.98b	12.85b	17.91b
S.E±	0.828	0.801	0.779	0.745	0.721	0.701
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.10.3 Number of branches plant^{-1} (12WAS)

The effect of poultry manure and weed control methods on number of branches plant^{-1} of three groundnut varieties at 12 WAS is presented in Table 29. Applications of 3.0 tonnes ha^{-1} and 1.5 tonnes ha^{-1} of the poultry manure was similar with respect to number of branches plant^{-1} produced by the groundnut crop but significantly higher than the control except in 2013 wet season where the application of 3.0 tonnes ha^{-1} of poultry manure produced plants with significantly highest number of branches plant^{-1} than the application of 1.5 tonnes ha^{-1} of the poultry manure. Also in 2012 wet season the application of 1.5 tonnes ha^{-1} of poultry manure was comparable to both the control and application of 3.0 tonnes ha^{-1} of the manure. Effect of weed control methods on number of branches plant^{-1} was consistent and was not significant at 12 WAS in both years of experimentation at the different locations**.**

The performance of the varieties with respect to the number of branches plant^{-1} produced was significant at 12 WAS. In 2012 wet season SAMNUT 11 had significantly highest number of branches plant^{-1}, which was followed by SAMNUT 22 and the SAMNUT 23 in that order but in the other years SAMNUT 11 had significantly the highest number of branches than that produced by SAMNUT 22 and SAMNUT 23, which were similar in number of branches produced. There were no significant interactions among all the factors throughout the period of experimentation in both locations

Table 29: Effect of poultry manure and weed control methods on number of branches $plant^{-1}$ of three groundnut varieties at 12 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
	51.13b	48.73c	49.93b	53.69b	66.04b	59.86b
0	57.39ab	58.70b	58.69a	60.25a	74.10a	67.18a
1.5	58.69a	69.37a	63.37a	61.62a	75.80a	68.71a
3.0	2.268	2.514	2.167	2.041	2.263	1.950
S.E. ±						
Weed control methods (W)						
Weedy check	57.93	60.74	59.33	60.83	80.52	70.67
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	54.41	57.56	55.98	57.13	75.63	66.38
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	56.30	59.63	57.96	59.12	78.26	68.69
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	56.15	59.30	57.72	58.96	78.05	68.50
Two hoe weeding at 3 and 6 WAS	53.9	57.42	55.65	56.60	74.92	65.76
S.E.±	2.433	2.854	2.567	2.381	3.152	2.767
Varieties (V)	59.87a	63.11a	61.49a	62.86a	83.21a	73.04a
SAMNUT 11	55.29b	58.46b	56.87b	58.05b	76.85b	67.45b
SAMNUT 22	52.04c	55.22b	53.63b	54.64b	72.33b	63.49b
SAMNUT 23	1.109	1.569	1.398	1.504	1.991	1.748
S.E±						
	NS	NS	NS	NS	NS	NS
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V						

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.11 Number of Leaves Plant^{-1}

4.11.1 Number of leaves plant^{-1}(6WAS)

The effect of poultry manure and weed control methods on number of leaves plant^{-1} of three groundnut varieties at 6 WAS is presented in Table 30. Application of 3.0 tonnes ha^{-1} of poultry manure produced plants with significantly highest number of leaves plant^{-1}, which was followed by the application of 1.5 tonnes ha^{-1}while the control resulted in significantly lowest number of leaves plant^{-1}.

The effect of weed control methods on the number of leaves plant^{-1} showed no significant differences in the number of leaves plant^{-1} produced during the wet seasons and 2013 dry season. However, during the 2012 dry season and the combined, two hoe weeding resulted in significantly highest number of leaves plant^{-1} over the weedy check and applications of 0.054 kg a.i. ha^{-1}, 0.108 kg a.i. ha$^{-1,}$ and 0.162 kg a.i.ha^{-1} of the herbicide produced similar numbers of leaves plant^{-1} that were comparable to both the weedy check and two hoe weeding that gave significantly lowest number of leaves plant^{-1}.

The varieties used exhibited significant differences among themselves with respect to number of leaves plant^{-1}. The results showed that SAMNUT 11 had significantly the highest number of leaves plant^{-1} and there were no significant differences between SAMNUT 22 and SAMNUT 23. Also in 2013 dry season, the number of leaves plant^{-1} produced by SAMNUT 22 was comparable to that produced by SAMNUT 11 and SAMNUT 23. There were no significant interactions among all the factors throughout the period of experimentation in both locations.

Table 30: Effect of poultry manure and weed control methods on number of leaves plant^{-1} of three groundnut varieties at 6 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	43.29c	41.25c	42.27c	38.29c	18.63c	28.46c
1.5	47.20b	57.07b	52.13b	42.20b	26.54b	34.37b
3.0	66.21a	66.21a	66.20a	61.21a	31.11a	46.16a
S.E. ±	0.982	1.308	1.145	0.884	1.177	1.031
Weed control methods (W)						
Weedy check	52.13	54.68	53.41	45.54b	25.34	35.44b
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	52.92	55.50	54.21	47.92ab	25.75	36.84ab
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	53.04	55.59	54.32	48.04ab	25.80	36.92ab
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	50.54	53.15	51.84	47.53ab	24.58	35.86b
Two hoe weeding at 3 and 6 WAS	52.52	55.68	53.90	51.52a	25.84	40.68a
S.E.±	1.170	1.569	1.369	1.553	1.412	1.483
Varieties (V)						
SAMNUT 11	56.26a	58.68a	57.47a	51.26a	27.34a	39.30a
SAMNUT 22	51.19b	54.07b	52.63b	46.19b	25.04ab	35.62b
SAMNUT 23	49.25b	51.78b	50.51b	44.25b	23.89b	34.07b
S.E±	0.907	1.052	0.920	0.816	0.947	0.828
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.11.2 Number of leaves plant^{-1} (9WAS)

The effect of poultry manure and weed control methods on number of leaves plant^{-1} of three groundnut varieties at 9 WAS is presented in Table 31. Application of 3.0 tonnes ha^{-1} of poultry manure produced plants with significantly highest number of leaves plant^{-1}, which was followed by the application of 1.5 tonnes ha^{-1} while the control resulted in the lowest number of leaves plant^{-1}.

The effect of weed control methods had no significant influence on number of leaves plant^{-1} produced during the wet seasons. However, during the dry seasons, two hoe weeding resulted in significantly highest number of leaves plant^{-1}, while the weedy check resulted in significantly lowest number of leaves plant^{-1}. In 2012 dry season applications of 0.108 kg a.i. ha^{-1} and 0.162 kg a.i.ha^{-1} of the herbicide were similar but produced significantly higher number of leaves plant^{-1} than when 0.054 kg a.i.ha^{-1} of the herbicide was applied. In 2013 dry season both the weedy check and all the herbicide rates were all similar with respect to number of leaves plant^{-1} produced. There were similarities in numbers of leaves plant^{-1} produced by applications of all the herbicide rates in the combined.

The varieties used exhibited significant differences among themselves with respect to number of leaves plant^{-1}. The results which were consistent indicated that SAMNUT 11 had significantly the highest number of leaves plant^{-1}, which was followed by SAMNUT 22 while SAMNUT 23 had significantly the lowest number of leaves plant^{-1} except in 2013 wet season where both SAMNUT 11 and SAMNUT 22 had similar number of leaves plant^{-1}. There were no significant interactions among the factors at this stage of growth.

Table 31: Effect of poultry manure and weed control methods on number of leaves plant^{-1} of three groundnut varieties at 9 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Seasons (Samaru)			Dry seasons (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	152.34c	145.18c	148.76c	147.34c	70.59c	108.97c
1.5	163.11b	197.20b	180.16b	158.11b	96.60b	127.36b
3.0	219.39a	219.39a	219.39a	214.39a	107.70a	161.04a
S.E. ±	1.927	2.056	1.992	1.734	1.850	1.793
Weed control methods (W)						
Weedy check	188.92	188.06	188.49	154.69d	87.72b	121.20c
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	182.09	185.23	183.66	167.09c	93.12b	130.10b
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	188.50	187.44	187.97	173.50b	96.72ab	135.11b
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	182.20	184.12	183.16	177.20b	93.56b	135.38b
Two hoe weeding at 3 and 6 WAS	189.69	189.44	189.57	183.89a	100.23a	142.06a
S.E.±	4.111	4.241	4.176	1.900	2.017	1.958
Varieties (V)						
SAMNUT 11	220.41a	198.93a	209.67a	204.96a	196.03a	200.50a
SAMNUT 22	186.70b	195.27a	191.00b	175.41b	182.47b	178.94b
SAMNUT 23	157.73c	167.57b	162.65c	151.70c	160.64c	156.17c
S.E±	1.711	1.398	1.66	1.540	1.258	1.494
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.11.3 Number of leaves plant^{-1} (12WAS)

The effect of poultry manure and weed control methods on number of leaves plant^{-1} of three groundnut varieties at 12 WAS is presented in Table 32. Application of 3.0 tonnes ha^{-1} of poultry manure produced plants with significantly highest number of leaves plant^{-1}, which was followed by the application of 1.5 tonnes ha-^{1}, while the control resulted in significantly lowest number of leaves plant^{-1}.

Effect of weed control methods on number of leaves plant^{-1} was significant at 12 WAS. The results showed that that two hoe weeding resulted in plants with significantly highest number of leaves plant^{-1}, while the weedy check produced plants with significantly lowest number of leaves plant^{-1}. Applications of all the rates of the herbicide were similar in their actions with respect to number of leaves plant^{-1}, except in 2012 dry season where two hoe weeding was comparable to all the herbicide rates.

The varieties used exhibited significant differences among themselves with respect to number of leaves plant^{-1} at this growth stage of the crop. The results indicated that SAMNUT 11 produced significantly the highest number of leaves plant^{-1}, which was followed by SAMNUT 22 while SAMNUT 23 had the lowest number of leaves plant^{-1}. There were no significant interactions among the factors throughout the period of experimentation.

Table 32: Effect of poultry manure and weed control methods on number of leaves plant^{-1}of three groundnut varieties at 12 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	174.16c	182.74c	178.45c	169.16c	89.37c	129.27c
1.5	191.76b	247.93b	219.85b	186.76b	121.69b	154.23b
3.0	205.07a	274.16a	239.62a	200.07a	135.08a	167.57a
S.E. ±	3.242	3.509	3.375	2.918	3.158	3.038
Weed control methods (W)						
Weedy check	200.39c	211.59c	205.99c	195.39c	122.96d	159.18c
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	228.84b	238.99b	233.92b	223.84b	217.50c	220.68b
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	237.59b	248.85b	233.22b	232.59ab	222.43bc	227.51b
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	230.56b	237.35b	233.90b	238.09a	230.69b	219.39b
Two hoe weeding at 3 and 6WAS	253.09a	284.20a	268.65a	233.84ab	273.80a	253.82a
S.E.±	4.186	3.987	4.086	3.767	3.588	3.677
Varieties (V)						
SAMNUT 11	273.46a	258.82a	266.14a	284.46a	242.41a	263.44a
SAMNUT 22	222.91b	235.68b	229.30b	262.91b	215.84b	239.38b
SAMNUT 23	197.62c	203.64c	200.63c	249.62c	199.82c	224.72c
S.E±	3.092	3.224	3.158	2.783	2.902	2.842
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.12 Number of Days to 50% Flowering

The effect of poultry manure and weed control methods on number of days to 50% flowering of three groundnut varieties is presented in Table 33. The control resulted in significantly longest days to 50% flowering, which was followed by the application of 3.0 tonnes ha^{-1} while the application of 1.5 tonnes ha^{-1} of poultry manure produced plants with significantly shortest days to 50 % flowering. There were significant differences on the number of days to 50% flowering with respect to weed control methods. The weedy check resulted in significantly highest number of days to 50 % flowering, which was followed by application of 0.054 kg a.i. ha^{-1}, then applications of 0.162kg a.i.ha^{-1} and 0.108kg a.i. ha^{-1} that were similar and two hoe weeding in that order but in 2012 wet season the application of 0.162kg a.i.ha^{-1} of the herbicide was comparable to both the application of 0.108kg a.i. ha of the herbicide and two hoe weeding.

The varieties used exhibited significant differences among themselves with respect to days to 50% flowering. The results indicated that SAMNUT 11 had significantly the longest days to 50% flowering, which was followed by SAMNUT 22 while SAMNUT 23 had significantly the shortest days to 50 % flowering. There were no significant interactions among the factors on number of days to 50% flowering.

Table 33: Effect of poultry manure and weed control methods on number of days to 50 % flowering of three groundnut varieties at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	38.64a	44.73a	41.69a	40.58a	49.91a	45.25a
1.5	35.29c	35.29c	35.29c	37.57c	45.58c	41.31c
3.0	37.00b	36.82b	36.91b	38.85b	47.79b	43.32b
S.E. ±	0.069	0.089	0.081	0.062	0.080	0.073
Weed control methods (W)						
Weedy check	37.78a	39.79a	38.78a	39.67a	40.42a	40.04a
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	37.11b	39.07b	38.09b	38.97b	39.70b	39.33b
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	36.78c	38.75c	37.76c	38.61c	39.35c	38.98c
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	36.74cd	38.71c	37.73c	38.58c	39.31c	38.94c
Two hoe weeding at 3 and 6 WAS	36.48d	38.43d	37.45d	38.30d	39.03d	38.67d
S.E.±	0.093	0.095	0.094	0.083	0.086	0.085
Varieties (V)						
SAMNUT 11	38.00a	40.03a	39.02a	40.90a	41.66a	41.28a
SAMNUT 22	37.53b	39.54b	38.54b	39.40b	40.15b	39.78b
SAMNUT 23	35.40c	37.27c	36.33c	37.17c	37.87c	37.52c
S.E±	0.056	0.055	0.050	0.050	0.049	0.045
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.13 Crop Growth Rate (g m^{-2} wk^{-1})

4.13.1 Crop growth rate (9WAS)

The effect of poultry manure and weed control methods on crop growth rate of three groundnut varieties at 9 WAS is presented in Table 34. Applications of 1.5 tonnes ha^{-1} and 3.0 tonnes ha^{-1} of poultry manure were at par in terms of crop growth rate and they gave significantly higher crop growth rate than the control except in 2013 wet season where application of 3.0 tonnes ha^{-1} of poultry manure produced plants with significantly higher crop growth rate, which was followed by the application of 1.5 tonnes ha^{-1} while the control resulted in significantly the lowest crop growth rate.

The effect of weed control methods on crop growth rate of groundnut was significant at 9 WAS. The results showed that two hoe weeding resulted in significantly highest crop growth rate, while the weedy check produced plants with significantly lowest crop growth rate except in 2013 wet season where the weedy check was similar to the applications of 0.054 kg a.i. ha^{-1} and 0.108kg a.i. ha^{-1} of the herbicide but in the other years, application of 0.054 kg a.i. ha^{-1} and 0.108kg a.i. ha^{-1} of the herbicide produced plants with similar crop growth rate, which were significantly lower than those, which received 0.162kg a.i.ha^{-1} of the herbicide.

The varieties used exhibited significant differences among themselves with respect to crop growth rate only in 2013 wet season and the combined. SAMNUT 23 had significantly the highest crop growth rate, which was followed by SAMNUT 11 while SAMNUT 22 had significantly the lowest crop growth rate in 2013 wet season. In the combined however, the crop growth rate for SAMNUT 11 was comparable to the other two varieties that differs significantly in terms of crop growth rate. There were no significant interactions among the factors on crop growth rate at this sampling period.

Table 34: Effect of poultry manure and weed control methods on crop growth rate (g m^{-2} wk^{-1}) of three groundnuts varieties at 9 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	15.25b	14.53c	14.89b	16.01b	16.31b	16.16b
1.5	18.09a	18.33b	18.98a	18.99a	19.35a	19.17a
3.0	18.33a	21.88a	20.33a	19.24a	19.61a	19.43a
S.E. ±	0.563	0.873	0.718	0.591	0.602	0.597
Weed control methods (W)						
Weedy check	12.79d	13.59c	13.19d	13.45d	13.68d	13.56d
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	14.75c	15.68c	15.22c	15.49c	15.78c	15.64c
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	15.18c	16.02c	15.60c	15.93c	16.24c	16.09c
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	18.93b	20.02b	19.48b	19.87b	20.26b	20.07b
Two hoe weeding at 3 and 6 WAS	24.47a	25.93a	25.20a	25.69a	26.18a	25.94a
S.E.±	0.567	0.987	0.777	0.595	0.606	0.601
Varieties (V)						
SAMNUT 11	17.03	18.07b	17.55ab	17.88	18.22	18.05
SAMNUT 22	17.29	16.21c	16.75b	17.05	18.36	17.71
SAMNUT 23	17.35	20.46a	18.91a	17.31	18.70	18.01
S.E±	0.439	0.606	0.585	0.460	0.469	0.468
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.13.2 Crop growth rate (12WAS)

The effect of poultry manure and weed control methods on crop growth rate of three groundnut varieties at 12 WAS is presented in Table 35. Application of 3.0 tonnes ha^{-1} of poultry manure produced plants with significantly higher crop growth rate, which was followed by the application of 1.5 tonnes ha^{-1} while the control resulted in significantly lowest crop growth rate.

The effect of weed control methods was significant on crop growth rate at 12 WAS. The results which indicated that two hoe weeding led to significantly highest crop growth rate, while the weedy check produced plants with significantly lowest crop growth rate. Among the herbicide rates evaluated, application of 0.054 kg a.i. ha^{-1} and 0.108kg a.i. ha^{-1} of the herbicide produced plants with similar crop growth rate, which were significantly lower when compared to the application of 0.162kg a.i.ha^{-1} of the herbicide.

The varieties evaluated also exhibited significant differences among themselves with respect to crop growth rates. SAMNUT 23 had significantly the highest crop growth rate, which was followed by SAMNUT 11 while SAMNUT 22 resulted in significantly lowest crop growth rate. There were no significant interactions among the factors on crop growth rate at this sampling period.

Table 35: Effect of poultry manure and weed control methods on crop growth rate (g m^{-2} wk^{-1}) of three groundnut varieties at 12WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	38.47c	36.66c	37.56c	40.39c	49.67c	45.03c
1.5	48.00b	51.92b	49.01b	50.40b	61.99b	56.19b
3.0	51.92a	58.03a	54.92a	54.51a	67.05a	60.80a
S.E. ±	1.276	1.305	1.287	1.148	1.175	1.158
Weed control methods (W)						
Weedy check	35.00d	37.17d	36.08d	36.75d	37.45d	37.10d
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	40.56c	43.04c	41.80c	42.58c	43.39c	42.99c
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	42.32c	44.68c	43.50c	44.44c	45.28c	44.86c
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	49.96b	52.87b	51.41b	52.45b	53.46b	52.96b
Two hoe weeding at 3 and 6 WAS	62.80a	66.57a	64.69a	65.94a	67.20a	66.57a
S.E.±	1.285	1.309	1.297	1.156	1.178	1.167
Varieties (V)						
SAMNUT 11	45.36b	48.11b	46.73b	47.63b	48.53b	48.08b
SAMNUT 22	41.82c	44.31c	43.07c	43.91c	44.75c	44.32c
SAMNUT 23	51.19a	54.19a	52.68a	53.75a	54.77a	54.26a
S.E±	1.215	1.300	1.138	1.094	1.170	1.024
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.13.3 Crop growth rate (Harvest)

The effect of poultry manure and weed control methods on crop growth rate of three groundnut varieties at harvest is presented in Table 36. Application of 3.0 tonnes ha^{-1} of poultry manure produced plants with significantly highest crop growth rate, which was followed by the application of 1.5 tonnes ha^{-1} while the control resulted in significantly the lowest crop growth rate. These results were consistent throughout the years and locations, except in the wet seasons combined where application of 1.5 tonnes ha^{-1} poultry manure was comparable to the application of 3.0 tonnes ha^{-1} of poultry manure.

The effect of weed control methods was significant at harvest. The results which showed that two hoe weeding resulted in significantly highest crop growth rate, while the weedy check produced plants with significantly lowest crop growth rate when compared to all the other weed control treatments. Among the herbicide rates evaluated, application of 0.054 kg a.i. ha^{-1} and 0.108kg a.i. ha^{-1} of the herbicide produced plants with similar crop growth rate, which were significantly lower when compared to the application of 0.162kg a.i.ha^{-1} of the herbicide.

The varieties used exhibited significant differences among themselves with respect to crop growth rate. SAMNUT 11 had significantly the highest crop growth rate, which was followed by SAMNUT 22 while SAMNUT 23 resulted in significantly lowest crop growth rate. There were no significant interactions among the factors throughout the period of sampling at this growth stage.

Table 36: Effect of poultry manure and weed control methods on crop growth rate (g m^{-2} wk^{-1}) of three groundnut varieties at harvest at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	23.87c	22.75c	23.31b	25.06c	30.83c	27.95c
1.5	29.92b	32.15b	33.04a	31.41b	38.64b	35.03b
3.0	32.15a	36.17a	32.15a	33.76a	41.52a	37.64a
S.E. ±	0.766	0.896	0.831	0.804	0.820	0.812
Weed control methods (W)						
Weedy check	21.63d	22.98d	22.30d	22.71d	23.14d	22.93d
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	25.23c	26.79c	26.01c	26.50c	27.00c	26.74c
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	26.29c	27.77c	27.03c	27.60c	28.13c	27.87c
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	31.09b	32.90b	32.00b	32.64b	33.27b	32.96b
Two hoe weeding at 3 and 6 WAS	38.99a	41.34a	40.17a	40.94a	41.72a	41.33a
S.E.±	0.804	0.951	0.877	0.999	1.017	1.008
Varieties (V)						
SAMNUT 11	31.75a	33.61a	32.68a	33.34a	33.97a	33.65a
SAMNUT 22	28.30b	30.03b	29.17b	29.72b	30.28b	30.00b
SAMNUT 23	25.88c	27.43c	26.66c	27.17c	27.69c	27.43c
S.E±	0.737	0.821	0.794	0.724	0.738	0.709
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.14 Relative Growth Rate (g $g^{-1}wk^{-1}$)

4.14.1 Relative growth rate (9WAS)

The effect of poultry manure and weed control methods on relative growth rate of three groundnut varieties at 9 WAS is presented in Table 37. Application 3.0 tonnes ha^{-1} of poultry manure produced plants with significantly highest relative growth rate which was followed by the application of 1.5 tonnes ha^{-1} while the control resulted in significantly lowest relative growth rate at this sampling period.

The effect of weed control methods on relative growth rate was significant at 9 WAS. The results which showed that two hoe weeding, application of 0.162 kg a.i.ha^{-1} and 0.108 kg a.i.ha^{-1} of the herbicide resulted in significantly highest relative growth rate, while the weedy check and application of 0.054 kg a.i. ha^{-1} produced similar plants with significantly lowest relative growth rate.

The varieties evaluated also exhibited significant differences among themselves with respect to relative growth rate. In 2012 wet season and the dry seasons, both SAMNUT 11 and SAMNUT 22 had significantly the highest crop growth rate than SAMNUT 23. In 2013 wet season and combined, SAMNUT 22 and SAMNUT 23 which had similar relative growth rate were significantly higher than the relative growth rates of SAMNUT 11. There were no significant interactions among the factors at this sampling period.

Table 37: Effect of poultry manure and weed control methods on relative growth rate (g $g^{-1}wk^{-1}$) of three groundnut varieties at 9 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	0.339c	0.320c	0.331c	0.203c	0.438c	0.397c
1.5	0.343b	0.350b	0.349b	0.217b	0.443b	0.402b
3.0	0.349a	0.420a	0.379a	0.251a	0.452a	0.409a
S.E. ±	0.0001	0.0005	0.0005	0.0004	0.0005	0.0005
Weed control methods (W)						
Weedy check	0.340b	0.358b	0.349b	0.357b	0.364b	0.360b
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	0.339b	0.357b	0.349b	0.355b	0.363b	0.359b
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	0.347a	0.366a	0.357a	0.364a	0.371a	0.368a
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	0.347a	0.366a	0.356a	0.364a	0.371a	0.367a
Two hoe weeding at 3 and 6 WAS	0.346a	0.366a	0.356a	0.363a	0.370a	0.367a
S.E.±	0.0006	0.0006	0.0006	0.0006	0.0006	0.0006
Varieties (V)						
SAMNUT 11	0.346a	0.359b	0.350b	0.363a	0.370a	0.367a
SAMNUT 22	0.346a	0.364a	0.355a	0.363a	0.370a	0.367a
SAMNUT 23	0.341b	0.365a	0.355a	0.358b	0.364b	0.361b
S.E±	0.0001	0.0001	0.0001	0.0010	0.0011	0.0011
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.14.2 Relative growth rate (12WAS)

The effect of poultry manure and weed control methods on relative growth rate of three groundnut varieties at 12 WAS is presented in Table 38. Application 3.0 tonnes ha^{-1} of poultry manure produced plants with significantly highest relative growth rate, which was followed by the application of 1.5 tonnes ha^{-1} while the control resulted in significantly lowest relative growth rate.

The effect of weed control methods was significant on relative growth rate at 12 WAS. The results indicated that two hoe weeding resulted in significantly highest relative growth rate, which was followed by the application 0.162kg a.i.ha^{-1} of the herbicide, while the weedy check, application of 0.054 kg a.i. ha^{-1} and 0.108kg a.i. ha^{-1} of the herbicide produced plants with similar relative growth rate, which were significantly lower when compared to the application of 0.162kg a.i.ha^{-1} of the herbicide and two hoe weeding.

The varieties used exhibited significant differences among themselves with respect to crop growth rate in 2013 wet season and wet seasons combined. Both SAMNUT 11 and SAMNUT 23 produced plants with significantly the highest relative growth rate while SAMNUT 22 produced plants with significantly the lowest relative growth rate. There were no significant interactions among the factors at this sampling period.

Table 38: Effect of poultry manure and weed control methods on relative growth rate (g $g^{-1}wk^{-1}$) of three groundnut varieties at 12 WAS at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Seasons (Samaru)			Dry seasons (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	0.240c	0.24c	0.239c	0.201c	0.301c	0.251c
1.5	0.259b	0.26b	0.263b	0.212b	0.334b	0.273b
3.0	0.270a	0.31a	0.286a	0.235a	0.348a	0.292a
S.E. ±	0.0002	0.0002	0.0002	0.0002	0.0002	0.0002
Weed control methods (W)						
Weedy check	0.250c	0.264c	0.257c	0.263c	0.268c	0.265c
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	0.251c	0.265c	0.258c	0.264c	0.269c	0.266c
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	0.249c	0.262c	0.250c	0.263c	0.266c	0.264c
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	0.262b	0.276b	0.269b	0.275b	0.280b	0.278b
Two hoe weeding at 3 and 6WAS	0.269a	0.284a	0.276a	0.282a	0.288a	0.285a
S.E.±	0.0007	0.0008	0.0008	0.0008	0.0009	0.0009
Varieties (V)						
SAMNUT 11	0.258	0.272a	0.265a	0.271	0.276	0.273
SAMNUT 22	0.258	0.265b	0.258b	0.271	0.276	0.273
SAMNUT 23	0.259	0.273a	0.266a	0.272	0.277	0.275
S.E±	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.15 Number of Pods Plant^{-1}

The effect of poultry manure and weed control methods on number of pods plant^{-1} of three groundnut varieties is presented in Table 39. Application of 1.5 tonnes ha^{-1} of poultry manure resulted in significantly the highest number of pods plant^{-1}, which was followed by the application of 3.0 tonnes ha^{-1} and the control in that order but in 2012 wet season application of 3.0 tonnes ha^{-1} of poultry manure resulted in significantly the highest number of pods plant^{-1}, which was followed by the application of 1.5 tonnes ha^{-1} and the control in that order. Also in the combined applications of 1.5 tonnes ha^{-1} and 3.0 tonnes ha^{-1} produced similar number of pods plant^{-1} that were significantly more than that produced in the control. The effect of weed control methods was significant on number of pods plant^{-1}. The results which were consistent throughout the trials indicated that two hoe weeding resulted in significantly the highest number of pods plant^{-1}, which was followed by the application of 0.162 kg a.i.ha^{-1} while application of 0.108 kg a.i.ha^{-1}and 0.054 kg a.i.ha^{-1}of Haloxyfop-R-methyl ester produced similar number of pods plant^{-1} that were significantly higher than those produced by the weedy check. The only exception to these results was in 2012 dry season where the application 0.054 kg a.i.ha^{-1}of Haloxyfop-R-methyl ester was comparable to both the weedy check and the application of 0.108 kg a.i.ha^{-1} of the herbicide. The varieties evaluated also exhibited significant differences with respect to number of pods plant^{-1}. SAMNUT 11 had significantly the highest number of pods plant^{-1}, which was followed by SAMNUT 22, while SAMNUT 23 had significantly the lowest number of pods plant^{-1} except in the wet seasons combined, where SAMNUT 11 had significantly the highest number of pods plant^{-1} than SAMNUT 22 and SAMNUT 23 that produced similar number of pods plant^{-1}. The significant interaction of poultry manure and weed control methods in 2012 dry season as shown in Table 40 revealed that an increase in poultry manure application rate beyond

Table 39: Effect of poultry manure and weed control methods on number of pods plant^{-1} of three groundnut varieties at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Season (Samaru)			Dry season (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	38.30b	36.50c	37.40b	35.22c	32.40c	33.81c
1.5	60.61a	59.00a	60.31a	54.54a	51.17a	52.86a
3.0	64.73a	53.77b	61.27a	46.68b	41.90b	44.29b
S.E. ±	1.145	1.225	1.185	1.439	1.540	1.754
Weed control methods (W)						
Weedy check	33.88d	35.82d	34.85d	34.4d	44.77d	39.58d
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	38.70c	40.91c	39.81c	39.02cd	51.13c	45.07c
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	40.46c	42.56c	41.51c	40.78c	53.20c	46.99c
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	47.70b	50.29b	48.99b	48.02b	62.86b	55.44b
Two hoe weeding at 3 and 6 WAS	58.77a	62.15a	60.46a	59.09a	77.68a	68.38a
S.E.±	1.465	1.531	1.498	1.841	1.924	1.883
Varieties (V)						
SAMNUT 11	48.74a	51.41a	50.08a	49.06a	64.26a	56.66a
SAMNUT 22	43.00b	42.12b	42.56b	43.32b	56.88b	49.99b
SAMNUT 23	39.00c	45.50c	42.25b	39.32c	52.65c	45.10c
S.E±	0.783	1.011	0.879	0.984	1.271	1.128
Interactions						
P x W	*	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. *-Significant interaction at 5% level of significance. NS – Not Significant.

Table 40: Interaction of poultry manure and weed control methods on number of pods plant^{-1} of groundnut at Samaru during the 2012 wet season.

	Poultry manure (tonnes ha^{-1})		
Weed control methods	0	1.5	3.0
Weedy check	30. 22g	35.32efg	36.10ef
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	34.10fg	40.87de	40.43de
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	38.28def	42.66d	42.09d
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	42.44d	51.86bc	52.80b
Two hoe weeding at 3 and 6 WAS	46.39cd	68.28a	69.63a
S.E. ±		1.955	

Means followed by the same letter are statistically the same using DMRT at 5% level of significance.

1.5 tonnes^{-1} did not result to significant increase in number of pods plant^{-1}. Similarly, increasing the herbicide rate led to increase in number of pods plant^{-1}, two hoe weeding and application of 1.5 tonnes^{-1} or 3.0 tonnes $^{-1}$ of poultry manure resulted in significantly highest number of pods plant^{-1}. There were no significant interactions among the other factors.

4.16 Pod Weight Plant^{-1} (g)

The effect of poultry manure and weed control methods on pod weight plant^{-1} of three groundnut varieties is presented in Table 41. The results showed that pod weight plant^{-1} was significantly highest when 1.5 tonnes ha^{-1} of poultry manure was applied, which was followed by application of 3.0 tonnes ha^{-1} of the poultry manure and then the control in that order. The effect of weed control methods was significant on pods weight plant^{-1}. The results showed that two hoe weeding resulted in significantly the highest pod weight plant^{-1}, which was followed by the application of 0.162kg a.i.ha^{-1} while application of 0.108kg a.i.ha^{-1} and 0.054 kg a.i.ha^{-1}of Haloxyfop-R-methyl ester produced similar pod weights that were significantly higher than that produced by the weedy check. The varieties evaluated also showed significant differences with respect to pod weight plant^{-1}. The results showed that SAMNUT 11 had significantly the highest pods weight plant^{-1}, which was followed by SAMNUT 22, while SAMNUT 23 had the lowest pod weight plant^{-1} in both seasons. The significant interaction of poultry manure and weed control methods during the 2013 wet seasons as shown in Table 42 indicated that an increase in poultry manure application rate beyond 1.5 tonnes ha^{-1} when 0.162kg a.i.ha^{-1} of the herbicide and two hoe weeding was applied resulted in decrease pod weight plant^{-1}. When the herbicide rates were increased from 0.108 kg a.i.ha^{-1} to 0.162kg a.i.ha^{-1} a significant increase was observed in all the poultry manure rates. Two hoe weeding and application of 1.5 tonnes ha^{-1} of poultry manure resulted in significantly highest pod weight plant^{-1}. There were no significant interactions among the other factors.

Table 41: Effect of poultry manure and weed control methods on pod weight plant^{-1} (g) of three groundnut varieties at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Seasons (Samaru)			Dry seasons (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	55.15c	52.56c	53.85c	50.71c	46.65c	48.68c
1.5	90.30a	80.85a	84.59a	83.49a	78.80a	81.18a
3.0	70.23b	73.61b	72.70b	74.88b	69.13b	72.01b
S.E. ±	1.231	1.926	1.579	1.727	1.849	1.788
Weed control methods (W)						
Weedy check	50.84d	53.83d	52.33d	51.36d	67.28d	59.32d
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	58.81c	62.22c	60.51c	59.13c	77.77c	68.45c
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	61.40c	64.64c	63.02c	61.72c	80.80c	71.26c
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	72.43b	76.42b	74.43b	72.75b	95.52b	84.13b
Two hoe weeding at 3 and 6WAS	91.12a	96.31a	93.72a	91.44a	120.38a	105.91a
S.E.±	2.302	2.406	2.354	2.211	2.310	2.261
Varieties (V)						
SAMNUT 11	77.01a	81.23a	79.12a	77.51a	101.53a	89.52a
SAMNUT 22	67.94b	71.89b	69.92b	68.45b	89.87b	79.16b
SAMNUT 23	61.62c	66.55c	64.09c	62.13c	83.18c	72.66c
S.E±	1.179	1.589	1.384	1.128	1.526	1.327
Interactions						
P x W	NS	*	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. *-Significant interaction at 5% level of significance. NS – Not Significant

Table 42: Interaction of poultry manure and weed control methods on pod weight plant^{-1} (g) of groundnut at Samaru during 2013 wet season.

Weed control methods	Poultry manure (tonnes ha^{-1})		
	0	1.5	3.0
Weedy check	43.69i	53.83gh	55.00gh
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	49.46hi	64.21ef	62.75f
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	55.47g	67.05e	66.67ef
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	61.62f	81.32c	74.35d
Two hoe weeding at 3 and 6 WAS	68.79de	110.60a	93.98b
S.E. ±		2.065	

Means followed by the same letter are statistically the same using DMRT at 5% level of significance.

4.17. Pod Weight Plot^{-1} (kg)

The effect of poultry manure and weed control methods on pod weight plot^{-1} of three groundnut varieties is presented in Table 43. Application of 1.5 tonnes ha^{-1} of poultry manure resulted in significantly the highest pod weight plot^{-1}, which was followed by the application of 3.0 tonnes ha^{-1} and the control in that order .These results were consistent throughout the trials.

The effect of weed control methods was significant on pod weight plot^{-1}. Two hoe weeding resulted in significantly the highest pod weight plot^{-1}, which was followed by the application of 0.162 kg a.i.ha^{-1} while applications of 0.054 kg a.i.ha^{-1}of Haloxyfop-R-methyl ester was comparable to both the weedy check and application of 0.108 kg a.i.ha^{-1} of the herbicide. Although, the application of 0.162 kg a.i.ha^{-1} of the herbicide and two hoe weeding were at par with respect to pod weight plot^{-1} produced in 2012 wet season. In 2013 dry season application of 0.108 kg a.i.ha^{-1} of the herbicide produced significantly higher pod weight plot^{-1} than when 0.054 kg a.i.ha^{-1}of Haloxyfop-R-methyl ester was applied. Both the weedy check and application of 0.054 kg a.i.ha^{-1}of Haloxyfop-R-methyl ester were at par.

The varieties evaluated also exhibited significant differences with respect to pod weight plot^{-1}. The results showed that SAMNUT 11 had significantly the highest pod weight plot^{-1}, which was followed by SAMNUT 22, while SAMNUT 23 had significantly the lowest pod weight plot^{-1} but in 2012 and we dry seasons there was no significant difference between SAMNUT 22 and SAMNUT 23 with respect to pod weight plot^{-1}. There were no significant interactions among the factors throughout the period of experimentation in both years and locations.

Table 43: Effect of poultry manure and weed control methods on pod weight plot^{-1} (kg) of three groundnut varieties at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Seasons (Samaru)			Dry seasons (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	1.10c	1.05c	1.08c	1.01c	0.93c	0.97c
1.5	1.81a	1.62a	1.69a	1.67a	1.57a	1.62a
3.0	1.40b	1.47b	1.45b	1.49b	1.38b	1.44b
S.E. ±	0.046	0.026	0.036	0.034	0.055	0.045
Weed control methods (W)						
Weedy check	0.91c	0.96d	0.94d	0.92d	0.95d	0.94d
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	1.06bc	1.08cd	1.07cd	1.06cd	1.09d	1.08cd
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	1.10b	1.18c	1.14c	1.11c	1.25c	1.18c
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	1.34a	1.36b	1.35b	1.39b	1.56b	1.48b
Two hoe weeding at 3 and 6WAS	1.45a	1.56a	1.51a	1.56a	1.73a	1.65a
S.E.±	0.054	0.050	0.052	0.049	0.057	0.053
Varieties (V)						
SAMNUT 11	1.42a	1.50a	1.46a	1.43a	1.88a	1.66a
SAMNUT 22	1.25b	1.33b	1.29b	1.27b	1.67b	1.47b
SAMNUT 23	1.20b	1.24c	1.22c	1.22b	1.54c	1.38c
S.E±	0.021	0.024	0.023	0.027	0.029	0.025
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.18 100 Kernel Weight Plot^{-1}(g)

The effect of poultry manure and weed control methods on 100 kernel weight of three groundnut varieties is presented in Table 44. Application of 1.5 tonnes ha^{-1} of poultry manure produced kernels with significantly highest 100 kernel weight, which was followed by the application of 3.0 tonnes ha^{-1} and the control in that order. But in 2013 wet seasons both the applications of both of 1.5 tonnes ha^{-1} and 3.0 tonnes ha^{-1} of poultry manure were at par and significantly higher than the control.

The effect of weed control methods was significant on 100 kernel weight. The results showed that both two hoe weeding and the application of 0.162kg a.i.ha^{-1} produced significantly highest 100 kernel weights, which was followed by the applications of 0.108kg a.i.ha^{-1} and 0.054 kg a.i.ha^{-1}of Haloxyfop-R-methyl ester, which produced similar 100 kernel weights and the weedy check gave significantly the lowest 100 kernel weight except in 2012 and the combined where the applications of 0.108kg a.i.ha^{-1} and 0.054 kg a.i.ha^{-1}of Haloxyfop-R-methyl ester was similar to the weedy check. The varieties evaluated also exhibited significant differences with respect to 100 kernel weight.

The varieties evaluated also showed significant differences with respect to 100 kernel weight. In the wet seasons and the dry seasons combined SAMNUT 11 had significantly the highest 100 kernel weight which was followed by SAMNUT 22 and SAMNUT 23 that produced similar 100 kernel weights while in 2013 wet and dry seasons SAMNUT 11 had significantly the highest 100 kernel weight, which was followed by SAMNUT 22 and then SAMNUT 23 in that order. The result in 2012 wet and dry seasons showed that SAMNUT 11 had significantly the highest 100 kernel weight, which was followed by SAMNUT 23 and then SAMNUT 22 in that order.

The significant interaction of poultry manure and weed control methods during the wet seasons combined as shown in Table 45 indicated that an increase in poultry manure beyond 1.5 tonnes ha^{-1} for all the herbicide rates and the weedy check did not result in significant increase in 100 kernel weight plot $^{-1}$ except when two hoe weeding was employed, which gave lower value compared to other rates of the poultry manure. Similarly, both two hoe weeding and application of 1.5 tonnes $ha^{-1}$of poultry manure, applications of 0.162 kg a.i.$ha^{-1}$of the herbicide and 3.0 tonnes ha^{-1} or 1.5 tonnes $ha^{-1}$of poultry manure resulted in significantly highest 100 kernel weight.

The significant interaction of poultry manure and variety was observed in 2012 dry season as shown in Table 45. A significant increase in 100 kernel weight was observed with increasing poultry manure rates. In the control SAMNUT 11 had significantly highest 100 kernel weight, which was followed by SAMNUT 22 and SAMNUT 23 in that order, but when both 1.5 tonnes ha^{-1} and 3.0 tonnes $ha^{-1}$of poultry manure were applied SAMNUT 22 had significantly higher 100 kernel weight than SAMNUT 23. There were no significant interactions among the other factors throughout the period of experimentation in both years and locations

Table 44: Effect of poultry manure and weed control methods on 100 kernel weight (g) per plot of three groundnut varieties at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Seasons (Samaru)			Dry seasons (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	49.46c	37.13b	43.30c	49.98c	58.91c	54.44c
1.5	54.13a	64.15a	59.14a	63.15a	79.16a	66.80a
3.0	52.78b	63.33a	58.05b	53.10b	67.66b	60.38b
S.E. ±	0.357	0.287	0.322	0.506	0.479	0.603
Weed control methods (W)						
Weedy check	49.21c	51.88c	50.55c	49.73b	64.85c	57.29b
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	50.81b	53.55b	52.18b	51.13b	66.93b	59.03b
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	50.76b	53.50b	52.13b	51.08b	66.87b	58.97b
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	54.81a	57.64a	56.23a	55.13a	72.05a	63.59a
Two hoe weeding at 3 and 6 WAS	55.03a	57.74a	56.39a	55.35a	72.17a	63.76a
S.E.±	0.543	0.305	0.424	0.597	0.509	0.708
Varieties (V)						
SAMNUT 11	54.58a	57.41a	56.00a	54.90a	71.76a	63.33a
SAMNUT 22	50.92c	54.58b	52.75b	50.24c	68.22b	59.23b
SAMNUT 23	51.87b	52.61c	52.24b	52.19b	65.76c	58.98b
S.E±	0.223	0.244	0.311	0.372	0.407	0.390
Interactions						
P x W	NS	NS	*	NS	NS	NS
P xV	NS	NS	NS	*	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. *-Significant interaction at 5% level of significance. NS – Not Significant

Table 45: Interaction of poultry manure and weed control methods on 100 kernel weight (g) of groundnut at Samaru during the 2012 and 2013 wet seasons combined.

	Poultry manure (tonnes ha^{-1})		
Weed control methods	0	1.5	3.0
Weedy check	45.82d	50.88c	50.92c
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	47.08d	53.02c	52.32c
0.108kg a.i. ha^{-1} Haloxyfop – R –methyl ester	47.04d	52.97c	52.26c
0.162kg a.i. ha^{-1} Haloxyfop – R –methyl ester	53.13c	56.39ab	54.91ab
Two hoe weeding at 3 and 6 WAS	54.25b	57.38a	53.46c
S.E. $\pm$		0.397	

Means followed by the same letter are statistically the same using DMRT at 5% level of significance.

Table 46: Interaction of poultry manure and varieties on 100 kernel weight (g) in 2012 dry season.

	Poultry manure (tonnes ha^{-1})		
Variety	0	1.5	3.0
SAMNUT 11	62.78e	76.63b	83.95a
SAMNUT 22	54.01f	63.07e	68.25d
SAMNUT 23	50.64g	68.94d	74.00c
S.E. $\pm$		0.348	

Means followed by the same letter are statistically the same using DMRT at 5% level of significance.

4.19 Pod Yield (kg ha^{-1})

The effect of poultry manure and weed control methods on pod yield in kg ha^{-1} of three groundnut varieties is presented in Table 47. The application of 1.5 tonnes ha^{-1} of poultry manure resulted in significantly highest pod yield, which was followed by the application of 3.0 tonnes ha^{-1} and the control in that order.

The effect of weed control methods was significant on pod yield ha^{-1}. Significantly highest pod yield was obtained with two hoe weeding, which was followed by the application of 0.162kg a.i.ha^{-1} of Haloxyfop-R-methyl ester. The applications of 0.108kg a.i.ha^{-1} and 0.054 kg a.i.ha^{-1} of the herbicide produced similar pod yield ha^{-1} that was significantly lower than when 0.162kg a.i.ha^{-1} of the herbicide was applied. The weedy check gave the least pod yield among all the weed control treatments except in 2013 wet season where the weedy check was comparable to the application of 0.054 kg a.i.ha^{-1} of the herbicide.

The varieties evaluated also exhibited significant differences with respect to pod yield ha^{-1}. The results which were consistent showed that SAMNUT 11 had significantly the highest pod yield ha^{-1}, which was followed by SAMNUT 22 and SAMNUT 23 in that order. Interaction between poultry manure and weed control methods for was significant in the dry season combined as shown in Table 48. Application of 1.5 tonnes ha^{-1} of poultry manure at each level of weed control method significantly increased pod yield over the control. Beyond this rate significant decrease in pod yield ha^{-1} was recorded when 0.162 kg a.i.ha^{-1} of Haloxyfop-R-methyl ester and two hoe weeding was employed. While the applications of the other two herbicide rates and weedy check resulted to non significant response over the application of 1.5 tonnes ha^{-1} of poultry manure when 3.0 tonnes ha^{-1} of poultry manure was applied.

Table 47: Effect of poultry manure and weed control methods on pod yield (kg ha^{-1}) of three groundnut varieties at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Seasons (Samaru)			Dry seasons (Kadawa)		
Treatments	2012	2013	Combine	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	1654c	1576c	1615c	1521c	1399c	1460c
1.5	2709a	2425a	2537a	2504a	2364a	2435a
3.0	2106b	2208b	2181b	2246b	2073b	2160b
S.E. ±	58.4	62.3	60.4	76.0	81.1	78.5
Weed control methods (W)						
Weedy check	1530d	1614d	1581d	1547d	1597d	1581d
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	1782c	1816cd	1799c	1782c	1983c	1816c
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	1850c	1984c	1917c	1867c	2102c	1984c
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	2253b	2287b	2270b	2337b	2623b	2489b
Two hoe weeding at 3 and 6 WAS	2438a	2623a	2539a	2623a	2909a	2770a
S.E.±	59.6	74.2	71.9	59.7	85.0	72.4
Varieties (V)						
SAMNUT 11	2388a	2523a	2455a	2405a	3162a	2792a
SAMNUT 22	2102b	2237b	2169b	2136b	2808b	2472b
SAMNUT 23	2018c	2085c	2052c	2052c	2590c	2321c
S.E±	23.2	26.7	25.0	23.8	26.9	25.4
Interactions						
P x W	NS	NS	NS	NS	NS	*
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. *-Significant interaction at 5% level of significance. NS – Not Significant

Table 48: Interaction of poultry manure and weed control methods on pod yield (kg ha^{-1}) of groundnut at Kadawa during the 2012 and 2013 dry seasons combined.

	Poultry manure (tonnes ha^{-1})		
Weed control methods	0	1.5	3.0
Weedy check	1483h	1809fg	1775fg
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	1630gh	2099ef	1957ef
0.108kg a.i. ha^{-1} Haloxyfop – R –methyl ester	1807fg	2214de	1970ef
0.162kg a.i. ha^{-1} Haloxyfop – R –methyl ester	1949f	2663c	2376d
Two hoe weeding at 3 and 6 WAS	2212de	3680a	3010b
S.E. $\pm$		81.5	

Means followed by the same letter are statistically the same using DMRT at 5% level of significance.

Two hoe weeding and application of 0.162 kg a.i.ha^{-1} of the herbicide resulted in significant increase in pod yield for all poultry manure rates. Combined applications of two hoe weeding and application of 1.5 tonnes ha^{-1} of poultry manure resulted to highest pod yield. There were no significant interactions among the other factors

4.20 Haulm Yield (kg ha $^{-1}$)

The effect of poultry manure and weed control methods on haulm yield in kg ha^{-1} of three groundnut varieties is presented in Table 49. Application of 3.0 tonnes ha^{-1} of poultry manure resulted in significantly highest haulm ha^{-1}, which was followed by the application of 1.5 tonnes ha^{-1} while the control resulted in significantly lowest haulm yield ha^{-1}.

The effect of weed control methods was significant on haulm yield ha^{-1}. The results, which were consistent, showed that two hoe weeding resulted in significantly the highest haulm yield ha^{-1}, which was followed by the application of 0.162kg a.i.ha^{-1}. The applications of 0.108kg a.i.ha^{-1} and 0.054 kg a.i.ha^{-1} of the herbicide produced similar haulm yield ha^{-1} that were significantly lower than when 0.162kg a.i.ha^{-1} of the herbicide was applied. The weedy check gave the least haulm yield among all the weed control treatments.

The varieties evaluated also exhibited significant differences with respect to haulm yield ha^{-1}. The results which were consistent showed that SAMNUT 11 had significantly the highest haulm yield ha^{-1}, which was followed by SAMNUT 22 and then SAMNUT 23 in that order. There were no significant interactions among the factors.

Table 49: Effect of poultry manure and weed control methods on haulm yield (kg ha^{-1}) of three groundnut varieties at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Seasons (Samaru)			Dry seasons (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	1313c	1206c	1260c	1101c	1055c	1038c
1.5	2767b	3095b	2930b	3044b	2792b	3422b
3.0	3449a	3920a	3684a	3991a	3477a	4300a
S.E. ±	76.0	81.1	78.6	98.8	105.4	102.1
Weed control methods (W)						
Weedy check	2677d	2824d	2766d	2707d	2794d	2766d
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	3218c	3378c	3348c	3215c	3207c	3376c
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	3237c	3472c	3354c	3267c	3378c	3472c
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	3742b	4002b	3970b	4089b	4590b	4355b
Two hoe weeding at 3 and 6 WAS	4266a	4590a	4443a	4590a	5090a	4856a
S.E.±	90.5	96.5	93.5	103.7	110.6	107.2
Varieties (V)						
SAMNUT 11	4179a	4443a	4310a	4238a	5533a	4885a
SAMNUT 22	3708b	3914b	3811b	3738b	4914b	4326b
SAMNUT 23	3559c	3648c	3603c	3589c	4532c	4060c
S.E±	49.1	73.7	61.4	50.6	73.9	62.2
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.21 Shelling Percentage

The effect of poultry manure and weed control methods on shelling percentage of three groundnut varieties is presented in Table 50. In the wet seasons and 2012 dry season, the results showed that the application of 1.5 tonnes ha^{-1} and 3.0 tonnes ha^{-1} had similar shelling percentages, which were significantly higher than the control. While in 2012 dry season and the combined the application of 1.5 tonnes ha^{-1} led to significantly highest shelling percentage, which was followed by the application of 3.0 tonnes ha^{-1} and then the control in that order.

The effect of weed control methods was significant on shelling percentage. The results, which were consistent, showed that both two hoe weeding and the application of 0.162kg a.i.ha^{-1}, which were similar gave significantly the highest shelling percentage and were followed by the applications of 0.108kg a.i.ha^{-1} and 0.054 kg a.i.ha-^{1}of Haloxyfop-R-methyl ester, which were also similar. The least shelling percentage was observed in the weedy check. However, in 2012 wet season application of 0.162 kg a.i.ha^{-1} Haloxyfop-R-methyl ester was comparable to the other two rates and two hoe weeding.

The varieties evaluated exhibited significant differences with respect to shelling percentage. In 2013 wet season SAMNUT 11 had significantly the highest shelling percentage, which was followed by SAMNUT 22 and SAMNUT 23 in that order, while in the other years, SAMNUT 11 produce significantly highest shelling percentage than both SAMNUT 22 and SAMNUT 23 that produced similar shelling percentage but in 2013 dry season both SAMNUT 11 and SAMNUT 22 had significantly the highest shelling percentage than SAMNUT 23.

Table 50: Effect of poultry manure and weed control methods on shelling percentage of three groundnut varieties at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Seasons (Samaru)			Dry seasons (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	39.46b	37.13b	38.30b	39.98b	48.91c	44.44c
1.5	44.13a	53.33a	48.73a	44.45a	69.16a	56.80a
3.0	43.78a	54.13a	48.96a	43.10a	57.66b	50.38b
S.E. $\pm$	0.535	0.517	0.526	0.995	1.582	1.289
Weed control methods (W)						
Weedy check	35.21c	37.88c	36.55c	36.73c	44.85c	40.79c
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	40.81b	42.55b	41.18b	41.13b	56.93b	49.03b
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	40.76b	42.50b	41.13b	41.08b	56.87b	48.97b
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	44.81ab	47.64a	46.23a	45.13a	62.05a	53.59a
Two hoe weeding at 3 and 6 WAS	45.03a	47.74a	46.39a	45.35a	62.17a	53.76a
S.E.$\pm$	1.470	1.423	1.447	1.233	1.249	1.241
Varieties (V)						
SAMNUT 11	49.58a	52.41a	51.00a	59.90a	61.76a	60.83a
SAMNUT 22	45.92b	49.58b	47.75b	45.24b	58.22a	51.73b
SAMNUT 23	46.87b	47.61c	47.24b	47.19b	53.76b	50.48b
S.E$\pm$	0.476	0.174	0.325	1.339	1.526	1.433
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.22 Harvest Index (%)

The effect of poultry manure and weed control methods on harvest index of groundnut varieties is shown in Table 51. The effect of poultry manure was highly variable. In 2012 wet season application of 1.5 tonnes ha^{-1} of poultry manure resulted in significantly highest harvest index while the control and application of 3 tonnes ha^{-1} resulted in significantly lowest harvest index. In 2013 wet season and the combined, both applications of 1.5 tonnes ha^{-1} and 3.0 tonnes ha^{-1} resulted in significantly highest harvest indices, while the control resulted in significantly lowest harvest index. In the dry season combined, application of 3.0 tonnes ha^{-1} of the poultry manure resulted in significantly highest harvest index, which was followed by application of 1.5 tonnes ha^{-1} of poultry manure while the control resulted in significantly lowest harvest index.

The effect of weed control methods was significant and consistent on harvest index of groundnut. Two hoe weeding resulted in significantly highest harvest index which was followed by the application of 0.162kg a.i of Haloxyfop R methyl ether. Application of 0.054 kg a.i was comparable to both application of 0.108kg a.i and the weedy check. There were no significant differences with respect to harvest indices among the varieties evaluated. There were no significant interactions among other factors.

Table 51: Effect of poultry manure and weed control methods on harvest index (%) of three groundnut varieties at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet Seasons (Samaru)			Dry seasons (Kadawa)		
Treatments	2012	2013	Combined	2012	2013	Combined
Poultry manure (P) (t ha^{-1})						
0	31.23b	29.78b	30.51b	26.67c	27.51c	31.66b
1.5	41.12a	40.23a	40.12a	31.09b	32.74b	34.00b
3.0	33.53b	41.12a	35.72a	37.44a	40.15a	41.66a
S.E. ±	1.530	1.558	1.544	1.170	1.199	1.188
Weed control methods (W)						
Weedy check	26.35d	27.74d	27.04d	27.66d	28.19d	27.93d
0.054 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	29.17cd	30.74cd	29.95cd	30.62cd	31.21cd	30.92cd
0.108 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	31.81c	33.35c	32.58c	33.40c	34.03c	33.71c
0.162 kg a.i. ha^{-1} Haloxyfop – R –methyl ester	38.70b	40.94b	39.82b	40.63b	41.40b	41.02b
Two hoe weeding at 3 and 6 WAS	50.45a	52.45a	51.45a	52.97a	53.98a	53.47a
S.E.±	1.560	1.589	1.574	1.000	1.223	1.211
Varieties (V)						
SAMNUT 11	35.87	37.57	36.72	37.66	38.38	38.02
SAMNUT 22	35.66	37.09	35.41	37.44	38.15	37.79
SAMNUT 23	34.35	37.09	36.37	36.06	36.75	36.41
S.E±	1.151	1.276	1.329	0.885	0.982	1.020
Interactions						
P x W	NS	NS	NS	NS	NS	NS
P xV	NS	NS	NS	NS	NS	NS
W xV	NS	NS	NS	NS	NS	NS
P x W x V	NS	NS	NS	NS	NS	NS

Means followed by the same letter within the same treatment group and years are statistically the same using DMRT at 5% level of significance. NS – Not Significant

4.23 Polynomial Response of Pod Yield to Poultry Manure Rates

The polynomial response of pod yields to poultry manure rates at Samaru during the 2012, 2013 and the combined is shown in Figure 1. The polynomial equations that best described the relationship between pod yield and poultry manure rates as shown in Figure 1, gave an R^2 value of 1 in both years and their combined. The optimum rates of 1.70 tonnes ha^{-1}, 1.95 tonnes ha^{-1} and 1.83 tonnes ha^{-1} were obtained in 2012, 2013 and the combined to give yields of 2725kg, 2472 kg and 2567 kg ha^{-1}, respectively.

The polynomial response of pod yield to poultry manure rates at Kadawa during the 2012, 2013 and the combined is shown in Figure 2. The polynomial equations that best described the relationship between yields and poultry manure rates are shown in Figure 1 and it gave an R^2 value of 1 in both years and the combined. The optimum rates of 1.94 tonnes ha^{-1}, 1.90 tonnes ha^{-1} and 1.92 tonnes ha^{-1} were obtained in 2012, 2013 and the combined to give yields of 2557kg ha^{-1}, 2409kg ha^{-1} and 2483 kg ha^{-1}, respectively.

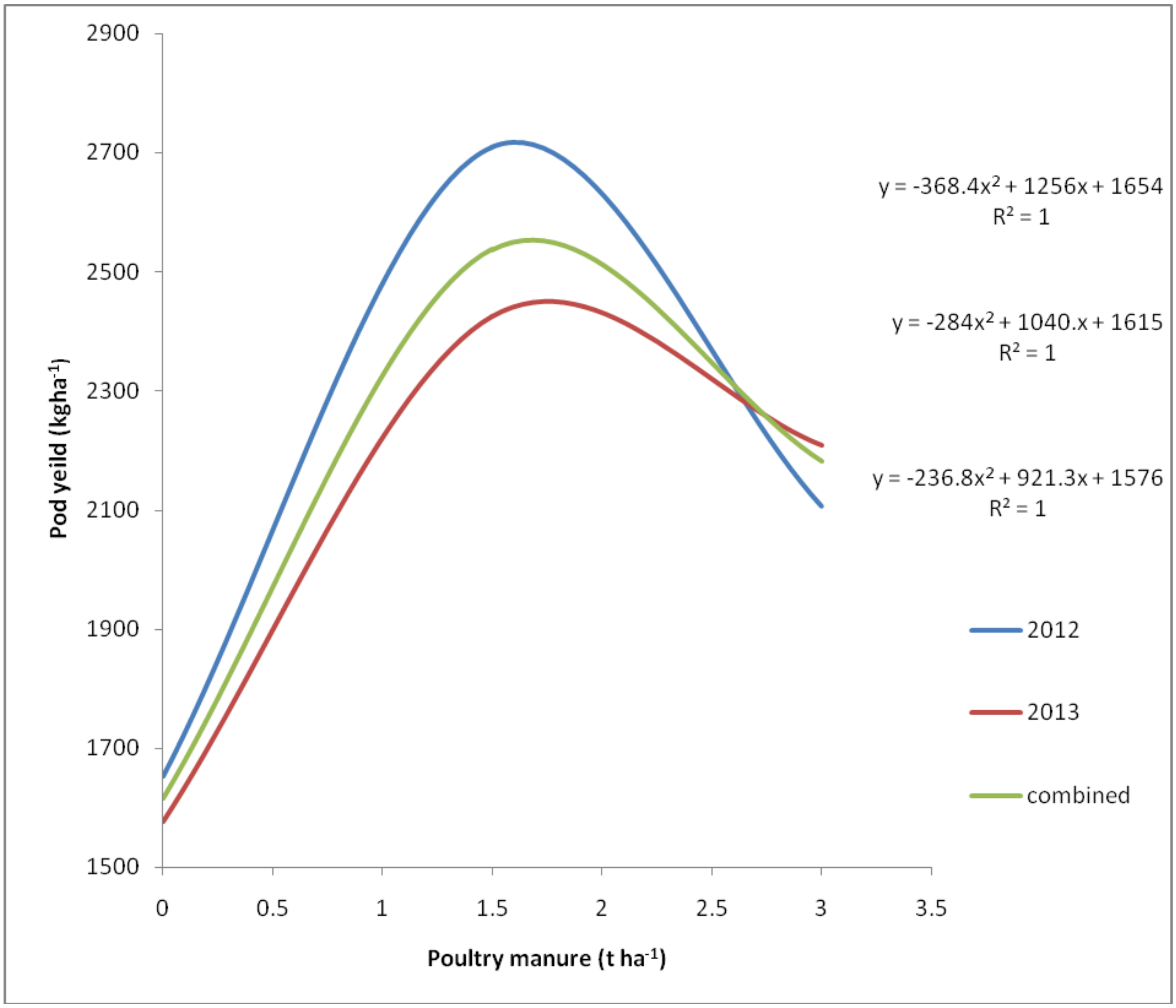

Figure1: Polynomial response of pod yield to poultry manure rates at Samaru during the 2012 and 2013 wet seasons and the combined.

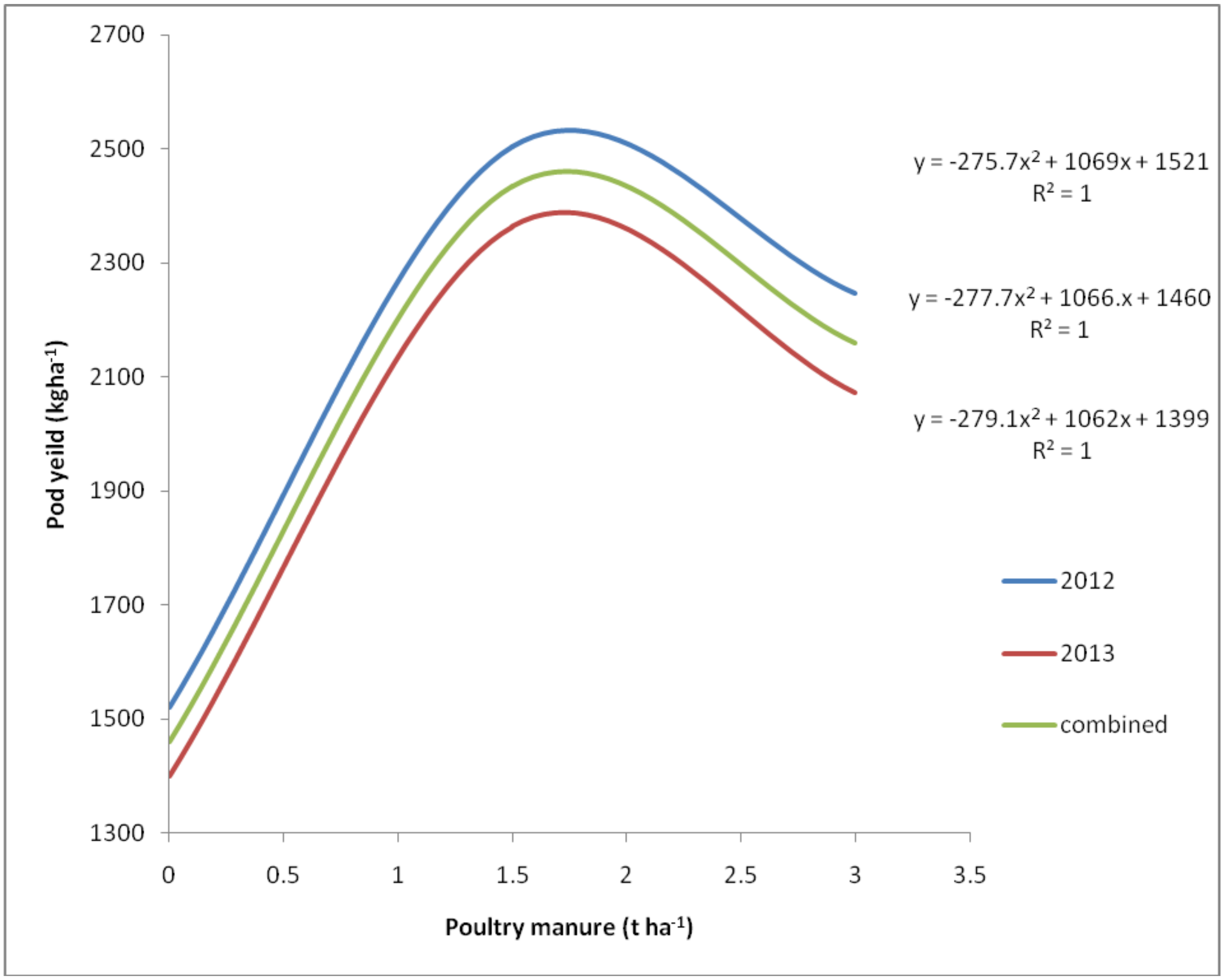

Figure 2: Polynomial response of pod yield to poultry manure rates at Kadawa during the 2012 and 2013 dry seasons and the combined.

4.24 Correlation Coefficient Matrix between Yield and Some Growth and Yield Characters

The correlation coefficient matrix between yield and some growth and yield characters are shown in Tables 52, 53, 54 and 55. In 2012 and 2013 wet seasons at Samaru, pod yield ha^{-1} was positively and highly correlated with number of branches, numbers of leaves, plant height, canopy spread, numbers of pod, pod weight, 100 kernel weight but was negatively correlated with haulm yield. Number of branches was positively and highly correlated with number of leaves, shoot dry weight, canopy spread, number of pods and haulm yield. Number of leaves was positively and highly correlated with shoot dry weight, canopy spread and haulm yield. Shoot dry weight was positively and highly correlated with plant height, canopy spread and haulm yield but was negatively correlated to pod weight. Canopy spread was positively and highly correlated with number of pods and haulm yield. Number of pods was positively and highly correlated with pod weight, 100 seed weight, but negatively and highly correlated with to haulm yield. Pod weight was positively and highly correlated with 100 kernel weight but negatively and highly correlated with haulm yield. The correlation value between 100 kernel weight and haulm yield was highly negatively correlated as shown in Tables 52 and 53 for 2012 and 2013 wet seasons, respectively. In 2012 and 2013 dry seasons at Kadawa, pod yield was positively and highly correlated with number of branches, numbers of pods, pod weight, 100 kernel weight but was negatively correlated with haulm yield. Number of branches was positively and highly correlated with number of leaves, canopy spread and haulm yield. Number of leaves was positively and highly correlated with shoot dry weight, canopy spread and haulm yield. Shoot dry weight was positively and highly correlated with canopy spread and haulm yield. Canopy spread was positively and highly correlated with number of pods and haulm yield. In 2012 dry season, number of pods was positive and highly correlated with to 100 kernel weight while in 2013 dry season number of pods was positively and highly correlated with pod weight. Pod weight was positively and highly correlated with 100 kernel weight but negatively and highly correlated with haulm yield. The correlation value between 100 kernel weight and haulm yield was highly negatively correlated as shown in Tables 54 and 55.

Table 52: Correlation coefficient matrix between yield and some growth and yield character of groundnut during the 2012 wet season at Samaru.

	Pod yield(kg)	Numbers of branches	Numbers of leaves	Shoot dry weight (g)	Plant height (cm)	Canopy spread (cm)	No of pods	Pod weight (g)	100 kernel weight (g)	Haulm yield (Kg)
Pod yield	1.00									
Numbers of branches	0.88**	1.00								
Numbers of leaves	0.33**	0.39**	1.00							
Shoot dry weight	0.18	0.33**	0.26**	1.00						
Plant height	0.55**	-0.12	0.14	-0.34**	1.00					
Canopy spread	0.56**	0.51**	0.59**	0.47**	- 0.01	1.00				
No of pods	0.92**	0.35**	0.11	-0.13	0.11	0.57**	1.00			
Pod weight	0.57**	0.09	0.12	-0.28**	0.09	0.12	0.23*	1.00		
100 kernel weight	0.75**	0.05	0.13	0.01	0.02	0.18	0.20*	0.77**	1.00	
Haulm yield	-0.41**	0.58**	0.24*	0.52**	0.05	0.45**	-0.39**	-0.43**	-0.25**	1.00

Df =133, r at 5% =0.195, r at 1% =0.254, *= significant at 5% level of probability, ** = significant at 1% level of probability.

Table 53: Correlation coefficient matrix between yield and some growth and yield character of groundnut during the 2013wet season at Samaru.

	Pod yield (kg)	Numbers of branches	Numbers of leaves	Shoot dry weight (g)	Plant height (cm)	Canopy spread (cm)	No of pods	Pod weight (g)	100 kernel weight (g)	Haulm yield (kg)
Pod yield	1.00									
Numbers of branches	0.73**	1.00								
Numbers of leaves	0.18	0.66**	1.00							
Shoot dry weight	0.12	0.42**	0.46**	1.00						
Plant height	0.55**	0.13	0.09	0.42**	1.00					
Canopy spread	0.21 *	0.59**	0.99**	0.47**	- 0.01	1.00				
No of pods	0.71**	0.55**	-0.13	0.11	0.16	0.31**	1.00			
Weight of pods	0.92**	0.19	0.12	-0.35	0.05	0.18	0.20*	1.00		
100 kernel weight	0.94**	0.18	0.01	0.09	0.08	0.09	0.19*	0.87**	1.00	
Haulm yield	-0.36**	0.45**	0.45**	0.90**	0.14	0.72**	-0.53**	0.34**	0.31**	1.00

Df =133, r at 5% =0.195, r at 1% =0.254, *= significant at 5% level of probability, ** = significant at 1% level of probability

Table 54: Correlation coefficient matrix between yield and some growth and yield character of groundnut during the 2012 dry season at Kadawa.

	Pod yield (kg)	Numbers of branches	Numbers of leaves	Shoot dry weight (g)	Plant height (cm)	Canopy spread (cm)	No of pods	Pod weight (g)	100 kernel weight (g)	Haulm yield (kg)
Pod yield	1.00									
Numbers of branches	0.71**	1.00								
Numbers of leaves	0.18	0.57**	1.00							
Shoot dry weight	-0.19	0.17	0.39**	1.00						
Plant height	0.33**	-0.21*	0.13	0.16	1.00					
Canopy spread	0.22*	0.30**	0.85**	0.44**	-0.01	1.00				
No of pods	0.51**	0.08	0.06	0.04	0.11	0.54**	1.00			
Pod weight	0.80**	0.04	0.11	0.14	0.09	0.13	0.22*	1.00		
100 kernel weight	0.83**	0.13	0.04	0.07	0.02	0.17	0.28**	0.74**	1.00	
Haulm yield	-0.35**	0.72*	0.46**	0.77**	0.05	0.43**	0.02	-0.27**	-0.36**	1.00

Df =133, r at 5% =0.195, r at 1% =0.254, *= significant at 5% level of probability, ** = significant at 1% level of probability

Table 55: Correlation coefficient matrix between yield and some growth and yield character of groundnut during the 2013 dry season at Kadawa.

	Pod yield(kg)	Numbers of branches	Numbers of leaves	Shoot dry weight (g)	Plant height (cm)	Canopy spread (cm)	No of pods	Pod weight (g)	100 kernel weight (g)	Haulm yield (kg)
Pod yield	1.00									
Numbers of branches	0.45**	1.00								
Numbers of leaves	0.30**	0.54**	1.00							
Shoot dry weight	-0.03	0.22*	0.35**	1.00						
Plant height	0.13	-0.04	0.12	0.13	1.00					
Canopy spread	0.14	0.40**	0.32**	0.29**	-0.16	1.00				
No of pods	0.27**	0.13	0.24*	0.08	0.17	0.26**	1.00			
Weight of pods	0.35**	0.14	0.02	0.06	0.07	0.11	0.38**	1.00		
100 kernel weight	0.39**	0.07	0.08	0.08	0.12	0.13	0.24*	0.47**	1.00	
Haulm yield	-0.48**	0.52**	0.51**	0.40**	0.03	0.22*	0.01	-0.34**	-0.29**	1.00

Df =133, r at 5% =0.195, r at 1% =0.254, *= significant at 5% level of probability, ** = significant at 1% level of probability

4.25 Path Analysis

4.25.1 Direct and indirect contribution

The partitioning of the total correlation to direct and indirect effects of some growth and yield characters on pod yield of groundnut at Samaru during the 2012 and 2013 wet seasons and at Kadawa during the 2012 and 2013 dry seasons were positive throughout the period under consideration. Pod weight had the highest direct contribution which was followed by 100 kernel weight, number of pods, number of branches, plant height and canopy spread in that order, while number of leaves had the lowest direct contribution as shown in Tables 56, 57, 58 and 59.

4.25.2 Percent contribution

The percent individual and combined contribution of some growth and yield characters on pod yield is shown in Table 60. In 2012 and 2013 wet seasons and dry seasons, the highest percent individual contribution was from pod weight followed by 100 kernel weight, number of pods, number of branches, plant height, canopy spread and number of leaves in that order. The combined effect of pod weight and 100 kernel weight gave the highest combined contribution while the combined contribution of number of branches and number of pods ranked second except in 2012 wet season where the combined contribution from number of branches and number of leaves ranked second. The least combined contribution was from number of leaves and number of pods and plant height and canopy spread that resulted in negative values.

The percent total individual contributions were 32.74%, 44.92%, 32.23% and 7.99% in 2012 wet season, 2013 wet season, 2012 and 2013 dry seasons, respectively. The total combined contribution were 47.23% in 2012 wet season, 42.55% in 2013 wet season, 51.86% in 2012 dry season and 62.51% in 2013 dry season. The total contribution from both the individual and the combined were 79.97% in 2012 wet season, 87.47% in 2013 wet season, 84.10% in 2012 dry season and 70.51% in 2013 dry season. The residuals, which were the un-accounted contributions from other characters to yield, were 20.03% in 2012 wet season, 12.53% in 2013 wet season, 15.91% in 2012 dry season and 29.49% in 2013 dry season.

Table 56: The direct and indirect effects of some growth and yield characters on pod yield of groundnut at Samaru during the 2012 wet season.

characters	Numbers of branches	Numbers of leaves	Plant height	Canopy spread	No of pods	Pod weight	100 kernel weight	Total correlation
Numbers of branches	**0.22**	0.18	0.05	0.11	0.13	0.04	0.15	0.88
Numbers of leaves	0.09	**0.06**	0.03	0.04	0.05	0.02	0.04	0.33
Plant height	0.03	0.15	**0.18**	0.03	0.08	0.03	0.05	0.55
Canopy spread	0.03	0.08	0.03	**0.15**	0.23	0.03	0.01	0.56
No of pods	0.27	0.01	0.08	0.09	**0.24**	0.07	0.16	0.92
Weight of pods	0.03	0.03	0.03	0.01	0.04	**0.30**	0.13	0.57
100 seed weight	0.09	0.05	0.09	0.06	0.04	0.15	**0.27**	0.75

Figures highlighted represent direct effects

Table 57: The direct and indirect effects of some growth and yield characters on pod yield of groundnut at Samaru during the 2013 wet season.

characters	Numbers of branches	Numbers of leaves	Plant height	Canopy spread	No of pods	Pod weight	100 kernel weight	Total correlation
Numbers of branches	**0.19**	0.14	0.04	0.09	0.11	0.04	0.12	0.73
Numbers of leaves	0.05	**0.03**	0.02	0.02	0.03	0.01	0.02	0.18
Plant height	0.03	0.15	**0.18**	0.03	0.08	0.03	0.05	0.55
Canopy spread	0.01	0.03	0.01	**0.06**	0.09	0.01	0.00	0.21
No of pods	0.20	0.01	0.06	0.07	**0.20**	0.05	0.12	0.71
Weight of pods	0.05	0.04	0.05	0.02	0.06	**0.49**	0.21	0.92
100 seed weight	0.12	0.07	0.11	0.08	0.06	0.19	**0.31**	0.94

Figures highlighted represent direct effects

Table 58: The direct and indirect effects of some growth and yield characters on pod yield of groundnut at Kadawa during the 2012 dry seasons.

characters	Numbers of branches	Numbers of leaves	Plant height	Canopy spread	No of pods	Pod weight	100 kernel weight	Total correlation
Numbers of branches	**0.13**	0.15	0.05	0.09	0.12	0.04	0.13	0.71
Numbers of leaves	0.05	**0.03**	0.02	0.02	0.03	0.01	0.02	0.18
Plant height	0.02	0.09	**0.10**	0.02	0.05	0.02	0.03	0.33
Canopy spread	0.01	0.03	0.01	**0.06**	0.09	0.01	0.01	0.22
No of pods	0.13	0.01	0.04	0.04	**0.19**	0.03	0.07	0.51
Weight of pods	0.04	0.04	0.05	0.02	0.05	**0.42**	0.18	0.80
100 seed weight	0.10	0.06	0.10	0.07	0.05	0.17	**0.28**	0.83

Figures highlighted represent direct effects

Table 59: The direct and indirect effects of some growth and yield characters on pod yield of groundnut at Kadawa during the 2013 dry season.

characters	Numbers of branches	Numbers of leaves	Plant height	Canopy spread	No of pods	Pod weight	100 kernel weight	Total correlation
Numbers of branches	**0.10**	0.09	0.03	0.06	0.07	0.02	0.08	0.45
Numbers of leaves	0.10	**0.02**	0.03	0.04	0.05	0.02	0.04	0.30
Plant height	0.01	0.01	**0.07**	0.01	0.01	0.01	0.01	0.13
Canopy spread	0.01	0.02	0.01	**0.03**	0.05	0.01	0.01	0.14
No of pods	0.06	0.01	0.02	0.02	**0.12**	0.01	0.03	0.27
Weight of pods	0.02	0.02	0.02	0.01	0.02	**0.18**	0.08	0.35
100 seed weight	0.05	0.03	0.05	0.03	0.02	0.08	**0.13**	0.39

Figures highlighted represent direct effects

Table 60: Percent individual and combined contributions of some growth and yield characters to pod yield of groundnut and their residual effects at Samaru and Kadawa during the 2012 and 2013 wet and dry seasons.

	Wet season (Samaru)		Dry season (Kadawa)	
Growth and yield characters	2012	2013	2012	2013
Individual Contribution				
No of branches	4.84	3.61	1.69	1.00
No of leaves	0.36	0.09	0.09	0.04
Plant height	3.24	3.24	1.0	0.49
Canopy spread	2.25	0.36	0.36	0.09
No of pods	5.76	4.00	3.61	1.44
Pod weight	9.00	24.01	17.64	3.24
100 kernel weight	7.29	9.61	7.84	1.69
Sub total	**32.74**	**44.92**	**32.23**	**7.99**
Combined contributions				
No of branches and no of leaves	3.81	4.29	3.18	4.29
No of branches and plant height	0.02	0.07	0.08	0.07
No of branches and canopy spread	0.15	0.24	0.22	0.24
No of branches and No of pods	1.51	4.97	5.62	4.97
No of branches and pod weight	0.11	0.38	0.43	0.38
No of branches and 100 kernel weight	0.80	0.60	0.26	0.60
No of leaves and plant height	0.03	0.03	0.02	0.03
No of leaves and canopy spread	0.51	1.11	1.14	1.11
No of leaves and No of pods	-0.004	-0.004	-0.002	-0.004
No of leaves and pod weight	0.04	0.07	0.06	0.07
No of leaves and 100 seed weight	0.06	0.05	0.02	0.05
Plant height and canopy spread	-0.01	-0.01	-0.001	-0.006
Plant height and No of pods	0.02	0.05	0.05	0.0475
Plant height and pod weight	0.01	0.04	0.04	0.035
Plant height and 100 seed weight	0.01	0.06	0.07	0.0575
Canopy spread and No of pods	0.46	0.30	0.09	0.2975
Canopy spread and pod weight	0.01	0.03	0.03	0.0275
Canopy spread and 100 seed weight	0.04	0.25	0.30	0.245
No of pods and pod weight	0.04	0.52	0.66	0.515
No of pods and 100 seed weight	0.19	0.24	0.19	0.2375
Pod weight and 100 seed weight	39.42	29.26	39.40	49.26
Sub total	**47.23**	**42.55**	**51.86**	**62.51**
Total	**79.97**	**87.47**	**84.10**	**70.51**
Residual	**20.03**	**12.53**	**15.91**	**29.49**

4. 26 Profitability Analysis

Effect of poultry manure and weed control methods on the profitability of three groundnut varieties at Samaru during the wet seasons is shown in Tables 61 and 62. The fixed cost of producing one hectare of groundnut at Samaru in 2012 and 2013 was ₦52,000. In 2012 wet season, among the various combinations of the factors the highest net farm income was from combinations of 1.5 tonnes ha^{-1} of poultry manure, two hoe weeding and SAMNUT 11, applications of 1.5 tonnes ha^{-1} poultry manure, 0.162 kg a.i.ha^{-1} of the herbicide and SAMNUT 11, application of 1.5 tonnes ha^{-1} of poultry manure, two hoe weeding and SAMNUT 22 and combinations of 1.5 tonnes ha^{-1} of poultry manure, two hoe weeding and SAMNUT 23 in that order. In 2013 wet season, combinations of 1.5 tonnes ha^{-1} of poultry manure, two hoe weeding and SAMNUT 11was also the highest, which was followed by the combinations of 3.0 tonnes ha^{-1} of poultry manure, two hoe weeding and SAMNUT 11, applications of 1.5 tonnes ha^{-1} poultry manure, 0.162 kg a.i.ha^{-1} of the herbicide and SAMNUT 11 and, application of 1.5 tonnes ha^{-1} of poultry manure, two hoe weeding and SAMNUT 22 in that order.

Effect of poultry manure and weed control methods on the profitability of three groundnut varieties at Kadawa during the dry seasons is shown in Tables 63 and 64. The fixed cost of producing one hectare of groundnut at Kadawa in 2012 and 2013 was ₦62,000. The combinations of 1.5 tonnes ha^{-1} of poultry manure, two hoe weeding and SAMNUT 11 was also the highest, which was followed by the applications of 3.0 tonnes ha^{-1} of poultry manure, two hoe weeding and SAMNUT 11, applications of 1.5 tonnes ha^{-1} poultry manure, 0.162 kg a.i.ha^{-1} of the herbicide and SAMNUT 11 and the applications of 3.0 tonnes ha^{-1} of poultry manure, 0.162 kg a.i.ha^{-1} of the herbicide and SAMNUT 11 in both years.

Table 61: Effect of poultry manure and weed control methods on the profitability of three groundnut varieties at Samaru during the 2012 wet season.

Treatments	Pod yield (kg)	Haulm yield (kg)	Revenue from pod (₦)	Revenue from haulm(₦)	Total revenue (₦)	Total fixed cost (₦)	Total variable cost (₦	Total cost (₦)	Net farm income (₦)
P1W1V1	1,857	2,723	185,700	136,150	321,850	52,000	13,000	65,000	256,850
P1W1V2	1,762	2,566	176,200	128,300	304,500	52,000	13,000	65,000	239,500
P1W1V3	1,734	2,516	173,400	125,800	299,200	52,000	13,000	65,000	234,200
P1W2V1	1,941	2,903	194,100	145,150	339,250	52,000	16,500	68,500	270,750
P1W2V2	1,846	2,746	184,600	137,300	321,900	52,000	16,500	68,500	253,400
P1W2V3	1,818	2,697	181,800	134,850	316,650	52,000	16,500	68,500	248,150
P1W3V1	1,964	2,910	196,400	145,500	341,900	52,000	18,000	70,000	271,900
P1W3V2	1,869	2,753	186,900	137,650	324,550	52,000	18,000	70,000	254,550
P1W3V3	1,841	2,703	184,100	135,150	319,250	52,000	18,000	70,000	249,250
P1W4V1	2,098	3,078	209,800	153,900	363,700	52,000	19,500	71,500	292,200
P1W4V2	2,003	2,921	200,300	146,050	346,350	52,000	19,500	71,500	274,850
P1W4V3	1,975	2,871	197,500	143,550	341,050	52,000	19,500	71,500	269,550
P1W5V1	2,160	3,253	216,000	162,650	378,650	52,000	28,000	80,000	298,650
P1W5V2	2,065	3,096	206,500	154,800	361,300	52,000	28,000	80,000	281,300
P1W5V3	2,037	3,046	203,700	152,300	356,000	52,000	28,000	80,000	276,000
P2W1V1	2,209	3,208	220,900	160,400	381,300	52,000	33,000	85,000	296,300
P2W1V2	2,114	3,051	211,400	152,550	363,950	52,000	33,000	85,000	278,950
P2W1V3	2,086	3,001	208,600	150,050	358,650	52,000	33,000	85,000	273,650
P2W2V1	2,293	3,388	229,300	169,400	398,700	52,000	36,500	88,500	310,200
P2W2V2	2,198	3,231	219,800	161,550	381,350	52,000	36,500	88,500	292,850
P2W2V3	2,170	3,181	217,000	159,050	376,050	52,000	36,500	88,500	287,550
P2W3V1	2,316	3,394	231,600	169,700	401,300	52,000	38,000	90,000	311,300
P2W3V2	2,220	3,237	222,000	161,850	383,850	52,000	38,000	90,000	293,850
P2W3V3	2,192	3,188	219,200	159,400	378,600	52,000	38,000	90,000	288,600

P2W4V1	2,450	3,563	245,000	178,150	423,150	52,000	39,500	91,500	331,650
P2W4V2	2,355	3,406	235,500	170,300	405,800	52,000	39,500	91,500	314,300
P2W4V3	2,327	3,356	232,700	167,800	400,500	52,000	39,500	91,500	309,000
P2W5V1	2,512	3,737	251,200	186,850	438,050	52,000	48,000	100,000	338,050
P2W5V2	2,416	3,580	241,600	179,000	420,600	52,000	48,000	100,000	320,600
P2W5V3	2,388	3,531	238,800	176,550	415,350	52,000	48,000	100,000	315,350
P3W1V1	2,008	3,435	200,800	171,750	372,550	52,000	48,000	100,000	272,550
P3W1V2	1,913	3,278	191,300	163,900	355,200	52,000	48,000	100,000	255,200
P3W1V3	1,885	3,228	188,500	161,400	349,900	52,000	48,000	100,000	249,900
P3W2V1	2,092	3,615	209,200	180,750	389,950	52,000	51,500	103,500	286,450
P3W2V2	1,997	3,458	199,700	172,900	372,600	52,000	51,500	103,500	269,100
P3W2V3	1,969	3,409	196,900	170,450	367,350	52,000	51,500	103,500	263,850
P3W3V1	2,115	3,622	211,500	181,100	392,600	52,000	53,000	105,000	287,600
P3W3V2	2,019	3,465	201,900	173,250	375,150	52,000	54,500	106,500	268,650
P3W3V3	1,991	3,415	199,100	170,750	369,850	52,000	54,500	106,500	263,350
P3W4V1	2,249	3,790	224,900	189,500	414,400	52,000	54,500	106,500	307,900
P3W4V2	2,154	3,633	215,400	181,650	397,050	52,000	54,500	106,500	290,550
P3W4V3	2,126	3,583	212,600	179,150	391,750	52,000	54,500	106,500	285,250
P3W5V1	2,311	3,965	231,100	198,250	429,350	52,000	63,000	115,000	314,350
P3W5V2	2,215	3,808	221,500	190,400	411,900	52,000	63,000	115,000	296,900
P3W5V3	2,187	3,758	218,700	187,900	406,600	52,000	63,000	115,000	291,600

P1= control, P2 =1.5 tonnes ha^{-1} of poultry manure and P3= 1.5 tonnes ha^{-1} of poultry manure,
W1= weedy check, W2 =0.054 kg a.i. ha^{-1}, W3= 0.108 kg a.i. ha, W4= 0.162 kg a.i. ha^{-1} of Haloxyfop – R –methyl ester and W5= Two hoe weeding at 3 and 6WAS
V1=SAMNUT 11, V2= SAMNUT 22and V3 SAMNUT 23

Table 62:Effect of poultry manure and weed control methods on the profitability of three groundnut varieties at Samaru during the 2013 wet season at Samaru

Treatments	Pod yield (kg)	Haulm yield (kg)	Revenue from pod (₦)	Revenue from haulm(₦)	Total revenue (₦)	Total fixed cost (₦)	Total variable cost (₦	Total cost (₦)	Net farm income (₦)
P1W1V1	1904	2824	190400	141,200	331,600	52,000	13,000	65,000	266,600
P1W1V2	1809	2648	180900	132,400	313,300	52,000	13,000	65,000	248,300
P1W1V3	1758	2559	175800	127,950	303,750	52,000	13,000	65,000	238,750
P1W2V1	1972	3009	197200	150,450	347,650	52,000	16,500	68,500	279,150
P1W2V2	1876	2833	187600	141,650	329,250	52,000	16,500	68,500	260,750
P1W2V3	1826	2744	182600	137,200	319,800	52,000	16,500	68,500	251,300
P1W3V1	2028	3040	202800	152,000	354,800	52,000	18,000	70,000	284,800
P1W3V2	1932	2864	193200	143,200	336,400	52,000	18,000	70,000	266,400
P1W3V3	1882	2775	188200	138,750	326,950	52,000	18,000	70,000	256,950
P1W4V1	2129	3217	212900	160,850	373,750	52,000	19,500	71,500	302,250
P1W4V2	2033	3041	203300	152,050	355,350	52,000	19,500	71,500	283,850
P1W4V3	1983	2952	198300	147,600	345,900	52,000	19,500	71,500	274,400
P1W5V1	2241	3413	224100	170,650	394,750	52,000	28,000	80,000	314,750
P1W5V2	2145	3237	214500	161,850	376,350	52,000	28,000	80,000	296,350
P1W5V3	2095	3148	209500	157,400	366,900	52,000	28,000	80,000	286,900
P2W1V1	2187	3454	218700	172,700	391,400	52,000	33,000	85,000	306,400
P2W1V2	2092	3278	209200	163,900	373,100	52,000	33,000	85,000	288,100
P2W1V3	2041	3189	204100	159,450	363,550	52,000	33,000	85,000	278,550
P2W2V1	2255	3639	225500	181,950	407,450	52,000	36,500	88,500	318,950
P2W2V2	2159	3462	215900	173,100	389,000	52,000	36,500	88,500	300,500
P2W2V3	2109	3374	210900	168,700	379,600	52,000	36,500	88,500	291,100
P2W3V1	2311	3670	231100	183,500	414,600	52,000	38,000	90,000	324,600
P2W3V2	2215	3494	221500	174,700	396,200	52,000	38,000	90,000	306,200

P2W3V3	2165	3405	216500	170,250	386,750	52,000	38,000	90,000	296,750
P2W4V1	2412	3847	241200	192,350	433,550	52,000	39,500	91,500	342,050
P2W4V2	2316	3670	231600	183,500	415,100	52,000	39,500	91,500	323,600
P2W4V3	2266	3582	226600	179,100	405,700	52,000	39,500	91,500	314,200
P2W5V1	2524	4043	252400	202,150	454,550	52,000	48,000	100,000	354,550
P2W5V2	2428	3866	242800	193,300	436,100	52,000	48,000	100,000	336,100
P2W5V3	2378	3778	237800	188,900	426,700	52,000	48,000	100,000	326,700
P3W1V1	2115	3729	211500	186,450	397,950	52,000	48,000	100,000	297,950
P3W1V2	2020	3553	202000	177,650	379,650	52,000	48,000	100,000	279,650
P3W1V3	1969	3464	196900	173,200	370,100	52,000	48,000	100,000	270,100
P3W2V1	2182	3914	218200	195,700	413,900	52,000	51,500	103,500	310,400
P3W2V2	2087	3737	208700	186,850	395,550	52,000	51,500	103,500	292,050
P3W2V3	2036	3649	203600	182,450	386,050	52,000	51,500	103,500	282,550
P3W3V1	2238	3945	223800	197,250	421,050	52,000	53,000	105,000	316,050
P3W3V2	2143	3769	214300	188,450	402,750	52,000	54,500	106,500	296,250
P3W3V3	2092	3680	209200	184,000	393,200	52,000	54,500	106,500	286,700
P3W4V1	2339	4122	233900	206,100	440,000	52,000	54,500	106,500	333,500
P3W4V2	2244	3945	224400	197,250	421,650	52,000	54,500	106,500	315,150
P3W4V3	2193	3857	219300	192,850	412,150	52,000	54,500	106,500	305,650
P3W5V1	2451	4318	245100	215,900	461,000	52,000	63,000	115,000	346,000
P3W5V2	2356	4141	235600	207,050	442,650	52,000	63,000	115,000	327,650
P3W5V3	2305	4053	230500	202,650	433,150	52,000	63,000	115,000	318,150

P1= control, P2 =1.5 tonnes ha^{-1} of poultry manure and P3= 1.5 tonnes ha^{-1} of poultry manure,
W1= weedy check, W2 =0.054 kg a.i. ha^{-1}, W3= 0.108 kg a.i. ha, W4= 0.162 kg a.i. ha^{-1} of Haloxyfop – R –methyl ester and W5= Two hoe weeding at 3 and 6WAS
V1=SAMNUT 11, V2= SAMNUT 22and V3 SAMNUT 23

Table 63: Effect of poultry manure and weed control methods on the profitability of three groundnut varieties at Kadawa during the 2012 dry season.

Treatments	Pod yield (kg)	Haulm yield (kg)	Revenue from pod (₦)	Revenue from haulm(₦)	Total revenue (₦)	Total fixed cost (₦)	Total variable cost (₦	Total cost (₦)	Net farm income (₦)
P1W1V1	1824	2682	228000	160,920	388,920	62,000	13,000	75,000	313,920
P1W1V2	1735	2515	216875	150,900	367,775	62,000	13,000	75,000	292,775
P1W1V3	1707	2466	213375	147,960	361,335	62,000	13,000	75,000	286,335
P1W2V1	1903	2851	237875	171,060	408,935	62,000	16,500	78,500	330,435
P1W2V2	1813	2685	226625	161,100	387,725	62,000	16,500	78,500	309,225
P1W2V3	1785	2635	223125	158,100	381,225	62,000	16,500	78,500	302,725
P1W3V1	1931	2869	241375	172,140	413,515	62,000	18,000	80,000	333,515
P1W3V2	1841	2702	230125	162,120	392,245	62,000	18,000	80,000	312,245
P1W3V3	1813	2652	226625	159,120	385,745	62,000	18,000	80,000	305,745
P1W4V1	2088	3143	261000	188,580	449,580	62,000	19,500	81,500	368,080
P1W4V2	1998	2976	249750	178,560	428,310	62,000	19,500	81,500	346,810
P1W4V3	1970	2926	246250	175,560	421,810	62,000	19,500	81,500	340,310
P1W5V1	2183	3310	272875	198,600	471,475	62,000	28,000	90,000	381,475
P1W5V2	2093	3143	261625	188,580	450,205	62,000	28,000	90,000	360,205
P1W5V3	2065	3093	258125	185,580	443,705	62,000	28,000	90,000	353,705
P2W1V1	2152	3330	269000	199,800	468,800	62,000	33,000	95,000	373,800
P2W1V2	2062	3163	257750	189,780	447,530	62,000	33,000	95,000	352,530
P2W1V3	2034	3113	254250	186,780	441,030	62,000	33,000	95,000	346,030
P2W2V1	2230	3499	278750	209,940	488,690	62,000	36,500	98,500	390,190
P2W2V2	2141	3332	267625	199,920	467,545	62,000	36,500	98,500	369,045
P2W2V3	2113	3283	264125	196,980	461,105	62,000	36,500	98,500	362,605
P2W3V1	2259	3516	282375	210,960	493,335	62,000	38,000	100,000	393,335
P2W3V2	2169	3350	271125	201,000	472,125	62,000	38,000	100,000	372,125

P2W3V3	2141	3300	267625	198,000	465,625	62,000	38,000	100,000	365,625
P2W4V1	2415	3790	301875	227,400	529,275	62,000	39,500	101,500	427,775
P2W4V2	2326	3624	290750	217,440	508,190	62,000	39,500	101,500	406,690
P2W4V3	2298	3574	287250	214,440	501,690	62,000	39,500	101,500	400,190
P2W5V1	2511	3957	313875	237,420	551,295	62,000	48,000	110,000	441,295
P2W5V2	2421	3791	302625	227,460	530,085	62,000	48,000	110,000	420,085
P2W5V3	2393	3741	299125	224,460	523,585	62,000	48,000	110,000	413,585
P3W1V1	2066	3645	258250	218,700	476,950	62,000	48,000	110,000	366,950
P3W1V2	1976	3479	247000	208,740	455,740	62,000	48,000	110,000	345,740
P3W1V3	1948	3429	243500	205,740	449,240	62,000	48,000	110,000	339,240
P3W2V1	2144	3815	268000	228,900	496,900	62,000	51,500	113,500	383,400
P3W2V2	2055	3648	256875	218,880	475,755	62,000	51,500	113,500	362,255
P3W2V3	2027	3598	253375	215,880	469,255	62,000	51,500	113,500	355,755
P3W3V1	2173	3832	271625	229,920	501,545	62,000	53,000	115,000	386,545
P3W3V2	2083	3665	260375	219,900	480,275	62,000	54,500	116,500	363,775
P3W3V3	2055	3616	256875	216,960	473,835	62,000	54,500	116,500	357,335
P3W4V1	2329	4106	291125	246,360	537,485	62,000	54,500	116,500	420,985
P3W4V2	2240	3939	280000	236,340	516,340	62,000	54,500	116,500	399,840
P3W4V3	2212	3890	276500	233,400	509,900	62,000	54,500	116,500	393,400
P3W5V1	2425	4273	303125	256,380	559,505	62,000	63,000	125,000	434,505
P3W5V2	2335	4106	291875	246,360	538,235	62,000	63,000	125,000	413,235
P3W5V3	2307	4057	288375	243,420	531,795	62,000	63,000	125,000	406,795

P1= control, P2 =1.5 tonnes ha^{-1} of poultry manure and P3= 1.5 tonnes ha^{-1} of poultry manure,
W1= weedy check, W2 =0.054 kg a.i. ha^{-1}, W3= 0.108 kg a.i. ha, W4= 0.162 kg a.i. ha^{-1} of Haloxyfop – R –methyl ester and W5= Two hoe weeding at 3 and 6WAS
V1=SAMNUT 11, V2= SAMNUT 22and V3 SAMNUT 23

Table 64: Effect of poultry manure and weed control methods on the profitability of three groundnut varieties at Kadawa during the 2013 dry season.

Treatments	Pod yield (kg)	Haulm yield (kg)	Revenue from pod (₦)	Revenue from haulm(₦)	Total revenue (₦)	Total fixed cost (₦)	Total variable cost (₦	Total cost (₦)	Net farm income (₦)
P1W1V1	2,053	3,127	256625	187,620	444,245	62,000	13,000	75,000	369,245
P1W1V2	1,935	2,921	241875	175,260	417,135	62,000	13,000	75,000	342,135
P1W1V3	1,862	2,794	232750	167,640	400,390	62,000	13,000	75,000	325,390
P1W2V1	2,131	3,265	266375	195,900	462,275	62,000	16,500	78,500	383,775
P1W2V2	2,013	3,059	251625	183,540	435,165	62,000	16,500	78,500	356,665
P1W2V3	1,941	2,931	242625	175,860	418,485	62,000	16,500	78,500	339,985
P1W3V1	2,221	3,422	277625	205,320	482,945	62,000	18,000	80,000	402,945
P1W3V2	1,577	2,412	197125	144,720	341,845	62,000	18,000	80,000	261,845
P1W3V3	2,030	3,088	253750	185,280	439,030	62,000	18,000	80,000	359,030
P1W4V1	2,395	3,726	299375	223,560	522,935	62,000	19,500	81,500	441,435
P1W4V2	2,277	3,520	284625	211,200	495,825	62,000	19,500	81,500	414,325
P1W4V3	2,204	3,392	275500	203,520	479,020	62,000	19,500	81,500	397,520
P1W5V1	2,490	3,893	311250	233,580	544,830	62,000	28,000	90,000	454,830
P1W5V2	2,372	3,686	296500	221,160	517,660	62,000	28,000	90,000	427,660
P1W5V3	2,299	3,559	287375	213,540	500,915	62,000	28,000	90,000	410,915
P2W1V1	2,374	3,706	296750	222,360	519,110	62,000	33,000	95,000	424,110
P2W1V2	2,256	3,500	282000	210,000	492,000	62,000	33,000	95,000	397,000
P2W1V3	2,184	3,373	273000	202,380	475,380	62,000	33,000	95,000	380,380
P2W2V1	2,453	3,844	306625	230,640	537,265	62,000	36,500	98,500	438,765
P2W2V2	2,335	3,638	291875	218,280	510,155	62,000	36,500	98,500	411,655
P2W2V3	2,262	3,510	282750	210,600	493,350	62,000	36,500	98,500	394,850
P2W3V1	2,543	4,001	317875	240,060	557,935	62,000	38,000	100,000	457,935

P2W3V2	2,425	3,795	303125	227,700	530,825	62,000	38,000	100,000	430,825
P2W3V3	2,352	3,667	294000	220,020	514,020	62,000	38,000	100,000	414,020
P2W4V1	2,716	4,305	339500	258,300	597,800	62,000	39,500	101,500	496,300
P2W4V2	2,598	4,099	324750	245,940	570,690	62,000	39,500	101,500	469,190
P2W4V3	2,526	3,971	315750	238,260	554,010	62,000	39,500	101,500	452,510
P2W5V1	2,812	4,472	351500	268,320	619,820	62,000	48,000	110,000	509,820
P2W5V2	2,694	4,265	336750	255,900	592,650	62,000	48,000	110,000	482,650
P2W5V3	2,621	4,138	327625	248,280	575,905	62,000	48,000	110,000	465,905
P3W1V1	2,277	3,935	284625	236,100	520,725	62,000	48,000	110,000	410,725
P3W1V2	2,159	3,728	269875	223,680	493,555	62,000	48,000	110,000	383,555
P3W1V3	2,087	3,601	260875	216,060	476,935	62,000	48,000	110,000	366,935
P3W2V1	2,356	4,072	294500	244,320	538,820	62,000	51,500	113,500	425,320
P3W2V2	2,238	3,866	279750	231,960	511,710	62,000	51,500	113,500	398,210
P3W2V3	2,165	3,739	270625	224,340	494,965	62,000	51,500	113,500	381,465
P3W3V1	2,446	4,229	305750	253,740	559,490	62,000	53,000	115,000	444,490
P3W3V2	2,328	4,023	291000	241,380	532,380	62,000	54,500	116,500	415,880
P3W3V3	2,255	3,896	281875	233,760	515,635	62,000	54,500	116,500	399,135
P3W4V1	2,619	4,533	327375	271,980	599,355	62,000	54,500	116,500	482,855
P3W4V2	2,501	4,327	312625	259,620	572,245	62,000	54,500	116,500	455,745
P3W4V3	2,429	4,200	303625	252,000	555,625	62,000	54,500	116,500	439,125
P3W5V1	2,715	4,700	339375	282,000	621,375	62,000	63,000	125,000	496,375
P3W5V2	2,597	4,494	324625	269,640	594,265	62,000	63,000	125,000	469,265
P3W5V3	2,524	4,366	315500	261,960	577,460	62,000	63,000	125,000	452,460

P1= control, P2 =1.5 tonnes ha^{-1} of poultry manure and P3= 1.5 tonnes ha^{-1} of poultry manure,
W1= weedy check, W2 =0.054 kg a.i. ha^{-1}, W3= 0.108 kg a.i. ha, W4= 0.162 kg a.i. ha^{-1} of Haloxyfop – R –methyl ester and W5= Two hoe weeding at 3 and 6WAS
V1=SAMNUT 11, V2= SAMNUT 22and V3 SAMNUT 23

CHAPTER FIVE

5.0 DISCUSSION

5.1 General Discussion

The results of the poultry manure analysis (Appendix I) showed that it contained nitrogen, phosphorous, potassium, calcium, magnesium and ash. The soil analysis also in appendix II indicated a sandy loam soil and the pH was slightly acidic in all the years and neutral at Samaru in 2012. The soil was generally low in organic carbon, total nitrogen and phosphorous but high in potassium as classified by (FMARD, 2002). Similarly, the good environmental factors (total rainfall, temperatures, sunshine and relative humidity) recorded in the study area as shown in appendix III fall within the optimum range for groundnut production as reported by (Anon.,2002) may have contributed to the good performance of the crop in general.

5.2 Effect of Poultry Manure on Growth and Yield of Groundnut

The significant increases in growth characters such as plant height, canopy spread, shoot dry weight, number of branches, number of leaves, crop growth rate and relative growth rate, as well as reduction in days to flowering, reduced weed infestation, increased yield and yield characters could be attributed to the fact that poultry manure contains nitrogen, phosphorous and potassium in addition to other micronutrients such as calcium, magnesium and ash that are essential for plant growth and development. It has been reported that nitrogen helps in photosynthetic activities, vigorous growth and dark green colour of the leaves (Kamara *et al.,* 2011). Phosphorous is essential in photosynthesis, respiration, energy storage and cell division while potassium is known to increase the availability of other nutrients essential for growth and development. It has also been reported that adequate calcium helps in germination, increased crop vigour and pod filling (Schilling and Gibbons, 2002). Magnesium (Mg) has also been found to help in protein synthesis and N fixation in groundnut (Schilling and Gibbons, 2002). The ash in the manure also helps to reduce soil acidity as reported by (Schilling and Gibbons, 2002). Apart from the nutrient supplying power of poultry manure, it also provides an excellent source of organic matter, which improves the structural characteristic of the soil. The structural improvement results in increase water holding capacity, aeration and drainage which enhance good root growth and development.

This work is in line with the work of Reddy and Guri (1989), who observed that, application of poultry manure has been found to decrease the adsorption capacity and increased the soluble phosphorous and desorption. Yanduraju *et al.* (1980) reported that application of poultry manure increased the available phosphorous content of the soil. It can be concluded that the application of essential nutrients which are available in poultry manure was responsible for the significant increase in the growth and yield of plots where poultry manure was applied.

Application of poultry manure beyond 1.5 tonnes ha^{-1} resulted in more vegetative growth and decreased yield, which is in line with the work of Mubarak (2004), and Ahmed *et al.* (2010) that reported excessive haulm yield when poultry manure was applied in excess of 5 tonnes ha^{-1}. The poor performance in plots where poultry manure was not applied when compared to where poultry manure was applied could be due to deficit in the essential nutrients, thereby resulting to low yield in the control**.**

5.3 Effect of Weed Control Methods on Growth and Yield Characters of Groundnut

The highest results obtained with two hoe weeding was due to good weed control that allowed vigorous growth of the crop and development of larger vegetative parts with consequent high light interception for increased dry matter production. This is further confirmed by low crop performance in the weedy check with respect to growth and yield characters. This low performance could be attributed to the effect of weeds resulting from interference and competition with the crops for moisture, nutrients, sunlight and space. Weeds led to yield loss of crops generally and specifically groundnut as observed by Ahmed *et al*. (2010) who reported significant decrease in plant height, number of branches in the weedy check when compared to two hoe weeding. Similarly, Yadava and Kaura (2007) and Weiss (1983) reported that uncontrolled weed in groundnut led to significant decrease in number of branches and pod yield and concluded that significant differences were due to competition for light, nutrient and space to allow the groundnut to grow. Pannu *et al.* (1991) reported that the partioning of biomass in groundnut was significantly affected by the presence of weeds during the whole season and therefore both dry weight and yield were significantly less in the plot kept weedy. According to Prusty *et al.* (1990) yield of groundnut was reduced by 25 to 70 % depending on the intensity of weed infestation. They concluded that groundnut crop is highly sensitive to competition by weeds and yield reduction could be severe reaching up to 70%. Weedy conditions in the weedy check treatment reduced pod yield to 36 % as compared to integrated weed control methods (Jhala *et al.,* 2010). Clewis et *al*. (2007) reported that the presence of weeds in groundnut reduced harvesting efficiency and increased yield losses up to 40%.

The highest herbicide rate of 0.162 kg a.i. ha^{-1} Haloxyfop- R- methyl ester applied gave good weed control as compared to the other rates. This could be due to the fact that herbicides exhibit their herbicidal effect with increasing dosage, which results not only in the drastic reduction of susceptible weeds but also in increased crop vigour and dry matter accumulation resulting to high pod yield. The highest rate was able to control all the grass family including *Panicum maximum* and *Paspalum* spp., which were not controlled by the lower rates. In addition, some broadleaves were partially controlled thereby reducing both weed density and types, making it more effective over the other lower rates that were not able to control even all the grass family members.

5.4 Varietal Response

Crops differ in their ability to assimilate photosynthates and partition of assimilates to growth and yield components. This difference has some effects on how efficiently water and nutrients can be utilized by the crop for production. The varieties used in this experiment exhibited consistent significant differences in their growth characters such as plant height, canopy spread, and shoot dry weight, number of branches, crop growth rate and days to 50% flowering. These differences could be attributed to variations in their genetic makeup and gene interaction with environment (moisture, abundant sunshine, soil fertility) as well as crop management (weed control and poultry manure treatments employed). Similar findings were reported by Patel *et al.* (2008) that varieties of groundnut differ in their potential productivity. Stephen (2009) also reported differences in the performance of four varieties of groundnut in Ghana and concluded that the large seeded varieties outperformed the small seeded in both wet and dry seasons. SAMNUT 11 had robust growth in both locations and seasons than the other varieties. SAMNUT 23 has erect bunch growth habit and flowered earlier than the other two varieties. The high CGR recorded by SAMNUT 23 might have been as result of its early maturity. The heavy branching in SAMNUT11 gave it some advantages for weed suppression as evident by low weed cover score and weed control efficiency. The ability of SAMNUT 11 to efficiently smother weeds and intercept more solar radiation might have led to its high dry matter production as well as pod yield. The poor performance of SAMNUT 23 could be attributed to its short life cycle, which is genetically lower yielding than SAMNUT 11 and SAMNUT 22 that has longer life cycles. SAMNUT 22 performed better than SAMNUT 23 but lower than SAMNUT 11 in all the parameters measured, probably due to the fact that it has moderate characteristics between SAMNUT 23 and SAMNUT 11.

5.5 Interactions

The use of 1.5 tonnes ha^{-1} of poultry manure with any of the weed control methods resulted in significant increase in pod yield. This could be due to adequate amount of nutrient in particular N achieved at this rate. Because further increase in poultry manure rate generally depressed pod, probably the high N content at this rate might have stimulate high vegetative growth at the expense of pod yield. The high pod yield generally recorded by two hoe weeding at each level of the poultry manure level when compared to the use of the herbicide and the weedy check could be due to the fact that this control method was non selective in weed control thereby reducing competition for environmental factors leading to better yield. The herbicide was observed to control mostly grasses leaving broadleaves and sedges that continue to compete with the crop for growth resources. Groundnut plots sprayed with 54 g a.i.ha^{-1} or 108 g a.i. ha^{-1} or on the other hand 108 g a.i. ha^{-1} or 162 g a.i. ha^{-1} of Haloxyfop-R-methyl ester and supplied with 1.5 tonnes ha^{-1} of poultry manure did not differ significantly in pod yield because of the ability of the herbicide to suppress the grass weeds thereby reducing the competition for growth factor. The least pod yield recorded by the weedy check could be attributed to stiff competition between crop and the weeds for environmental resources. Similar finding were earlier reported by Adekpe (2005) that good weed suppression allows greater efficiency in the use of the available growth resources in garlic.

5.6 Polynomial Response

The R^2 Value of 1 indicated that the model best described the relationship between poultry manure and the yield and therefore it is adequate to use this equation to carry out optimization. In optimizing for pod yield it was discovered that an increase beyond 1.5 tonnes ha^{-1} resulted in optimum pod production depending on the soil and poultry manure nutrients. This implies that optimum was not achieved using 1.5 tonnes ha^{-1} for pod production.

5.7 Correlation and Path Coefficient Analysis

The significant and positive correlations between pod yield and growth characters indicated the importance of good vegetative development as being necessary for high yields. This is in conformity with the work of Wright (1934) who noted a highly significant positive relationship between pod yield and vegetative characters. The positive significant relationships between pod yield and yield characters indicate that these characters are important yield indices (Mukhtar, *et al.*, 2013). All the direct and indirect effects were positive throughout the period under consideration, which suggests that these characters are important in pod production and the higher the direct or indirect effects the most critical determinant in pod production and thus constitute important characters that the breeders should consider when breeding for high yielding groundnut varieties.

5.8 Profitability

The profitability analysis showed that the combinations of 1.5 tonnes ha^{-1} of poultry manure, two hoe weeding and SAMNUT 11 gave the highest net farm income. This is because the highest pod yield was obtained when 1.5 tonnes ha^{-1} of poultry manure was applied; also the highest pod and haulm yield were obtained from two hoe weeding while SAMNUT 11 produced the highest pod and haulm yield. This combination gave the highest revenue which also gave the highest net farm income.

CHAPTER SIX

6.0 SUMMARY AND CONCLUSIONS

6.1 Summary

Field trials were conducted during the 2012 and 2013 rainy seasons at the Teaching and Research Farm of Samaru College of Agriculture, Ahmadu Bello University Zaria and in 2012/2013 and 2013/2014 dry seasons at the Irrigation Research Station of the Institute for Agricultural Research Kadawa. The treatments consisted of three levels of poultry manure (0, 1.5 and 3 tonnes ha^{-1}), five weed control methods, which included three rates of post emergence herbicide (0.054 kg a.i.ha^{-1}, 0.108 kg a.i ha^{-1} and 0.162 kg a.i ha^{-1} of Haloxyfop-R-methyl ester), weedy check, and hoe weeding at 3 and 6 weeks after sowing (WAS) and three varieties of groundnut (SAMNUT 11, SAMNUT 22 and SAMNUT 23). The treatments were laid out in a split-plot design with factorial combinations of the weed control methods and poultry manure occupying the main plot while the varieties were allocated to the subplots. The treatments were replicated three times.

The results from the study revealed that application of 3.0 tonnes ha^{-1} of poultry manure significantly increased growth parameters such as plant height $plant^{-1}$, shoot dry weight $plant^{-1}$, number of branches $plant^{-1}$, number of leaves $plant^{-1}$, crop growth rate and relative growth rate. Days to 50% flowering was reduced by the application of 3.0 tonnes ha^{-1} of poultry manure. Application of 3.0 tonnes ha^{-1} of poultry manure increased both the crop vigour score and weed control efficiencies of the groundnut plant. Application of poultry manure increased pod weight $plot^{-1}$, 100 kernel weight and pod yield ha^{-1} however, a further increase from 1.5 tonnes ha^{-1} to 3.0 tonnes ha^{-1} resulted in significant decrease in these yield characters. Application of 3.0 tonnes ha^{-1} of poultry manure resulted in significant haulms production.

Among the weed control methods evaluated, two hoe weeding resulted in significant increase in growth characters such as plant height plant^{-1}, shoot dry weight plant^{-1}, number of branches plant^{-1}, number of leaves plant^{-1}, crop growth rate and relative growth rate, while days to 50% flowering was significantly reduced by two hoe weeding. Similarly, two hoe weeding resulted in highest crop vigour and highest weed control efficiency. Other weed control parameters such as crop injury, weed cover, weed dry weight were significantly reduced by two hoe weeding. Yield and yield characters such as number of pods plant^{-1}, pod weight plant^{-1}, 100 kernel weight, harvest index, haulm yield and pod yield ha^{-1} were significantly increased by two hoe weeding. Among the herbicide rates evaluated, the highest rate of 0.162 kg a.i. ha^{-1} of Haloxyfop-R-methyl ester resulted in significant increase in all the growth characters, while days to 50% flowering were significantly reduced, but characters such as crop injury, weed cover and weed dry weight were highest in the weedy check. Other weed control parameters such as weed cover and weed dry weight were significantly reduced by the application of 0.162kg a.i. ha^{-1} of Haloxyfop-R-methyl ester while weed control efficiency was significantly higher when applied to groundnut at 3WAS. Yield and yield characters such as number of pods plant^{-1}, pod weight plant^{-1}, 100 kernel weight, harvest index, haulm yield and pod yield ha^{-1} were also significantly increased by the application of 0.162kg a.i. ha^{-1} of Haloxyfop-R-methyl ester.

SAMNUT 11 produced the tallest plant, shoot dry weight plant^{-1}, number of branches plant^{-1}, number of leaves plant^{-1}, crop growth rate and relative growth rate, number of days to 50%, crop vigor and lowest weed cover score and dry weight in both locations. Similarly, yield and yield characters such as number of pods plant^{-1}, pod weight plant^{-1}, 100 kernel weight, harvest index, haulm yield and pod yield ha^{-1} were highest in SAMNUT 11 in both locations.

The optimum rates of 1.70 tonnes ha^{-1}, 1.95 tonnes $ha^{-1}$and 1.83 tonnes ha^{-1} were obtained in 2012 and 2013 wet seasons and the combined to give a yield of 2,725kg, 2,472 kg and 2,567 kg ha^{-1}, respectively. The optimum rates of 1.94 tonnes ha^{-1}, 1.90 tonnes ha^{-1} and 1.92 tonnes ha^{-1} were obtained in 2012 and 2013 dry seasons and the combined to give a yield of 2557kg ha^{-1}, 2409kg ha^{-1} and 2483 kg ha^{-1}, respectively.

Pod yield ha^{-1} was positively and highly correlated with number of branches, numbers of leaves, plant height, canopy spread, numbers of pod, pod weight, 100 kernel weight, but was negatively correlated with haulm yield. Pod weight had the highest direct contribution which was followed by 100 kernel weight, number of pods, number of branches, plant height and canopy spread in that order, while number of leaves had the lowest direct contribution. The highest percent individual contribution was from pod weight followed by 100 kernel weight, number of pods, number of branches, plant height, canopy spread and number of leaves in that order. The combined effect of pod weight and 100 kernel weight gave the highest combined contribution while the combined contribution of number of branches and number of pods ranked second except in 2012 wet season where the combined contribution from number of branches and number of leaves ranked second. The least combined contribution was from number of leaves and number of pods and plant height and canopy spread, which resulted in negative values. The percent total individual contributions were 32.74%, 44.92%, 32.23% and 7.99% in 2012 wet season, 2013 wet season, 2012 and 2013 dry seasons, respectively. The total combined contribution were 47.23% in 2012 wet season, 42.55% in 2013 wet season, 51.86% in 2012 dry season and 62.51% in 2013 dry season. The total contribution from both the individual and the combined were 79.97% in 2012 wet season, 87.47% in 2013 wet season, 84.10% in 2012 dry season and 70.51% in 2013 dry season. The residuals, which were the un-accounted contributions from other characters to yield, were 20.03% in 2012 wet season, 12.53% in 2013 wet season, 15.91% in 2012 dry season and 29.49% in 2013 dry season. The profitability analysis showed that the combinations of 1.5 tonnes ha^{-1} of poultry manure, two hoe weeding and SAMNUT 11 gave the highest net farm income.

6.2 Conclusions

From the results of this study it can be concluded that;

- Application of 1.5 tonnes ha^{-1} of poultry manure, which supplied 20 kg N ha^{-1} to the crop, gave the highest pod yield while the application of 3.0 tonnes ha^{-1}, which supplied 40 kg N ha^{-1}, resulted in the best weed control and highest haulm yield.
- Hoe weeding at 3 and 6 WAS gave the best weed control, highest pod and haulm yield, which was followed by the application of 0.162kg a.i. ha^{-1} Haloxyfop – R –methyl ester among the herbicide rates.
- SAMNUT 11 resulted in better weed control, highest pod and haulm yield than SAMNUT 22 and SAMNUT 23.
- All the growth and yield characters such as pod weight, 100 kernel weight, number of pods, number of branches, plant height, canopy spread and number of leaves considered in this work made significant contribution to pod yield and thus constitute important characters when breeding for high yielding varieties.
- The combinations of 1.5 tonnes ha^{-1} of poultry manure, two hoe weeding and SAMNUT 11 gave the highest net farm income.

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Appendix I: Results of poultry manure analysis used for the experiment in 2012 and 2013 wet and dry Seasons at Samaru and Kadawa.

	Wet Seasons (Samaru)		Dry Seasons (Kadawa)	
Parameters (%)	2012	2013	2012	2013
N	1.80	2.90	2.40	2.70
P	1.17	1.23	1.31	1.22
K	1.25	1.66	1.49	1.74
Ca	1.30	5.30	6.23	1.79
Mg	0.30	2.80	2.00	1.80
Ash	20.20	19.00	17.50	18.8

Source: Soil science Department, ABU, Zaria

Appendix II: Results of soil analysis of the experimental site in 2012 and 2013 wet and dry seasons at Samaru and Kadawa

	Wet seasons (Samaru)		Dry seasons (Kadawa)	
Soil Parameters	2012	2013	2013	2013
Particle size distribution (g kg^{-1})				
Clay	160.00	140.00	150.00	120.00
Silt	320.00	220.00	260.00	250.00
Sand	520.00	640.00	590.00	630.00
Textural class	Sandy loam	Sandy loam	Sandy loam	Sandy loam
Chemical properties				
pH in water	6.70	6.25	6.00	6.20
Organic Carbon (g kg^{-1})	9.80	8.70	8.2	9.30
Total N (g kg^{-1})	0.17	0.18	0.16	0.19
Available P (mg kg^{-1})	7.50	7.10	6.90	7.56
Exchangeable Cation				
K (cmol kg^{-1})	0.63	0.62	0.59	0.60
Mg (cmol kg^{-1})	0.91	0.86	0.93	0.92
Ca (cmol kg^{-1})	3.20	3.04	3.08	3.00
Na (cmol kg^{-1})	0.39	0.32	0.37	0.38
CEC (cmol kg^{-1})	4.86	4.52	3.68	3.81

Source: Soil science Department, ABU, Zaria

Appendix III: Meteorological data showing rainfall, temperature, relative humidity and sunshine during the 2012 and 2013 wet seasons at Samaru

2012 Wet Season

Month	Rainfall (mm)	Temperature ^{0}C		Relative humidity (%)	Sunshine (hours)
		Maximum	Minimum		
June	120.70	32.00	12.97	76.10	6.70
July	165.30	30.10	20.30	82.61	5.26
August	426.70	29.10	19.50	82.32	4.48
September	270.30	30.40	19.80	77.23	5.02
October	79.60	33.80	20.80	70.22	7.32
November	0.00	34.30	17.40	32.90	8.59

2013 Wet Season

Month	Rainfall (mm)	Temperature ^{0}C		Relative humidity (%)	Sunshine (hours)
		Maximum	Minimum		
June		31.00	13.03	76.56	6.99
July	223.90	30.80	20.00	79.55	6.26
August	239.00	30.27	19.60	83.00	4.67
September	113.30	32.03	18.90	78.50	6.47
October	54.00	34.07	18.20	73.50	6.60
November	0.00	34.20	11.97	24.80	8.93

Appendix IV: Meteorological data showing mean temperature, relative humidity and sunshine during the 2012 and 2013 dry seasons at Kadawa

2013 Dry Season

Month	Temperature ^{0}C		Relative humidity (%)	Sunshine (hours)
	Maximum	Minimum		
January	30.71	16.29	36.84	8.58
February	34.43	17.96	24.50	9.06
March	40.00	21.29	41.06	8.44
April	39.40	25.03	60.37	8.03
May	39.06	27.29	70.90	9.56

2014 Dry Season

Month	Temperature ^{0}C		Relative humidity (%)	Sunshine (hours)
	Maximum	Minimum		
January	31.32	15.13	21.03	11.95
February	32.82	18.54	28.71	8.74
March	34.43	17.96	24.50	9.06
April	40.00	21.29	41.06	8.44
May	39.40	25.03	60.37	8.03

Appendix V: Fixed and variable cost of producing one hectare of groundnut.

Fixed cost

Cost	**₦ per Hectare**
Fixed cost	
Rent on land	5,000
land clearing	5,000
harrowing and ridging	8,000
cost of insecticides and fungicides	3,000
harvesting and processing	15,000
Supervision	10,000
charge on capital	6,000
Total Fixed cost	**52,000**

Variable cost of producing one hectare of groundnut

Treatments	Cost of inputs (₦)	Cost of applications/ planting (₦)	Total variable cost (₦)
Poultry manure (P)			
0 tonnes ha^{-1}	0	0	0
1.5 tonnes ha^{-1}	15,000	5,000	20,000
3.0 tonnes ha^{-1}	30,000	5,000	35,000
Weed control (W)			
Weedy check	0	0	0
0.054 kg a.i. ha^{-1} of H	1,500	2,000	3,500
0.108 kg a.i. ha^{-1}of H	3,000	2,000	5,000
0.162 kg a.i. ha^{-1} of H	4,500	2,000	6,500
Two hoe weeding	15,000	0	15,000
Varieties (V)			
SAMNUT 11	8,000	5,000	13,000
SAMNUT 22	8,000	5,000	13,000
SAMNUT 23	8,000	5,000	13,000

H= Haloxyfop – R –methyl ester . Source: market survey.

BIOGRAPHY

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