RESPONSE OF GROUNDNUT (*Arachis hypogaea* L.)VARIETIESTO WEED MANAGEMENT STRATEGIES IN SOUTHERN GUINEA SAVANNA OF THE GAMBIA.

By

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JULY, 2019

DECLARATION

I hereby declare that this work is the product of my research efforts undertaken under the supervision of Dr. Abdulrahman Lado and Dr Faye J. Manneh and has not been presented anywhere for the award of a degree or certificate. All sources have been duly acknowledged.

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CERTIFICATION

This is to certify that the research work for this dissertation and subsequent write-up by Sagarr A.F Jallow (SPS/16/MAG/00027) were carried out under our supervision.

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APPROVAL

This dissertation has been examined and approved for the award of Master of Science Degree in Agronomy (Crops and Cropping Systems in Dryland Agriculture).

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DEDICATION

This research work is dedicated to my beloved wife, Mrs Hawa Gaye, My son, Muhammad Jallow and my entire family.

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ABSTRACT

Field trials were conducted in 2018 rainy season at National Agricultural Research Institute Banjulinding and Teaching and Research Farm of the University of The Gambia Faraba Banta to determine the effect of various weed management strategies on weed management, growth and yield of groundnut varieties. The experiment consisted of three groundnut varieties (Senegal 28/206, Fleur 11 and Samnut 24) and ten levels of weed management strategies (Pendimethalin at 1.0kg a.i h^{-1}, Pendimethalin at 1.5kg a.i ha^{-1}, Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}, Quizalofop-P-Ethylat at1.5kg a.i ha^{-1}, Pendimethalin at 1.0kg a.i ha^{-1} followed by Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}, Pendimethalin at 1.0kg a.i ha^{-1} followed by supplementary hoe weeding at 6 weeks after sowing, Manual hoe weeding at 3 and 6 weeks after sowing, Pendimethalin at 1.5kg a.i ha^{-1} followed by supplementary hoe weeding at 6 weeks after sowing,, Pendimethalin at 1.5kg a.i ha^{-1} followed by Quizalofop-P-Ethyl at 1.5kg a.i ha^{-1} and Weedy check). The experiment was laid out in a Split plot design, replicated three times with the weed management strategies as the main plots while the groundnut varieties as the sub plots. The result revealed that, manual hoe weeding at 3 and 6 weeks after sowing recorded the lowest weed density (94580-141729) and highest weed control efficiency (88.4-82.6%) in both locations. The result indicated that, weedy check had the lowest plant dry matter (29.6-27.9g) in both locations. Application of pendimethalin at 1.5kg a.i ha^{-1} followed by quizalofop-p-ethyl at 1.5kg a.i ha^{-1} recorded the higher pod yield (1149 kg ha^{-1}) and kernel yield (817.3 kg $ha^{-1)}$ at Banjulinding. At UTG Farba Banta pendimethalin at 1.5kg a.i ha^{-1} followed by supplementary hoe weeding at 6 weeks after sowing recorded higher pod yield (1030 kg ha^{-1}) while pendimethalin at 1.0kg a.i ha^{-1} followed by quizalofop-p-ethyl at 1.0 kg a.i ha^{-1} had higher kernel yield (765.2 kg ha^{-1}). Samnut 24 out yielded other varieties and had exhibited superior growth and economic return than other varieties.It could be concluded that application of pendimethalin at 1.5kg a.i ha^{-1} followed by quizalofop-p-ethyl at 1.5kg a.i ha^{-1}, pendimethalin at 1.5kg a.iha^{-1} followed by supplementary hoe weeding at 6 weeks after sowing and manual hoe weeding at 3 and 6 weeks after sowing had led to the production of highestpod and kernel yields of groundnut.

CHAPTER ONE

1.0 INTRODUCTION

1.1BACKGROUND OF THE STUDY

The primary sector of the economy of The Gambia, which is agriculture, has been dominated by subsistence farming for production of food crops (early millet, late millet, maize, sorghum and rice); semi-intensive cash crop production (groundnuts, cotton, sesame and horticulture) and traditional livestock-raising (Permanent Interstates Committee for Drought Control in the Sahel, 2008). Among the crops, groundnut is the most important; occupying 40-50% of the cultivated area followed by early millet (25%), rice (8%), sorghum and maize (7% each) (CILSS, 2008).According to Vara Prasad *et al*. (2017), the world groundnut harvested area in 2007 was about 23.4 million ha with a total production of 34.9 million metric tons (Mt). Thus, the total harvested area in 2007 increased by 3.7 million ha when compared to 1990, while production increased by 11.7 million Mt. Groundnuts are mainly grown in developing countries (Africa), where the crop finds the appropriate climates for optimum production (Romain, 2001). About 90% of the total world production came from Africa region and about 60% of production came from the semiarid tropics (SAT) of the world (Vara Prasad *et al*.,2017). Worldwide, China produced the highest groundnut production with a total production in 2014 of 13,420,000 million metric tons (Shamim, Nauman, Iftikhar, Armghan and Hafiz ,2014).Groundnut production in Africa stood at 8.7 million Mt from 9.04 million ha (Vara Prasad *et al*., 2017). The average production in this region was 964 $kgha^{-1}$, which was poor when compared to the US and other developed countries where it is close to 3500 $kgha^{-1}$. Average productivity was 1720 $kgha^{-1}$ in Nigeria, 500 $kgha^{-1}$ in Sudan, and

close to 700 $kgha^{-1}$ in Senegal. For a long time, groundnut was the main export crop of Senegal and The Gambia (Vara Prasad*et al*.,2017).

Groundnut production in The Gambia was estimated at 151,069 metric tons in 2001 and 71,526 metric tons in the following year giving a 53% decline. A thirty percent increase in groundnut production was recorded between 2002 and 2003. Groundnut is one of the main cash crops in The Gambia and its average production from 2008 to 2013 was 108,660 MT. Generally, Senegal 28/206 was one of the most popular local variety which recorded 1000 $kgha^{-1}$ in 2007 (Agriculture and Natural Resource Policy, 2015). Because of the high nutritional value of the seeds and their pleasant flavor, the groundnut is one of the most important human food crops in the tropics and subtropics. The nuts are eaten fresh, boiled or grilled and preparation of soup.Groundnut kernels are processed into a wide variety of edible products such as edible oil, groundnut butter, salted groundnut, etc. About two- thirds of the world production is used for produce edible oil which provides a good salad and cooking oil used in the margarine production industries. Groundnut also provides cake used for human and animal consumption. The groundnut hay is used as animal feeds and has about the same nutritional value as hay. The shells are used as fuel and fertilizers. Other non-food used of groundnuts includes soap, cosmetic and for medicinal purposes (Romain, 2001).

1.2 PROBLEM STATEMENT

The major problems that hindered groundnut production in The Gambia are lack of improved cultural practices, inadequate rainfall, soil fertility, chemical fertilizers, farm implements, low yielding varietiesand lack of appropriate weed control strategies (Jallow, 2012). The major limiting factors arediseases and pests including weeds. The presence of weeds as pest is more pernicious and serious because it can drastically reduce the yield, (Jallow,2012). According to Ayomide (2010), weed caused much damage to the groundnut crop during the first 45 days of its growth. The most critical period of weed competition is between 3-6 weeks after sowing. His studies further highlighted that, the average yield loss due to weed was about 30%. Sathya Priya*et al.* (2013) in their studies reported that, yield of groundnut was reduced by 25 to 70 percent depending on the intensity of weed infestation. Groundnut crop is highly sensitive to competition by weeds and yield reduction could be as high as 70 percent. The productivity of crop was affected by competition with weeds causing reduction in pod yield by 17 to 84 percent (Sathya Priya*et al.* 2013).

According to Dzomeku (2017) yield loss in groundnuts could be as a result of erratic distribution of rainfall, lack of high yielding varieties, low soil fertility and poor knowledge of effective disease and weed management. Dzomeku (as cited in Singh and Yadav, 2012) asserted that, weed infestation seriously reduced the yield of groundnut through competition for sunlight, soil nutrients and other environmental resources. Groundnut crop is highly susceptibleto weed infestation because of its slow growth in the initial stages up to 40 days, shorterplant height and underground pod bearing habit (Jat *etal.*,2011). The average yield loss due to weeds has been reported to be about 30%

and may reach up to 60% under poor weed management practices (Hakeem *et al*.2015). The most common method of weed control in the study area was manual hoe weeding which has been reported to interfere with pegging, pod development leading to significant yield reduction (Tasmiya *et al.* 2017). Season long weed competition reduces the yield as high as 24 to 70% (Tasmiya*et al.,* 2017). Weeds can deplete 30 – 40 kg of Nitrogen per hectare, 10-15kg of phosphorous per hectare and 20-40kg of potassium per hectare (Das ,2011). Among all the crop pests, weeds alone are responsible for about one third loss in cropproduction (Jat *etal.* 2011). In groundnut, the loss in pod yield ranges from 13to100% depending on the season, cultivars, weed composition and duration of crop-weed competition (Jat *etal.* 2011). Most of the groundnut varieties in The Gambia are low yielding and low fodder value. They usually shed their leaves before maturity and mostly they are spreading growing habits that compete poorly with weeds and with low oil contents (ANR, 2015).

1.3JUSTIFICATION

Weed management practices is an issue that farmers faced in The Gambia however, most of the farmers lack application techniques of herbicides. Appropriate use of herbicides could reduce drudgery to meet target timing of weed control. Dzomeku (2017) further reported that, combinations of pre-emergence herbicides currently registered for use in groundnut have not shown any crop injury.

The combination of two or more control methods can lead to better yields in groundnut and more economical (Hakeem *et al*.2015). This can certainly help in attaining level of food security, economic growth and development of poor resource farmers in The Gambia. Application of pre-emergence herbicide like pendimethalin

followed by manual hoe weeding once or twice to keep the crop free of weeds after emergence has shown promising in controlling weeds in groundnut. Manual hoe weeding leads to soil disturbance and interfere with pegging, to prevent this, an alternative method of weed control is not only needed but necessary. Patel *etal*. (2008) reported that areas were labour is shortage, combination of manual hoe weeding and herbicide application reduced weed dry weight and recordedhigher weed control efficiency in groundnut but necessity to study and compare the different weed control measures so as to come up with the best methods that would be more efficient, accessible and cost effective to the average farmers and this justify the study.

The use of appropriate varieties for particular agro- ecology is very important in groundnut production. However, introducing groundnut variety with high fodder value, high yield, early maturity, high oil content and with the ability to suppress weeds can address the constraints of the local varieties in the study area.

1.4 OBJECTIVES

The Objectives of the study were:

- To determine the effect of weed management strategies on the growth and yield of groundnut.
- To evaluate the performance of the three groundnut varieties in the southern guinea savanna of the study area.
- To evaluate the profitability of different weed management strategies in the study area.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 WEED FLORA

Chapparaband (2011) stated that, the degree of damage caused by weeds is related to the type, species and density of weeds growing in a crop community and it varied from place to place and season to season. Jat*et al*. (2011) reported that the weed flora in groundnut varied with agro-ecological conditions and as well as with the level of management. Weeds in groundnut comprised of diverse species of narrow-leaf, broad-leaf and sedges. Although the grassy weeds usually dominate in number and broad-leaved weeds also offer a stiff competition to the crop. Chapparaband (2011) reported that grass constituted 70 per cent and sedges 20 per cent of the total weed population in groundnut. Some of the common weed species associated with groundnut were *Cynodon dactylon, Digitaria marginata, Chloris barbata, Amaranthus spinosus, Corchorus olitorious, Phyllanthus amaros, Dactyloctenium aegytium, Tridax prucumben, Pancum spp, Eleusine indica* etc (Chapparaband, 2011).

2.2 EFFECTS OFWEED COMPETITION ON GROWTH AND YIELD OF GROUNDNUT

Besides the adverse effects caused by timely weed control on groundnut,weed control strategies could alsoinfluencegroundnut yield. It is quite true that an effective weed control measure is an essential ingredient in improving both the quality and quantity of crop production. Ayomide (2010) in his studies stated that groundnut is very sensitive to weeds and farmers often abandoned their fields when weeds pressure becomes unbearable. He however, stressed that weeds reduced yields of groundnut by

competing with the crop for minerals, light, nutrients and space. Jat *et al.* (2011) reported that, crop plants and weeds share the same ecological niche and they compete for nutrient, sunlight, moisture and space and therefore, reduce the supply of these inputs to the crop plant and that can drastically reduce both number and size of sink and yield. Jat *et al.* (2011) also asserted that, among all crop pests, weeds alone can reduce about one third in crop production. Groundnut yield and the losses in pod yield ranged from 13 to 100% depending on the cultivar, season, weed species, duration of weed competition and the types of agronomic practices adopted. The yield reduction due to weed competition in groundnut ranged between 20 -90 percent at various intensity of competition (Annadurai, *et al.* 2010).Dzomeku (2017) reported that yield loss in groundnuts could be as a result of erratic distribution of rainfall, lack of high yielding varieties, low soil fertility and poor knowledge of effective disease and weed management. Monaco (2002) reported that 41 to 100 % yield reduction would be theresult of weed competition if the first weeding is delayed.

2.3 EFFECT OF VARIETY ON GROWTH,YIELD AND WEED CONTROLIN GROUNDNUT

Environment and genotype interact to determine how a crop grows and how in turn, growth determines yield. The main factor affecting growth and yield of groundnut in semi-arid regions of the Sudan savanna is mainly the availability of moisture during the growing period as well as improved varieties (Ibrahim, 2010). Improved groundnut varieties are much more efficient at partitioning assimilates to the seeds than the old varieties (Ibrahim, 2010). In a field trial, to evaluate the performance of groundnut varieties as influenced by weed control treatment by Garko*et.al.* (2016) found significant

difference in pod yield and growth among varieties.Ibrahim (2010) reported that,improved varieties are much more efficient in increasing growth and yield than older varieties. The difference in yield and yield attributes of groundnut were associated with differences in their genetic compositions. Jallow (2012) cited that, the used of semi erects and taller varieties were found to be very effective in suppressing weeds in groundnut. However, non significant interaction between groundnut varieties and weed control in groundnut was reported by Ibrahim (2010).

2.4 METHODS OF WEED CONTROL STRATEGIES IN GROUNDNUT

2.4.1 Manual Hand Weeding

Hoe-weeding is the most primitive type of weed control and despite the drudgery; it is still the major method in The Gambia (Kunjo, 1981). It is often the most practical method for small farmers with limited resources or an abundance of human labour. However, hoe-weeding is limited to small farms of less than two hectares as the labour requirement is very high. Animal traction is also used by many farmers in The Gambia as a method of management of weeds. Normally the sine-hoe or the weeder is pulled by animals example horse, donkey, oxen etc as source of power. This method is accomplished by other cultural practices like hand pulling, hoeing, (Kunjo, 1981). Arthur (2016) reported that, in groundnut cultivation, three weeding may be done in the fields depending on the season, days to maturity and weed situation. Hand weeding is not advisable once pegging begins. Hoeing breaks and loosens the soil particles to facilitate pegging, pod development and improving aeration. However, Kunjo (1981), reported that hoe-weeding could be detrimental to the crop if it is done at a very early stage of crop growth due to root injury and crop disturbance; while any hoe weeding done at a later

stage may result in considerable root pruning and significant yield reduction. Other cultural methods used for controlling weeds in upland crop fields included use of cutlass and burning for land preparation. Tractor mounted equipment are also in use, however, the inaccessibility to the crop lands, the sizes of the farm lands, the cost involved, the undulation of the land and many other factors limit the use of this method and in most cases makes it unreliable. According to Feakin (1973), hand-hoeing is very laborious, and the crop iseasily damaged by careless manipulation of the hoe, particularly if weeding is carried out at the pegging stage. Care should be taken to avoid throwing soil on the crop thus creating conditions which are suitable for disease organisms. Feakin's studies confirmed the need for weed control within two to three weeks after crop emergence because competition during this period is equal to the entire season's competition.

2.4.2Chemical Weed Control

Another weed control practice which is fast gaining momentum especially in groundnut cultivation is the use of chemicals. This refers to all weed control practices in which toxic chemicals called herbicides are used to kill, suppress or modify weed growth in such a way as to prevent interference with crop establishment, growth and production of economic yield (Jallow, 2012). Herbicides application are alternatives to manual hand weeding control and may be classified based on the time of application. Herbicides can be preemergence applied few days after planting before crops or weeds emerge and post-emergence, applied after emergence of crops and weeds. Some pre-emergence herbicides labeled for groundnut production include Pendimethalin, Metolachlor, Butachlor, Norflurazone, Diclosulam, Flumioxazin, Dimethenamid etc and postemergence,

Imazethapyr, Imazapic, Quzalofop ethyl, Acifluorfen, Bentazone etc(Arthur,2016). Although chemical weed control has within the last four decades become the most widely used weeding method in the developed countries. Herbicides use in the developing countries is limited by quite a good number of factors: the inadequacy of current information on local requirements, the limitation of available herbicides, scientific knowledge, skills and the application methods and time etc. Formulations suitable for temperate conditions may not be the best for the tropics especially where there is heavy rain soon after spraying can wash the herbicide off the foliage before it has been effective. Economic is also a limiting factor, as many farmers in developing countries cannot afford the chemical (Kunjo, 1981).However, application of herbicides can be highly useful at a time when there is a shortage of laborers. The use of correct or right herbicides can provided completely weed-free situation and can effectively combat a diversity of both grassy and broad-leaf weeds (Jat *et al*.,2011)**.** Sathya Priya *et al.* 2013 reported that, in modern agricultural production, herbicides are commonly used as an alternative method to traditional methods of hand weeding at initial period for better control of weed management. The selection of herbicides will depend on the crop type, its potential use, the variety, crop growth stage, condition of the foliage, soil type and weeds present.

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 EXPERIMENTAL SITE

The experiment was conducted during the wet growing season of 2018 at two different locations in The Gambia.The first location was carried out at the National Agricultural Research Institute Farm in Banjulinding (Latitude 13^0 22.171 N and Longitude$16^0$38.858W). The second location was at Teaching and Research Farm of the University of The Gambia Faraba Banta (Latitude 13^0 14.910 N and Longitude 16^0 32.040W).

The two locations were characterized by two seasons, wet season (June to October) and dry season (November to May). The annual rainfall of the first location (Banjulinding) was 859 mm and the second location (UTG Faraba Banta) was 951mm (courtesy of The Gambia Meteorological Office in Banjul).

3.2 METEOROLOGICAL DATA

Rainfall data were collected for the two locations from Yundum and Sibanor Meteorological Station, West Coast Region of The Gambia.

3.3 SOIL ANALYSIS

Soil samples from the two locations were randomly collected at the depth of 0-30 cm using auger. The samples were air dried, grounded and sieved before laboratory analysis. Samples were analyzed at the soil Science Laboratory of Department of Soil Science of Bayero University, kano. The samples were subjected to the following methods: Soil Textural Class; percentage of sand, silt and clay using Hydrometer Method, of Soil Mechanical Analysis (Bouyoucos, 1951),Soil PH using Glass- electrode

PH meter Method (Bates,1954),Total Nitrogen (Macro-Kjeldahl Method (Honda ,1962),Available Phosphorus using Bray No.1 Method (Bray and Khurtz, 1945),Organic Carbon using Walkley- Black Method (Walkley and Black, 1934),CEC using Extraction Method as described by Anderson and Ingram (1993), Exchangeable bases: K, Na, Mg, Ca using Extraction Method as described by Anderson and Ingram (1993).

3.4 TREATMENTS AND EXPERIMENTAL DESIGN

The experimentsconsisted of two factors, groundnut varieties (Senegal 28/206, Fleur 11 and Samnut 24) and ten levels of weed management strategies (Pendimethalin at 1.0kg a.i h^{-1}, Pendimethalin at 1.5kg a.i ha^{-1}, Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}, Quizalofop-P-Ethylat at 1.5kg a.i ha^{-1}, Pendimethalin at 1.0kg a.i ha^{-1} followed by Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}, Pendimethalin at 1.0kg a.i ha^{-1} followed by supplementary hoe weeding at 6 weeks after sowing, Manual hoe weeding at 3 and 6 weeks after sowing, Pendimethalin at 1.5kg a.i ha^{-1}followed by supplementary hoe weeding at 6 weeks after sowing, Pendimethalin at 1.5kg a.i ha^{-1} followed by Quizalofop-P-Ethyl at 1.5kg a.i ha^{-1} and Weedy check).

The treatments were factorial combined and were laid out in a Split plot design and replicated three times. Level of weed management strategies were assigned to the main plots while the groundnut varieties allocated to the sub plots. Gross and net plots sizes were 13.5m^2 and 4.5m^2 respectively.

3.5 TREATMENT DETAILS

3.5.1 Varieties

The groundnut varieties used were:

Senegal 28/206

This is a local variety which requires 120 days from planting to maturity which is the length of the wet season in an average in The Gambia. It is a spreading type. The variety was sourced at National Seed Secretariat, The Gambia.

Fleur 11

It is an erect type which mature in 90 – 110 days and it is known for high oil content. The variety was sourced at National Seed Secretariat, The Gambia.

Samnut 24

This variety was jointly developed by ICRISAT and Institute for Agricultural Research (IAR), Ahmadu Bello University, Samaru, Nigeria. It was an early maturing (80-90 days) variety with high kernel and fodder yield. The variety was sourced from International Institute for Tropical Agriculture (IITA), Nigeria.

3.5.2 Herbicides

Quizalofop-P-Ethyl

Quizalofop-P-Ethyl is a selective herbicide used for post-emergence control of annual and perennial grass weeds. It was used on soybeans, groundnut and other broad-leaved crops. The active ingredient is $100gL^{-1}$, Sipes*et al*. (2013).

Pendimethalin

This is a pre-emergence herbicide for thecontrol of annual grasses and certain

broadleaf weeds. It inhibits cell division and cell elongation(Ashton and Craft, 1981).

3.6 CULTURAL PRACTICES

3.4.1Land Preparation

The land was cleared before the rainy season, tilt, harrowed and well loosened. The land was demarcated into plot of 3m x 4.5m.Gross and net plots sizes were 13.5m^2 and 4.5m^2 respectively.

3.6.2 Sowing

Sowing was done when the rainy season was fully established and the crops were spaced with 75cm inter rows and 25cm intra rows with two seeds planted per stand.

3.6.3 Weeding

Weeding was done as per treatments.

3.6.4 Herbicide Application

The pre-emergence herbicide (Pendimethalin) was applied on sowing date according to the treatments while the post-emergence herbicide (Quizalofop-P-Ethyl) was applied at 6 weeks after sowing using knapsack sprayers.

3.6.5Fertilizer Application

Fertilizer was applied at rate of 20 $kgha^{-1}$ of nitrogen, 40$kgha^{-1}$ of phosphorous (P_2O5) and 20$kgha^{-1}$ of potassium using NPK 15:15:15 and single super phosphate 18%.

3.7 DATA COLLECTION

3.7.1 Weed Parameters

Morphological composition of weeds

The morphological composition of weeds of the experiment were identified and counted as number of broad leaves, grasses and sedges using one metre square quadrat. (Okezie and Agyakwa, 1998)

Weed relative frequency (WRF)

The weed relative frequency at harvest was calculated using the equation below as suggested by Das (2011).

$$\text{WRF} = \frac{\text{Number of occurrence of a species}}{\text{Total of occurrence of all species}} \text{X } 100\%$$

Weed relative density (WRD)

Weed elative density was determined at harvest as described by Das, (2011)

$$\text{WRD} = \frac{\text{Total number of individuals of a species in all the quadrats}}{\text{Total number of individuals of all the species in all quadrats}} \text{X } 100\%$$

Weed relative abundance (WRA)

This was determined at harvest as follow:

$$\text{WRA} = \frac{\text{Abundance of a species}}{\text{Sum} - \text{Total of abundance of all species}} \text{X } 100\%$$

Whereas Abundance of a species is calculated as follow:

$$\text{Abundance} = \frac{\text{Total number of inividuals of a species in all quadrats}}{\text{Total number of quadrats in which the species occured}}$$

Importance of value index (IVI)

This was proposed by Phillips (1959) and was determined at harvest as follow:

$$\text{IVI} = \text{WRF} + \text{WRA} + \text{WRD}$$

Weed control efficacy index (WCEI)

This was determined by using the following formula as suggested by Das (2011).

$$WCEI \quad \frac{\frac{Yr - Yc}{Yr} \times 100}{\frac{WDrMa}{WDrMc} \times 100}$$

Yr = Crop yield from the treated plot

Yc = Crop yield from the weedy check

WDrMa = Weed dry matter from the treated plot

WDrMc = Weed dry matter from the weedy check

Weed dry matter at harvest (g)

Weeds from 1metre square quadrat of each plot were cut from the ground level and oven dry at 65^0C to a constant weight at physiological maturity.

Weed density

Weed count was taken from $1m^2$ quadrat in each plot at physiological maturity and extrapolated to hectare basis.

Weed control efficiency (%)

Weed control efficiency was calculated on dry weight basis at harvested using equation below as suggested by Mani *et al*. (1976).

$$WCE = \frac{\text{Dry weeds weight in weedy check (g)} - \text{dry weight of treatment in question (g)}}{\text{Dry weeds weight in weedy check(g)}}$$

3.7.2 Growth Parameters

Percent of establishment

Percent of establishment was taken from three weeks after sowing.

$$\text{Percent of emergence} = \frac{\text{Number of germinated seeds}}{\text{Number of sowed seeds}} \text{X } 100\%$$

Crop growth rate (g)

As suggested byHapper, (1999) the crop growth rate was taken at 6 WAS (Week After Sowing). Four plants per plot were randomly selected at 3 and 6 WAS. The plants were removed, freed from soil and dried in an oven at 65^0C to a constant weight and dry matter was determined. The growth rate was computed using the equation below:

$$\text{CGR} = \frac{\text{W2} - \text{W1}}{T2 - T1} \text{g/wk}$$

Where W2 and W1 = total dry weight in gram plant^{-1} and T2 and T1= weeks respectively.

Stand count at harvest

Stand count at harvest was taken from the net plot (4.5m^2) and recorded and extrapolated to ha $^{-1}$ basis.

Number of branches

Four plants were randomly selected at harvest and number of branches per plant were counted and average was determined.

Canopy height (Cm)

Four plants were randomly selected at harvest from each plot, their heights were measured at harvest with a ruler from the ground to the tip of the uppermost leaf and mean was recorded.

Plant dry matter at maturity (g)

Four randomly selected plants were uprooted and oven dry at 65^0C to a constant weight. Their weights were taken using RADWAG WTB 200ONr 246649/09 electric balance.

3.7.4Yield Parameter

Number of pods plant^{-1}

Pods were counted from all plants in each plot and divided by the number of plants plot^{-1}.

Number of kernels plant^{-1}

Pods were decorticated and the kernels were counted from plot and divided by the number of plants plot^{-1}.

Pod yield (kgha^{-1})

At maturity the groundnuts were carefully uplifted from the ground and the pods were removed from the soil and air dried and weighed using RADWAG WTB 200ONr 246649/09 electric balance to obtain the pod yield per net plots. Pod yield per net plotwas taken and extrapolated to per hectare basis.

$$\text{Pod Yield/Ha} = \frac{\text{Pod yield / net plot(kg)}}{\text{Net plot area(m2)}} \text{X } 10{,}000\text{m2}$$

Kernel yield (kg ha^{-1})

Kernel yield per net plot was taken and extrapolated tohectare^{-1} basis.

$$\text{Kernel Yield/Ha} = \frac{\text{kernel yield /net plot(kg)}}{\text{Net plot area(m2)}} \text{X } 10{,}000\text{m2}$$

100- Kernels weight (g)

One hundred (100) kernels were randomly selected from the net plot and weighed in grams using RADWAG WTB 200ONr 246649/09 electric balance.

Haulm yield (kgha^{-1})

After removing the pods, the biomass was dried under shade and weight using handing scale. This was extrapolated to hectare basis.

$$\text{HaulmYield/Ha} = \frac{\text{Haulm yield/ net plot(kg)}}{\text{Net plot area(m2)}} \text{X } 10{,}000\text{m2}$$

2.7.5 Economic Returns

Cost of all inputs and labour were determined and the economic returns was calculate based on the following parameters.

Total cost: The cost of all production (Land preparation, planting, cost herbicide application, cost of herbicides, soil analysis, weeding, cost of seeds and cost of harvest)

Gross revenue = Pod yield X unit price of twenty Dalasis per kilogram (D20 Kg^{-1})(the prevailing market price of groundnutin The Gambia at the time of harvest).

Net return = Gross Revenue – Total cost

Benefit cost ratio= Gross Revenue/ Total Cost.

3.8 DATA ANALYSIS

Data generated from the experiment were subjected to analysis of variance (ANOVA) using GenStat software**,** 17th Edition and the difference between the means were compared using Students-NeumanKeuls' Test (SNK). Economic analysis was calculated using the above parameters.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 RESULTS

4.1.1 Soil Analysis

The result of soil analysis is presented in Table 1. The result indicated the soil was sandy clay at Banjulinding while at UTG Faraba Banta it was sandy clay loam. The pH was strongly acidic in both locations. The organic carbon content was low in both locations however the total N and available P were high in both locations respectively. The exchangeable bases and CEC were low in both locations.

4.1.2 Phytosociological Attributes of Weed Species in Groundnut Field

Table 2 shows the phytosociological attributes of weed species in groundnut field at Bnjulinding and UTG Faraba Banta. The results indicated that a total of 4 narrow leaved species, 6 broad leaved species and 1 sedge appeared in Banjulinding while at UTG Faraba Banta there were 2 narrow leave species, 6 broad leaved species and 2 sedges appeared. At Banjulinding, *Cyperus* difformishad the highest weed relative frequency while *Sclerocarpus africanus, Urena lobata* and *Cyperus rotundus* recorded the lowest weed relative frequency. However, at UTG Faraba Banta, *Cyperus rotundus* recorded the highest weed relative frequency while *Andropogon gayanus, Digitaria ciliaris* and *Pyllanthus amarus* were among the species with least relative frequency.*Eleusine indica* recorded the highest weed relative density while *Sclerocarpus africanus, Urena lobata,* and *Cyperus rotundus* recorded the least weed relative density at Banjulinding. However, at UTG Faraba Banta *Cyperus difformis* recorded the highest weed relative density while *Andtropogon gayanus, Digitaria ciliaris* and *Pyllanthus*

Table 1. Physico-Chemical properties of the soils of the Experimental sites.

Soil Properties	Banjulinding	UTG Faraba Banta
Physical		
Sand %	54	64
Silt %	5.92	5.92
Clay	40.08	30.08
Textural Class	Sandy Clay	Sandy Clay Loam
Chemical		
pH in H2O	5.4	5.1
Organic Carbon (gkg^{-1})	0.94	0.49
Total N (gkg^{-1})	0.35	0.28
Available P ($mgKg^{-1}$)	17.32	17.75
Exchangeable bases (Cmol Kg^{-1})		
Ca	0.27	0.21
Mg	0.06	0.03
K	0.08	0.08
Na	0.09	0.09
CEC (cmol kg^{-1})	0.48	0.41

Source: Soil Science Laboratory, Faculty of Agriculture, BUK

Table 2. Effect of Weed Management Strategies and Groundnut Varieties on Phytosociological Attributes of Groundnut Weeds at Banjulinding and UTG Faraba Banta during 2018 Rainy Season

		Location						
		Banjulinding			UTG Fraba Banta			
Weedspecies	WRF	WRD	WRA	IVI	WRF	WRD	WRA	IVI
Narrow leaved species								
Antropogon gayanus	6.67	0.22	1.97	8.86	0	0	0	0
Dactyloctenium aegytium	40	4.1	9.39	53.49	60	4.74	10.05	74.79
Digitaria ciliaris	41.11	4.02	9.39	53.49	0	0	0	0
Eleusine indica	64.44	22.84	33.61	120.89	46.67	4.93	12.14	64
Broad leaved species								
Accanthospermum hispidum	16.67	0.09	1.89	65.92	18.89	0.54	3.39	22.82
Hytis suaveolens	56.67	1.28	2.03	59.98	87.78	8.58	11.66	108.02
Mitracarpus villosus	48.89	9.18	18.45	76.52	20	1.07	5.69	26.76
Pyllanthus amarus	27.78	0.33	0.59	28.7	0	0	0	0
Sclerocarpus africanus	0	0	0	0	24.44	0.57	2.62	27.63
Sida rhombifolia	56.67	3.45	5.8	65.92	56.67	2.33	6.14	65.24
Sinna obtusifolia	11.11	0.32	2.39	13	20	0.41	2.62	23.1
Urena lobata	0	0	0	0	8.89	0.17	2.62	11.68
Sedges								
Cyperusdifformis	98.89	16.6	15.19	130.68	98.89	19.07	22.7	140.66
Cyperusrotundus	0	0	0	0	100	17.28	20.33	137.61

WRF- Weed Relative Frequency, WRD-Weed Relative Density, WRA-Weed Relative Abundance, IVI- Importance of Value Index

amarus recorded the lowest weed relative density. *Eleusine indica* recorded the highest weed relative abundance while *Sclerocarpus africanus, Urena lobata* and *Cyperus rotundus* had the least. However, at UTG Faraba Banta, *Cyperus difformis* recorded

highest wee relative abundance while *Antropogon gayanus, Digitaria ciliaris* and *Pyllanthus amarus* recorded the lowest.*Cyperus difformis* had the highest important value index at Banjulinding while *Sclerocarpus africanus, Urena lobata* and *Cyperus rotundus* recorded the lowest important value index. Similarly, at UTG Faraba Banta, *Cyperus difformis* recorded the highest important value index while *Cyperus rotundus, Digitaria ciliaris* and *Pyllanthus amarus* had the least.

4.1.3 Morphological Composition of Weeds at Harvest

The morphological composition of weeds at harvest in groundnut field as influenced by weed management strategies and groundnut varieties is shown in Table 3. The results indicated that weed management strategies had significant effect on morphological composition of weeds at harvest in groundnut field at both locations. Weedy check recorded the highest number of broad leaves, grasses and sedges than other weed management strategies in both locations. Manual hoe weeding at 3 and 6 weeks after sowing recorded the lowest number of broad leaves at Banjulinding while at UTG Faraba Banta pre-emergence application of Pendimethalin at 1.5 kg a.i h^{-1} recorded the lowest number of broad leaves.

The groundnut varieties significantly affected number of broad leaves and sedges at UTG Faraba Banta while non-significant effect was observed at Banjulinding. Fleur 11 recorded the highest number of broad leaves and sedges than the other varieties. The interaction between weed management strategies and groundnut varieties on

Table 3. Effect of Weed Management Strategies and Groundnut Varieties on Number of Broad leaves, Grasses and Sedges at Banjulinding and UTG Faraba Banta during 2018 Rainy Season

	Location

Treatments	Banjulinding			UTG Faraba Banta		
	Broad Leaves	Grasses	sedges	Broad Leaves	Grasses	Sedges
Weed Management Strategies						
Pendimethalin at 1.0kg a.i h^{-1}	26.8ab	71.2b	361.00b	10.10b	10.70b	51.4a
Pendimethalin at 1.5kg a.i ha^{-1}	23.3ab	52.8b	24.80b	8.60b	4.90b	52.0ba
Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	53.1ab	7.1cd	31.00b	16.20b	4.10b	75.8a
Quizalofop-P-Ethylatat 1.5kga.i ha^{-1}	46.3ab	1.4cd	41.90ab	12.20b	2.30b	79.4a
Pendimethalin at 1.0kg a.iha^{-1}						
FbQuizalofop-P-Ethyl at 1.0kg a.iha^{-1}	26.6ab	3.0d	26.40b	13.90b	2.70b	80.0a
Pendimethalin at 1.0kg a.i ha^{-1}						
fb SHW at 6 WAS	12.7ab	39.1bc	26.40b	9.70b	4.30b	61.4a
Manual hoe weeding at 3 and 6 WAS	7.4b	16.1cd	20.00b	10.00b	7.40b	42.6a
Pendimethalin 1.5kg a.i ha^{-1}						
fb SHW at 6 WAS	19.1ab	42.6bc	23.70b	13.00b	2.80b	66.8a
Pendimethalin 1.5kg a.i ha^{-1}						
fb.Quizalofop-P-Ethylat 1.5kg a.i ha^{-1}	16.1ab	2.3cd	30.60b	9.00b	2.60b	49.7a
Weedy check	65.2a	125.2a	55.30a	41.00a	49.00a	41.2a
Level of significance	0.031	0.001	0.010	0.022	0.001	0.042
SE±	11.35	9.00	5.510	5.564	2.665	9.24
Variety						
Senegal 28/206	29.6	35.2	31.90	12.80b	8.70	56.2b
Fleur 11	31.3	33.1	30.30	16.30a	10.13	69.0a
Samnut 24	28.1	39.9	32.60	14.00ab	8.40	54.9a
Level of significance	0.585	0.294	0.626	0.029	0.468	0.043
SE±	3.91	3.08	1.686	0.908	1.053	4.22
Interaction						
WM*V	0.473	0.555	0.557	0.116	0.033	0.335

Means followed by the same letter(s) in a column are not significantly different at 5% level of probability using Students-Neuman Keuls (SNK) Test. SHW= Supplementary Hand Weeding, WAS=week after sowing, fb= followed by

morphological composition of weeds at harvest in groundnut field was not significant except on grasses at UTG Faraba Banta. Un weeded control of all the three varieties significantly recorded the highest number of grasses than the other weed management strategies. Pre-emergence application of pendimethalin followed by supplementary hoe weeding as well as pendimethalin 1.5kg a.i ha^{-1} followed by quizalofop-P-Ethylat 1.5kg a.i ha^{-1} recorded the lowest number of grasses (Table 4).

4.1.4 Weed Control Efficacy Index and Weed Dry Matter at Harvest

The effect of weed management strategies and groundnut varieties on weed control efficacy index and weed dry matter at harvest is presented in Table 5. The results indicated that weed management strategies had significant effect on weed control efficacy index and weed dry matter at both locations. Manual hoe weeding at 3 and 6 weeks after sowing recorded the highest weed control efficacy index and lowest weed dry matter which were statistically different from other weed management strategies at Banjulinding. However, at UTG Faraba Banta, pendimethalin at 1.5kg a.i ha^{-1} followed by quizalofop-p-ethyl at 1.5kg a.i ha^{-1} recorded the highest weed control efficacy index and the lowest weed dry matter which were statistically at par with other weed management strategies.

The variety had no significant effect on weed control efficacy index and weed dry matter at both locations. There was no significant interaction between weed management strategies and groundnut varieties on weed control efficacy index and weed dry matter in both locations.

Table 4. Interaction between Weed Management Strategies and Groundnut varieties on Number of Grasses at UTG Faraba Banta during 2018 Rainy Season

Weed Management Strategies	Varieties		
	Senegal 28/206	Fleur 11	Samnut 24
Pendimethalin at 1.0kg a.i ha^{-1}	12.0c	7.3c	12.7c
Pendimethalin at 1.5kg a.i ha^{-1}	6.7c	6.3c	1.7c
Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	2.3c	3.3c	6.7c
Quizalofop-P-Ethyl at at1.5kg a.i ha^{-1}	3.3c	2.3c	1.3c
Pendimethalin at1.0kg a.i ha^{-1} fb Quizalofop-P-Ethyl at1.0kg a.i ha^{-1}	4.3c	1.3c	2.3c
Pendimethalin at 1.0kg a.i ha^{-1} fb SHWat 6WAS	5.3c	3.3c	4.3c
Manual hoe weeding at 3 and 6WAS	6.0c	8.0c	8.3c
Pendimethalin at1.5kg a.i ha^{-1} fb SHWat 6WAS	3.7c	3.7c	1.0c
Pendimethalin at1.5kg a.i ha^{-1} fb.Quizalofop-P-Ethyl at at1.5kg a.i ha^{1}	3.3c	1.3c	3.0c
Weedy check	40.0b	64.3a	42.7b
SE_±50.4			

Means followed by the same letter(s) in a column are not significantly different at 5% level of probability using Students-Neuman Keuls (SNK) Test. SHW= Supplementary Hand Weeding, WAS=week after sowing, fb= followed by

Table 5. Effect of Weed Management Strategies and Groundnut Varieties on Weed Control Efficacy Index and Weed Dry Matter (g plot^{-1}) at Banjulinding and UTG Faraba Banta during 2018 Rainy Season

Treatments	Location			
	Banjulinding		UTG Faraba Banta	
	Weed Control Efficacy Index	Weed Dry Matter at Harvest (g)	Weed Control Efficacy Index	WeedDry Matter at Harvest (g)
Weed Management Strategies				
Pendimethalin at 1.0kg a.i ha^{-1}	1.11b	363b	1.02ab	223.9b
Pendimethalin at 1.5kg a.i ha^{-1}	1.53b	263.3bc	1.19ab	215.5b
Quizalofop-P-Ethyl at 1.0kg a.iha^{-1}	1.45b	250.2bc	1.81ab	184.1b
Quizalofop-P-Ethylat at 1.5kg a.i ha^{-1}	0.85b	373.3b	1.29ab	193.3b
Pendimethalin at 1.0kg a.i ha^{-1} fb Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	1.62b	226.0bc	2.78ab	115.6b
Pendimethalin at 1.0kg a.i ha^{-1} fb SHW at 6WAS	1.95b	202.5bc	2.41ab	96.2b
Manual hoe weeding at 3 and 6 WAS	8.41a	76.4c	2.62ab	104.9b
Pendimethalin at 1.5kg a.i ha^{-1} fb SHW at 6 WAS	2.18b	202.7bc	4.04ab	138.6b
Pendimethalin at1.5kg a.i ha^{-1} fb.Quizalofop-P-Ethyl at 1.5kg a.i ha^{-1}	2.13b	208.4bc	5.09a	92.0b
Weedy check	0.0b	628.5a	0.0b	420.9a
Level of significance	0.001	0.001	0.021	0.001
SE±	0.604	42.96	1.389	32.87
Variety				
Senegal 28/206	1.65	273.3	2.360	166.5
Fleur11	2.66	291.0	2.280	185.6
Samnut24	2.06	275.0	2.040	183.4
Level of significance	0.424	0.668	0.859	0.472
SE±	0.544	15.95	0.4221	11.91
Interaction				
WM*V	0.176	0.867	0.815	0.105

Means followed by the same letter(s) in a column are not significantly different at 5% level of probability using Students-Neuman Keuls (SNK) Test. SHW= Supplementary Hand Weeding, WAS=week after sowing, fb= followed by

4.1.5 Weed Density ha^{-1} and Weed Control Efficiency (%)

The effect of weed management strategies and groundnut varieties on weed density and weed control efficiency at harvest is presented in Table 6. Weed management strategies significantly affected weed density and weed control efficiency in both locations. Weedy check significantly recorded the highest weed density and the lowest weed control efficiency in both locations. Manual hoe weeding at 3 and 6 was significantly recorded the lowest weed density and the highest weed control efficiency at both locations.

The groundnut varieties showed no significant effect on weed density and weed control efficiency at Banjulinding. However, at UTG Faraba Banta, groundnut varieties significantly affected weed density. Fleur 11 recorded the highest number of weeds while Samnut 24 and Senegal 28/206 recorded the lowest. There was no significant interaction between groundnut variety and weed management strategies on weed density ha^{-1} and weed control efficiency at both locations.

4.1.6Percent Establishment of Groundnut Seeds

Percent establishment of groundnut seeds at 3 weeks after sowingas influenced by weed management strategies and groundnut varieties is shown in Table 7. The results indicated that there was no significant effect of weed management strategies on percent establishment of groundnut seeds at both locations. The variety had significant effects on the percent establishment of groundnut seeds at both locations. Samnut 24 consistently recorded the highest percent establishment than Senegal 28/206 and Fleur 11 in both locations. At Banjulinding, Senegal 28/206 and Fleur 11 had statistical similar percent of establishment while

Table 6. Effect of Weed Management Strategies and Groundnut Varieties on Weed Density (ha^{-1}) and Weed Control Efficiency (%) at Banjulinding and UTG Faraba Banta during 2018 Rainy Season

Treatments	Location			
	Banjulinding		UTG Faraba Banta	
	Weed Density at Harvest (h^{-1})	Weed Control Efficiency (%)	Weed Density at Harvest (h^{-1})	Weed Control Efficiency (%)
Weed Management Strategies				
Pendimethalin at 1.0kg a.i ha^{-1}	310371b	49.5c	174926b	52.7ab
Pendimethalin at 1.5kg a.i ha^{-1}	226420bc	62.3b	170370b	50.1b
Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	201728bc	65.3b	212346b	62.2ab
Quizalofop-P-Ethylat at 1.5kg a.i ha^{-1}	192592bc	46.2c	228148b	61.0ab
Pendimethalin at 1.0kg a.i ha^{-1} fb Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	134074c	67.6b	223210b	74.3ab
Pendimethalin at 1.0kg a.i ha^{-1} fb SHW at 6 WAS	165432bc	69.5b	172099b	79.0ab
Manual hoe weeding at 3 and 6 WAS	94580c	88.4a	141729b	82.6a
Pendimethalin at1.5kg a.i ha^{-1} fb SHW at 6 WAS	173827bc	71.3b	208395b	78.0ab
Pendimethalin at 1.5kg a.i ha^{-1} fb.Quizalofop-P-Ethyl at 1.5kg a.i ha^{-1}	102716c	70.7b	147160b	81.2a
Weedy check	561481a	11.1d	334568a	17.5c
Level of significance	0.001	0.001	0.001	0.001
SE±	32581.4	3.94	20506.5	4.74
Variety				
Senegal 28/206	218000	60.5	188815b	66
Fleur11	205926	58.9	226256a	61
Samnut 24	224741	61.2	188815b	63
Level of significance	0.483	0.787	0.003	0.268
SE±	11078.1	2.38	8341.1	2.6
Interaction				
WM*V	0.800	0.818	0.608	0.146

Means followed by the same letter(s) in a column are not significantly different at 5% level of probability using Students-Neuman Keuls (SNK) Test. SHW= Supplementary Hand Weeding, WAS=week after sowing, fb= followed by

Table 7. Effect of Weed Management Strategies and Groundnut Varieties on Percent Establishment (%) of Groundnut at Banjulinding and UTG Faraba Banta during 2018 Rainy Season

Treatments	Location	
	Banjulinding	UTG Faraba Banta
	Establishment at 3 weeks (%)	Establishment at 3 weeks (%)
Weed management Strategies		
Pendimethalin at 1.0kg a.i ha^{-1}	73.8	76.60
Pendimethalin at 1.5kg a.i ha^{-}	71.8	79.90
Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	85a	73.10
Quizalofop-P-Ethylat at 1.5kg a.i ha^{-1}	68.9	79.40
Pendimethalin at 1.0kg a.i ha^{-1} fb Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	75.4	83.70
Pendimethalin at 1.0kg a.i ha^{-1} fb SHW at 6 WAS	74.0	69.20
Manual hoe weeding at 3 and 6 WAS	87.8	75.80
Pendimethalin 1.5kg a.i ha^{-1} fb SHW at 6 WAS	74.0	73.10
Pendimethalin at 1.5kg a.i ha^{-1} fb.Quizalofop-P-Ethylat at 1.5kg a.i ha^{-1}	76.6	78.30
Weedy check	88.4	83.20
Level of significance	0.248	0.264
SE±	7.57	3.912
Variety		
Senegal 28/206	77.1b	76.30b
Fleur 11	72.7b	70.20c
Samnut 24	82.9a	83.20a
Level of significance	0.002	0.001
SE±	1.89	1.511
Interaction		
WM*V	0.54	0.771

Means followed by the same letter(s) in a column are not significantly different at 5% level of probability using Students-Neuman Keuls (SNK) Test. SHW= Supplementary Hand Weeding, WAS=week after sowing, fb= followed by

Senegal 28/206 recorded significantly higher percent of establishment than Fleur 11 at UTG Faraba Banta. There was no significant interaction between weed management strategies and groundnut varieties on percent of establishment of groundnut in both locations.

4.1.7Crop Growth Rate and Stand Count at Harvest

The effect of weed management strategies and groundnut varieties on crop growth rate and stand count at harvest is presented in Table 8. Weed management strategies had no significant effect on crop growth rate in both locations. However, the weed management strategies indicated a significant effect on stand count at harvest in both locations. The unweeded control recorded the lowest stand count at harvest than all other weed management strategies in both locations.

The variety showed no significant effect on crop growth rate in both locations. However, at Banjulinding, groundnut varieties significantly affected stand count at harvest. Samnut 24 recorded the highest stand count at harvest than all other varieties tested. There was no significant interaction between weed management strategies and groundnut varieties on crop growth rate and stand count harvest in both locations.

Table 8. Effect of Weed Management Strategies and Groundnut Varieties on Crop Growth Rate (g ha^{-1}) and Stand Count at Banjulinding and UTG Faraba Banta during 2018 Rain Season

Treatments	Location			
	Banjulinding		UTGFaraba Banta	
	Crop Growth Rate at 6 WAS	Stands Count at Harvest	Crop Growth Rate at Harvest	Stand Count at Harvest
Weed Management Strategies				
Pendimethalin at 1.0kg a.i ha^{-1}	11.53	34321a	7.59	39506a
Pendimethalin at 1.5kg a.i ha^{-1}	11.12	38519a	7.63	39013a
Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	12.68	34568a	6.75	33827a
Quizalofop-P-Ethylat at 1.5kg a.i ha^{-1}	10.24	35062a	6.58	35802a
Pendimethalin at 1.0kg a.i ha^{-1} fb Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	20.48	37284a	8.83	39951a
Pendimethalin at 1.0kg a.i ha^{-1} fb SHW at 6 WAS	13.58	37284a	6.89	35556a
Manual hoe weeding at 3 and 6 WAS	14.20	37284a	10.32	39259a
Pendimethalin at 1.5kg a.i ha^{-1} fb SHW at 6 WAS	15.83	35556a	8.06	40494a
Pendimethalin at 1.5kg a.i ha^{-1} fb.Quizalofop-P-Ethyl at 1.5kg a.i ha^{-1}	15.77	36296a	8.92	39506a
Weedy check	9.29	18518b	6.43	24938b
Level of significance	0.100	0.001	0.839	0.002
SE±	2.335	1557.5	1.301	1844.6
Variety				
Senegal 28/206	13.21	33481b	7.71	36889
Fleur 11	13.32	31926b	8.65	35837
Samnut 24	13.89	38000a	7.04	37630
Level of significance	0.919	0.001	0.154	0.398
SE±	1.263	1060.6	0.713	1010.3
Interaction				
WM*V	0.637	0.458	0.247	0.825

Means followed by the same letter(s) in a column are not significantly different at 5% level of probability using Students-Neuman Keuls (SNK) Test. SHW= Supplementary Hand Weeding, WAS=week after sowing, fb= followed by

4.1.8Number of Branches and Canopy Height

Number of branches plant^{-1} and canopy height at harvest as influenced by weed management strategies and groundnut varieties is presented in Table 9. Weed management strategies significantly affected number of branches plant^{-1}in both locations and canopy height at UTG Faraba Banta. At both locations, the weedy check recorded the least number of branches than other weed management strategies. Similarly, pendimethalin at 1.5kg a.i ha^{-1} followed by supplementary hoe weeding at 6 weeks after sowing recorded the highest number of branches than all other weed management strategies at Banjulinding while at UTG Faraba Banta, pendimethalin at 1.5kg a.i ha^{-1} followed by quizalofop-p-ethylat at 1.5kg a.i ha^{-1} recorded the highest number of branches than other weed management strategies. However, weedy check recorded the shortest plants which was significantly different from all other weed management strategies at UTG Faraba Banta.

The varieties showed significant effect on number of branches and canopy height in both locations. Senegal 28/206 and Samnut 24 recorded the highest number of branches and taller plant than other varieties respectively in both locations. There was significant interaction between weed management strategies and groundnut varieties on number of branches in both locations and canopy height at UTG Faraba Banta (Table 9).

All the 3 varieties responded differently to weed management strategies at Banjulinding. Pre-emergence application of pendimethalin at 1.5kg a.i ha^{-1} followed by supplementary how weeding at 6 weeks after sowing recorded higher number of branches than all other weed management strategies (Table 10). However, at UTG Faraba Banta, Fleur 11 and Samnut 24 recorded statistically similar number of branches irrespective to

Table 9. Effect of Weed Management Strategies and Groundnut Varieties on Number of Branches and Canopy Height (cm) at Banjulinding and UTG Faraba Banta during 2018 Rainy Season

Treatments	Location			
	Banjulinding		UTG Faraba Banta	
	Number Of Branches at Harvest	Canopy Height at harvest	Number Of Branches at Harvest	Canopy Height at Harvest
Weed Management Strategies				
Pendimethalin at 1.0kg a.i ha^{-1}	26.11a	53.28	23.97a	45.87a
Pendimethalin at 1.5kg a.i ha^{-1}	25.11a	55.66	20.56a	42.01a
Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	23.67a	51.11	19.83a	42.58a
Quizalofop-P-Ethylat at 1.5kg a.i ha^{-1}	23.89a	50.49	18.97a	43.4a
Pendimethalin at 1.0kg a.i ha^{-1} fb Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	26.22a	49.98	20.64a	43.08a
Pendimethalin at 1.0kg a.i ha^{-1} fb SHW at 6 WAS	26.33a	54.14	22.31a	41.42a
Manual hoe weeding at 3 and 6 WAS	24.78a	53.93	22.14a	43.86a
Pendimethalin at 1.5kg a.i ha^{-1} fb SHW at 6 WAS	26.89a	55.73	24.06a	44.46a
Pendimethalin at 1.5kg a.i ha^{-1} fb.Quizalofop-P-Ethyl at 1.5kg a.i ha^{-1}	25.89a	50.54	25.42a	43.19a
Weedy check	10.00b	43.22	12.28b	33.58b
Level of significance	0.001	0.161	0.001	0.009
SE±	1.646	2.835	1.462	1.737
Variety				
Senegal 28/206	37.73a	36.93c	39.23a	31.60c
Fleur11	18.97b	48.04b	12.72b	40.10b
Samnut 24	14.97c	70.45a	11.10b	55.33a
Level of significance	0.001	0.001	0.001	0.001
SE±	0.902	1.198	0.862	0.631
Interaction				
WM*V	0.043	0.101	0.001	0.002

Means followed by the same letter(s) in a column are not significantly different at 5% level of probability using Students-Neuman Keuls (SNK) Test. SHW= Supplementary Hand Weeding, WAS=week after sowing, fb= followed by

Table 10. Interaction between Weed Management Strategies and Groundnut Varieties on Number of Branches at Banjulindingduring 2018 Rainy Season

Weed Management Strategies	Varieties		
	Senegal 28/206	Fleur 11	Samnut24
Pendimethalin at 1.0kg a.i ha^{-1}	42.33a	20.67f	15.33f
Pendimethalin at 1.5kg a.i ha^{-1}	44.33a	15.00f	16.00f
Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	37.67a-d	17.67f	15.67f
Quizalofop-P-Ethylat at 1.5kg a.i ha^{-1}	37.67a-e	20.00ef	14.00f
Pendimethalin at 1.0kg a.i ha^{-1} fbQuizalofop-P-Ethyl at1.0kg a.i ha^{-1}	39.67ab	20.33f	18.67f
Pendimethalin at 1.0kg a.i ha^{-1} Fb SHW at 6 WAS	41.67a	22.00c-f	15.33f
Manual hoe weeding at 3 and 6 WAS	38.33abc	20.67cf	15.33f
Pendimethalin at1.5kg a.i ha^{1-} fb SHW at 6 WAS	45.00a	20.33f	15.33f
Pendimethalin at 1.5kg a.i ha^{-1} fb.Quizalofop-P-Ethyl at1.5kg a.i ha^{1}	39.00ab	23.00b-f	15.67f
Weedy check	11.67f	10f	8.33f
SE±2.830			

Means followed by the same letter(s) in a column are not significantly different at 5% level of probability using Students-Neuman Keuls (SNK) Test. SHW= Supplementary Hand Weeding, WAS=week after sowing, fb= followed by

weed management strategies. Weed check to Samnut 24 had the lowest number of branches than other weeding strategies (Table 11). Similar trend was observed on Senegal 28/206 to unweeded plots at UTG Faraba Banta (Table 12).

4.1.9Plant Dry Matter at Harvest

The effect of weed management strategies and groundnut varieties on plant dry matter is presented in Table 13. Weed management strategies significantly affected plant dry matter in both locations. The weedy checkrecorded the least plant dry matter which was significantly different from all other weed management strategies.

The varieties showed significant effect on plant dry matter at UTG Faraba Banta while non significant effect was observed at Banjulinding. Senegal 28/206 recorded the highest plant dry matter than Fleur 11 and Samnut 24. There was no significant interaction between weed control strategies and groundnut variety on plant dry matter in both locations.

4.1.10Number of Pods Plant^{-1} and Kernels plant^{-1}

Number of pods plant^{-1} and kernels plant^{-1} as influenced by weed management strategies and groundnut varieties is shown in Table 14. Weed management strategies had significant effect on number of pod and kernel plant^{-1} in both locations. Pendimethalin at 1.5kg a.i ha^{-1} followed by quizalofop-p-ethyl at 1.5kg a.i ha^{-1} significantly recorded higher number of pods and kernels plant^{-1} while weedy check recorded the lowest in at Banjulindingg. However, Pendimethalin at 1.0kg a.i ha^{-1} followed by quizalofop-p-ethyl at 1.0kg a.i ha^{-1} recorded higher pods and kernels while the weedy check had the lowest at UTG Faraba Banta.

Table 11. Interaction between Weed Management Strategies and Groundnut Varieties on Number of Branches at UTG Faraba Banta during 2018 Rainy Season

Weed Management Strategies	Varieties		
	Senegal 28/206	Fleur 11	Samnut24
Pendimethalin at 1.0kg a.i ha^{-1}	48.42a	11.67b	10.42b
Pendimethalin at 1.5kg a.i ha^{-1}	36.83a	13.25b	11.58b
Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	36.00a	13.25b	10.25b
Quizalofop-P-Ethyl at at 1.5kg a.i ha^{-1}	33.42a	12.90b	10.58b
Pendimethalin at 1.0kg a.i ha^{-1} fb Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	40.33a	11.17b	10.42b
Pendimethalin at 1.0kg a.i ha^{-1} fb SHW at 6 WAS	44.58a	11.17b	11.17b
Manual hoe weeding at 3 and 6 WAS	41.33a	14.67b	10.42b
Pendimethalin at1.5kg a.i ha^{-1} fb SHW at 6 WAS	47.33a	12.25b	12.58b
Pendimethalin at1.5kg a.i ha^{-1} fb.Quizalofop-P-Ethylat 1.5kg a.i ha^{-1}	46.75a	17.00b	12.50b
Weedy check	17.25a	9.92b	9.67b
SE± 2.662			

Means followed by the same letter(s) in a column are not significantly different at 5% level of probability using Students-Neuman Keuls (SNK) Test. SHW= Supplementary Hand Weeding, WAS=week after sowing, fb= followed by

Table 12. Interaction between Weed Management Strategies and Groundnut Varieties on Canopy Height (cm) at UTG Faraba Banta during 2018 Rainy Season.

Weed Management Strategies	Varieties		
	Senegal 28/206	Fleur 11	Samnut24
Pendimethalin at 1.0kg a.i ha^{-1}	33.67fgh	42.27b-f	61.67a
Pendimethalin at 1.5kg a.i ha^{-1}	30.07fgh	41.1d-h	54.87abc
Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	30.03fh	41.93c-g	55.77ab
Quizalofop-P-Ethylat at 1.5kg a.i ha^{-1}	34.83fgh	39.63fgh	55.73abc
Pendimethalin at 1.0kg a.i ha^{-1} fb Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	32.63fgh	38.97fgh	57.63a
Pendimethalin at 1.0kg a.i ha^{-1} fb SHW at 6 WAS	30.13fgh	39.93fgh	54.20a-e
Manual hoe weeding at 3 and 6 WAS	32.93fgh	40.53e-h	58.10a
Pendimethalin at 1.5kg a.i ha^{-1} fb SHW at 6 WAS	30.97fgh	39.37fgh	63.03a
Pendimethalin at 1.5kg a.i ha^{-1} fb.Quizalofop-P-Ethyl at 1.5kg a.i ha^{-1}	33.00fgh	41.70b-h	54.87a-d
Weedy check	27.70h	35.60fgh	37.43fgh
SE± 2.382			

Means followed by the same letter(s) in a column are not significantly different at 5% level of probability using Students-Neuman Keuls (SNK) Test. SHW= Supplementary Hand Weeding, WAS=week after sowing, fb= followed by

Table 13. Effect of Weed Management Strategies and Groundnut Varieties on Plant Dry Matter (g plot^{-1})at Harvest at Banjulinding and UTG FarabaBanta during 2018 Rainy Season

Treatments	Location	
	Banjulinding	UTG Faraba Banta
	Plant Dry Matter at Harvest (g plot $^{-1}$)	Plant Dry Matter at Harvest (g plot $^{-1}$)
Weed Management Strategies		
Pendimethalin at 1.0kg a.i ha^{-1}	95a	92a
Pendimethalin at 1.5kg a.i ha^{-1}	98a	87a
Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	124a	73a
Quizalofop-P-Ethylat at 1.5kg a.i ha^{-1}	89a	70a
Pendimethalin at 1.0kg a.i ha^{-1} fb Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	88a	76a
Pendimethalin at 1.0kg a.i ha^{-1} fb SHW at 6 WAS	125a	67a
Manual hoe weeding at 3 and 6 WAS	107a	85a
Pendimethalin at 1.5kg a.i ha^{-1} fb SHW at 6 WAS	94a	86a
Pendimethalin at 1.5kg a.i ha^{-1} fb.Quizalofop-P-Ethyl at 1.5kg a.i ha^{-1}	113a	66a
Weedy check	29b	27b
Level of significance	0.003	0.001
SE_+	12.6	6.02
Variety		
Senegal 28/206	99.7	86.5a
Fleur 11	88.1	63.9b
Samnut 24	101.9	70.6b
Level of significance	0.239	0.001
SE_+	6.05	3.63
Interaction		
WM*V	0.903	0.583

Means followed by the same letter(s) in a column are not significantly different at 5% level of probability using Students-Neuman Keuls (SNK) Test. SHW= Supplementary Hand Weeding, WAS=week after sowing, fb= followed by

Table 14. Effect of Weed Management Strategies and Groundnutt Varieties on Number of Pods and Kernels Plant^{-1} at Banjulinding and UTG Faraba Banta during 2018 Rainy Season

Treatments	Location			
	Banjulinding		UTG Faraba Banta	
	Number of Pods Plant^{-1}	Number of Kernels Plant^{-1}	Number of Pods Plant^{-1}	Number of Kernels Plant^{-1}
Weed Management Strategies				
Pendimethalin at 1.0kg a.i h^{-1}	15.00a	27.44a	14.00a	25.67a
Pendimethalin at 1.5kg a.i ha^{-1}	14.22abc	27.22a	14.00a	24.33a
Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	12.67a-d	22.89a	14.56a	26.44a
Quizalofop-P-Ethylat at 1.5kg a.i ha^{-1}	14.44abc	27.67a	13.22a	24.44a
Pendimethalin at 1.0kg a.i ha^{-1} fb Quizalofop-P-Ethyl at 1.0 kg a.i ha^{-1}	12.33a-e	21.11a	15.22a	28.11a
Pendimethalin at 1.0kg a.i ha^{-1} fb SHW at 6 WAS	13.11a-d	23.44a	14.44a	26.78a
Manual hoe weeding at 3 and 6 WAS	14.67ab	26.67a	12.67a	23.33a
Pendimethalin at 1.5kg a.i ha^{-1} fb SHW at 6 WAS	18.22a	34.00a	14.33a	26.90a
Pendimethalin at 1.5kg a.i ha^{-1} fb.Quizalofop-P-Ethyl at 1.5kg a.i ha^{-1}	18.56a	33.56a	12.56a	22.56a
Weedy check	6.00bd	9.56b	5.56b	8.89b
Level of significance	0.011	0.003	0.001	0.001
SE±	1.857	3.267	0.954	2.026
Variety				
Senegal 28/206	13.03b	23.33b	11.90b	21.53b
Fleur 11	13.70ab	24.83b	12.23b	22.00b
Samnut 24	15.00a	27.90a	15.03a	27.60a
Level of significance	0.022	0.010	0.001	0.002
SE±	0.497	1.027	0.561	1.210
Interaction				
WM*V	0.203	0.100	0.518	0.541

Means followed by the same letter(s) in a column are not significantly different at 5% level of probability using Students-Neuman Keuls (SNK) Test. SHW= Supplementary Hand Weeding, WAS=week after sowing, fb= followed by

The variety showed a significant effect on number of pods and kernel plant^{-1} in both locations. Samnut 24 consistently recorded the highest number of pods and kernels plant^{-1} than other two varieties in both locations. The interaction between weed management strategies and groundnut varieties on number of pods and kernels plant^{-1} was not significant in both locations.

4.1.11 Pod Yield and Kernel Yield (kg ha^{-1})

Table 15 shows the effect of weed management strategies and groundnut varieties on pod and kernel yield ha^{-1}. Weed management strategies had a significant effect on pod and kernel yield in both locations. Pendimethalin at 1.5kg a.i ha^{-1} followed by quizalofop-p-ethyl at 1.5kg a.i ha^{-1} recorded the higher pod and kernel yield which were statistically similar with other weed management strategies except weedy check at Banjulinding. However, pendimethalin at 1.5kg a.i ha^{-1} followed by supplementary hoe weeding at 6 weeks after sowing recorded higher pod yield than other weed management strategies. Similarly,pendimethalin at 1.0kg a.i ha^{-1} followed by quizalofop-p-ethyl at 1.0 kg a.i ha^{-1} had higher kernel yield which was statistically similar to all other weed management strategies but different from the weedy check at UTG Faraba Banta.

The effect of groundnut varieties on kernel yield was significant at Banjulinding as well as pod and kernel yield at UTG Faraba Banta (Table 15). Samnut 24 recorded the highest kernel yield which was statistically similar with Fleur11but different from Senegal 28/206 at Banjulinding. Similarly, at UTG Faraba Banta Samnut 24 significantly recorded the highest pod and kernel yield than other two varieties. The interaction

Table 15. Effect of Weed management Strategies and Groundnut Varieties on Pod Yield and Kernel Yield (kg ha^{-1}) at Banjulinding and UTG Faraba Banta during 2018 Rainy Season

Treatments	Location			
	Banjulinding		UTG Faraba Banta	
	Pod Yield (kg ha^{-1})	Kernel Yield (kg ha^{-1})	Pod Yield (kgha^{-1})	Kernel Yield (kg ha^{-1})
Weed Management Strategies				
Pendimethalin at 1.0kg a.i ha^{-1}	1084a	762.4a	963a	614.6a
Pendimethalin at 1.5kg a.i ha^{-1}	1097a	768.2a	1024a	721.2a
Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	969a	724.7a	924a	728.7a
Quizalofop-P-Ethylat at 1.5kg a.i ha^{-1}	1020a	755.8a	910a	679.0a
Pendimethalin at 1.0kg a.i/ha fb Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	954a	725.0a	1025a	765.2a
Pendimethalin at 1.0kg a.i ha^{-1} fb SHW at 6WAS	1072a	761.5a	978a	707.9a
Manual hoe weeding at 3 and 6 WAS	1075a	751.4a	964a	705.4a
Pendimethalin at 1.5kg a.i ha^{-1} fb SHW at 36WAS	1142a	801.0a	1030a	725.0a
Pendimethalin at 1.5kg a.i ha^{-1} fb.Quizalofop-P-Ethyl at 1.5kg a.i ha^{-1}	1149a	817.3a	976a	710.6a
Weedy check	213b	128.9b	174b	80.0b
Level of significance	0.001	0.001	0.001	0.001
SE±	76.1	36.97	59.6	22.37
Variety				
Senegal 28/206	959	665.3b	843b	608.4c
Fleur 11	981	704.4a	864b	648.5b
Samnut 24	992	729.5a	983a	704.3a
Level of Significance	0.696	0.003	0.004	0.001
SE±	27.7	12.54	30.0	12.27
Interaction				
WM*V	0.523	0.738	0.927	0.750

Means followed by the same letter(s) in a column are not significantly different at 5% level of probability using Students-Neuman Keuls (SNK) Test. SHW= Supplementary Hand Weeding, WAS=week after sowing, fb= followed by

between weed management strategies and groundnut varieties on pod and kernel yield was not significant in both locations.

4.1.12100 Kernel Weight (g) and Haulm Yield (kg ha^{-1})

Table 16 shows the effect of weed management strategies and groundnut varieties on 100 kernel weight (g) and haulm yield (kg ha^{-1}). Weed management strategies had no significant effect on kernel weight but significantly affected haulm yield in both locations. Pendimethalin at 1.5kg a.i ha^{-1} followed by supplementary hoe weeding at 6 weeks after sowing had higher haulm yield which was statistically similar with other weed management strategies but different from weedy check in Banjulinding. Manual hoe weeding at 3 and 6 weeks after showing had higher haulm yield which was statistically similar with other weed management strategies but different from weedy check in UTG Faraba Banta.

The varieties recorded significant effect on kernel weight and haulm yield in both locations. At Banjulinding Fleur 11 and Samnut 24 had heavier kernel and higher haulm yield respectively than other varieties. However, at UTG Faraba Banta, Fleur 11 and Samnut 24 recorded heavier kernel and higher haulm yield respectively than other variety. The interaction between weed management strategies and groundnut varieties on kernel weight and haulm yield was not significant at both locations.

4.1.13Net Revenue (D ha^{-1}) and Benefit Cost Ratio

The effect of weed management strategies and groundnut varieties on net revenue and benefit cost ratio is shown in Table 17 and 18 respectively.At Banjulinding, pendimethalin at 1.0kg a.i h^{-1} combined with Fleur 11 resulted in gross revenue of D10,490.00 and a benefit cost ratio of 1.80 closely followed by pendimethalin at 1.0kg a.i

h^{-1} with Samnut 24 with gross revenue of D9730.00 and a benefit cost ratio of 1.74 while weedy check combined with Samnut 24 operated at loss of gross revenue of -D8370.00and a loss benefit cost ratio of 0.30 (Table 17). However, at UTG Faraba Banta, pendimethalin at 1.5kg a.i ha^{-1} followed by supplementary hoe weeding at 6 weeks after sowing combined with Samnut 24 resulted in gross revenue of D13747.20 and a benefit cost ratio of 1.95 closely followed by pendimethalin at 1.0kg a.i h^{-1}combined with Samnut 24 with gross revenue of D9390.00 and a benefit cost ration of 1.71 while weedy check combined with Fleur 11 operated at loss of gross revenue of -D9030.00 and a loss benefit cost ratio of 0.26 (Table 18).

Table 16. Effect of Weed Management Strategies and Groundnut Varieties on 100 Kernel Weight (g) and Haulm Yield (kg ha^{-1}) at Banjulinding and UTG Faraba Banta during 2018 Rainy Season

Treatments	Location			
	Banjulinding		UTG Faraba Banta	
	100 Kernel Weight(g)	Haulm Yield (kg ha^{-1})	100 Kernel Weight (g)	Haulm Yield (kg ha^{-1})
Weed Management Strategies				
Pendimethalin at 1.0kg a.i ha^{-1}	34.69	6222a	34.42	6642a
Pendimethalin at 1.5kg a.i ha^{-1}	33.10	6988a	33.58	6247a
Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	32.09	5926a	34.16	4021ab
Quizalofop-P-Ethylat at 1.5kg a.i ha^{-1}	34.14	5802a	34.01	4321ab
Pendimethalin at 1.0kg a.i ha^{-1} fb Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}	33.70	6667a	34.51	5506a
Pendimethalin at 1.0kg a.i ha^{-1} fb SHW at 6 WAS	35.70	6049a	33.94	5012ab
Manual hoe weeding at 3 and 6 WAS	33.54	5630a	35.47	6914a
Pendimethalin at 1.5kg a.i ha^{-1} fb SHW at 6 WAS	33.90	7161a	34.76	6815a
Pendimethalin at 1.5kg a.i ha^{-1} fb.Quizalofop-P-Ethyl at 1.5kg a.i ha^{-1}	33.29	7037a	33.37	6494a
Weedy check	33.58	1728b	30.64	2889b
Level of significance	0.623	0.001	0.068	0.001
SE±	1.076	667.3	0.857	594.8
Variety				
Senegal 28/206	31.21c	6185a	29.83b	6563a
Fleur 11	37.11a	4963b	36.37a	4756b
Samnut 24	33.00b	6615a	35.70a	5156b
Level of significance	0.001	0.011	0.001	0.001
SE±	0.550	365.5	0.560	336.1
Interaction				
WM*V	0.670	0.415	0.920	0.164

Means followed by the same letter(s) in a column are not significantly different at 5% level of probability using Students-Neuman Keuls (SNK) Test. SHW= Supplementary Hand Weeding, WAS=week after sowing, fb= followed by

Table 17. Effect of Weed management Strategies and Groundnut Varieties onCost Benefit and Return Analysis at Banjulinding during 2018 Rainy Season

Treatmens		Banjulinding					
		Total Yield (kg ha^{-1})	Total Variable Cost(TVC) (D)	Average Price/kg (D)	Gross Revenue (D)	Net Revenue (D)	Benefit Cost Ratio
WM	VAR						
1	1	1012	12700	20	20240	7540	1.59
2	1	1207	13000	20	22140	9140	1.7
3	1	900	12770	20	18000	5230	1.41
4	1	947	13095	20	18940	5845	1.45
5	1	953	13570	20	19060	5490	1.4
6	1	1135	14684.1	20	22700	8015.9	1.55
7	1	1012	16529.4	20	20240	3710.6	1.22
8	1	1108	14984.1	20	22160	7175.9	1.48
9	1	1135	14195	20	22700	8505	1.6
10	1	185	11900	20	3700	-8200	0.31
1	2	1177	13050	20	23540	10490	1.8
2	2	935	13350	20	18700	5350	1.4
3	2	1024	13120	20	20480	7360	1.56
4	2	1062	13445	20	21240	7795	1.58
5	2	844	13920	20	16880	2960	1.61
6	2	1119	15034.1	20	22380	7345.9	1.49
7	2	1039	16879.4	20	20780	3900.6	1.23
8	2	1151	15334	20	23020	7686	1.5
9	2	1189	14545	20	23780	9235	1.63
10	2	267	12250	20	5340	-6910	0.44
1	3	1064	12910	20	21280	8370	1.65
2	3	1147	13210	20	22940	9730	1.74
3	3	983	12980	20	19660	6680	1.51
4	3	1050	13305	20	21000	7695	1.58
5	3	1066	13780	20	21320	7540	1.55
6	3	962	14894.1	20	19240	4345.9	1.29
7	3	1174	16739.1	20	23480	6740.9	1.4
8	3	1167	15194.1	20	23340	8145.9	1.51
9	3	1122	14405	20	22440	8035	1.56
10	3	187	12110	20	3740	-8370	0.3

Calculation of total revenue is based on D20 per kg groundnut the prevailing market price in The Gambia, D= Gambia Dalasi, WM= Weed Management: 1=Pendimethalin at 1.0kg a.i h^{-1}, 2=Pendimethalin at 1.5kg a.i ha^{-1},3= Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}, 4=Quizalofop-P-Ethylat at 1.5kg a.i ha^{-1},5= Pendimethalin at 1.0kg a.i ha^{-1} followed by Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}, 6=Pendimethalin at 1.0kg a.i ha^{-1} followed by supplementary hoe weeding at 6 weeks after sowing, 7=Manual hoe weeding at 3 and 6 weeks after sowing,8= Pendimethalin at 1.5kg a.i ha^{-1}followed by supplementary hoe weeding at 6 weeks after sowing, 9=Pendimethalin at 1.5kg a.i ha^{-1} followed by Quizalofop-P-Ethyl at 1.5kg a.i ha^{-1} ,10=Weedy check
VAR=Variety:1= Senegal 28/206, 2= Fleur11,3 = Samnut24

Table 18. Effect of Weed management Strategies and Groundnut Varieties on Cost Benefit and Return Analysis at UTG Faraba Banta during 2018 Rainy Season

Treatmens		UTG Faraba Banta					
		Total Yield (kg ha^{-1})	Total Variable Cost (TVC) (D)	Average Price/kg (D)	Gross Revenue (D)	Net Revenue (D)	Benefit Cost Ratio
WM	VAR						
1	1	930	12700	20	18600	5900	1.46
2	1	1058	13000	20	21160	8160	1.62
3	1	949	12800	20	18980	6180	1.48
4	1	811	13125	20	16220	3095	1.24
5	1	953	13600	20	19060	5460	1.4
6	1	893	14028	20	17860	3832	1.27
7	1	851	15603.8	20	17020	1416.2	1.09
8	1	911	14322.8	20	18220	3897.2	1.27
9	1	880	14225	20	17600	3375	1.24
10	1	193	11900	20	3860	-8040	0.32
1	2	921	13050	20	18420	5370	1.41
2	2	885	13350	20	17700	4350	1.32
3	2	882	13150	20	17640	4490	1.34
4	2	927	13475	20	18540	5065	1.38
5	2	1004	13950	20	20080	6130	1.44
6	2	1015	14372.8	20	20300	5927.2	1.41
7	2	907	15953.8	20	18140	2186.2	1.13
8	2	964	14672.8	20	19280	4607.2	1.31
9	2	975	14575	20	19500	4925	1.34
10	2	161	12250	20	3220	-9030	0.26
1	3	1038	12910	20	20760	7850	1.61
2	3	1130	13210	20	22600	9390	1.71
3	3	941	13010	20	18820	5810	1.45
4	3	993	13335	20	19860	6525	1.49
5	3	1118	13810	20	22360	8550	1.61
6	3	1026	14232.8	20	20520	6287.2	1.44
7	3	1133	15813.8	20	22660	6846.2	1.43
8	3	1414	14532.8	20	28280	13747.2	1.95
9	3	1073	14435	20	21460	7025	1.49
10	3	170	12110	20	3400	-8710	0.28

Calculation of total revenue is based on D20 per kg groundnut the prevailing market price in The Gambia. D= Gambian Dalasi

WM= Weed Management: 1=Pendimethalin at 1.0kg a.i h^{-1}, 2=Pendimethalin at 1.5kg a.i ha^{-1},3= Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}, 4=Quizalofop-P-Ethylat at 1.5kg a.i ha^{-1},5= Pendimethalin at 1.0kg a.i ha^{-1} followed by Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}, 6=Pendimethalin at 1.0kg a.i ha^{-1} followed by supplementary hoe weeding at 6 weeks after sowing, 7=Manual hoe weeding at 3 and 6 weeks after sowing,8= Pendimethalin at 1.5kg a.i ha^{-1}followed by supplementary hoe weeding at 6 weeks after sowing, 9=Pendimethalin at 1.5kg a.i ha^{-1} followed by Quizalofop-P-Ethyl at 1.5kg a.i ha^{-1},10=Weedy check

VAR=Variety: 1= Senegal 28/206, 2= Fleur11,3 = Samnut24

4.2 DISCUSSION

4.2.1 Effect of Weed Management Strategies on Weed Control

It was observed that all the treatments treated with post-emergence herbicide recorded lowest number of grasses. This indicated the post emergence application of quizalofop-p-ethyl was effective against grasses. The highest number of broad leaves, grasses and sedges, weed density and weed dry matter at harvest were recorded by the weedy check in both locations. This is because the experimental sites were species- rich weed communities which were able to emerge freely because no any weed management measures were applied. This is in line with Pabitra*et al.*(2016) who reported that maximum weed density and dry matter were recorded in the weedy check treatment. Efficient weed management resulted to higher weed control efficacy index and lower weed dry mater by manual hoe weeding at 3 and 6 weeks after sowing than other management strategies. This is because manual hoe weeding resulted in cutting of the weed seedlings and burial of weed seeds into the soil at greater depth than other management strategies. At Banjulinding, all the treatments treated with herbicides showed minimum values of weed control efficacy index compared to UTG Faraba Banta. This could be attributed to the fact that there was heavy rainfall after 7 hours of application of pre- emergence herbicide which might reduced the weed efficacy of the applied herbicide. All the weed management treatments were effective in reducing weed density and decreasing weed dry matter compared to the weedy check. The highest weed density and lowest weed control efficiency was recorded by the weedy check. This is because of the available dormant weed seeds in the soil seed bank which germinate as

they not controlled. This result agreed with Pabitra *et al.* (2016) who reported that maximum weed density was noticed in the weedy check on groundnut field.

4.2.2 Effect of Weed Management Strategies on Growth and Yield of Groundnut

Low stand count recorded in weedy checks plot might be attributed to the fact that some weeds might have some alleophatic effect on groundnut which lead to eliminate of some stands.Similar result was reported by Lado, Hussaini and Muhammed (2015) that weedy checks recorded the least stand count of groundnut at harvest. A serious competition for limited resources between weeds and groundnut might responsible for lower number of branches recorded in the weedy checked plots. Similarly, Garko*et.al.* (2016) reported that the unweeded treatment recorded the least number of branches of groundnut in their weed management trial. The lack of weed control throughout the growth period caused significant reduction in plant dry matter in both locations. This is because weeds compete with crops for growth resources hence reduced plant dry matter. Generally, the pod yields were moderately low at UTG Faraba Banta compared to Banjulinding. This could be attributed to the poor soil fertility with low organic matter and moderate acidityat UTG Faraba Banta. This is in accordance with the findings of Dzomeku (2017) who reported that yield loss in groundnuts could be as a result of erratic distribution of rainfall, poor and variation of soil fertility. Pendimethalin at 1.5kg a.i ha^{-1} followed by quizalofop-p-ethylat at 1.5kg a.i ha^{-1} recorded higher pod and kernel yield than other weed management strategies. Weed control with herbicide in groundnut were effective in managing weeds with no peg disturbance compare to manual hoe weeding which could disturb pegging hence reduced yield. Similarly, unweeded treatment had the lowest yield component in both locations. This could be related to reduction of dry matter

production due to competition between crops and weeds for limited environmental resources. This agreed with Ayomide (2010) who reported that weed caused stressed which reduced yields of groundnut by competing with the crop for minerals, light, nutrients and space. However, manual hoe weeding as a strategy of weed management was not economical due to high labour cost. Application of pendimethalin at 1.5kg a.iha^{-1} followed by supplementary hoe weeding at 6 weeks after sowing combined with Samnut 24 gave higher net revenue (D ha^{-1}) and benefit cost ratio than other weed management strategies. This implies that the farmer recorded higher profit when weeds are control by chemical means. This result is in line with Patel*et al.* (2017) who reported application of pendimethalin at 1.0 a.i ha^{-1} recorded higher net revenue and benefit cost ratio which was more economical than other weed control treatments.

4.2.3 Effect of Groundnut Varieties on Weed Control

Fleur 11 recorded the highest number of grasses, sedges and weed density. This is because the variety is semi- erect type which is poor in suppressing weeds. Similarly, Senegal 28/2016 gave a good control of weeds at the initial growth stage but in later stage of the crop growth its suppressing ability of weeds subsided. This is because the variety is a spreading type with shorter canopy.

4.2.4 Effect of Groundnut Varieties on Growth and Yield of Groundnut

Samnut 24 which was a new variety in the study area performed extremely well compared to other local varieties. Similarly, the variety had the highest percent of establishment and stand count at harvest. This is because the variety showed higher germination percentage that was conducted in the lab. Samnut 24 had taller canopy than other varieties resulting in good control of weeds hence gave the highest yield. Although

Senegal 28/206 had produced the highest number of branches but yet still recorded the lowest yield. This indicated genetic superior of Samnut 24 over other varieties. Samnut 24 out yielded the other varieties and recorded the highest net revenue and benefit cost ratio. This result suggested that this variety could be better than other varieties and should be promoted to farmers in The Gambia. This will help in attaining food security, economic growth and development of the poor resource farmers in the country.

4.2.5 Interaction between Weed Management Strategies and Groundnut Varieties on Weed Management, Growth, Yield of Groundnut

The three groundnut varieties responded positively to weed management strategies. Low weed density, high weed control efficiency, high weed control efficacy index and low weed dry matter were recorded with manual hoe weeding at 3 and 6 weeks after sowing and pendimethalin at 1.5kg a.i ha^{-1} followed by quizalofop-p-ethyl at 1.5kg a.i ha^{-1} on the three groundnut varieties. This result is conformity with Sathya Priya *et al.*(2013) who reported that pre-emergence application of pendimethalin at 1.5kg a.i ha^{-1}reduced the weed density, weed dry matter and increased weed control efficiency. This result suggested that the varieties responded well to weed management strategies and tolerate the both pre and post-emergence herbicides. The effective weed management resulted to healthy growth and development of these varieties which lead to minimum competition for limited growth resources. Similarly, higher number of branches and taller canopy were better on these weed management strategies. Application of pendimethalin at 1.5kg a.i ha^{-1} followed by quizalofop-p-ethyl at 1.5kg a.i ha^{-1} and pendimethalin at 1.5kg a.i ha^{-1} followed by supplementary hoe weeding at 6 weeks after sowing gave

higher yield and yield component of groundnut. This could be attributed increase in growth characters and less peg disturbance which supported higher pod and kernel yield.

CHAPTER FIVE

5.0 SUMMARY, CONCLUSION AND RECOMMENDATION

5.1 SUMARRY

The experiment was conducted during the wet growing season of 2018 at two different locations in The Gambia. The first location was at the National Agricultural Research Institute farm in Banjulinding (Latitude 13^0 22.171 N and Longitude $16^0$38.858W). The second location was at Teaching and Research Farm of the University of The Gambia Faraba Banta (Latitude 13^0 14.910 N and Longitude 16^0 32.040W). The objective of the research was to evaluate the response of groundnut varieties to weed management strategies in Southern Guinea Savanna of The Gambia.The experiment consisted of two factors, groundnut varieties (Senegal 28/206, Fleur 11 and Samnut 24) and ten levels of weed management strategies (Pendimethalin at 1.0kg a.i h^{-1}, Pendimethalin at 1.5kg a.i ha^{-1}, Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}, Quizalofop-P-Ethylat at1.5kg a.i ha^{-1}, Pendimethalin at 1.0kg a.i ha^{-1} fb Quizalofop-P-Ethyl at 1.0kg a.i ha^{-1}, Pendimethalin at 1.0kg a.i ha^{-1} fb SHW at 6 WAS, Manual hoe weeding at 3 and 6 WAS, Pendimethalin at 1.5kg a.i ha^{-1} fb SHW at 6 WAS, Pendimethalin at 1.5kg a.i ha^{-1} fb . Quizalofop-P-Ethyl at 1.5kg a.i ha^{-1} and Weedy check). The treatments were factorial combined and were laid out in a Split plot Design and replicate three times. Level of weed managements were assigned to the main plots while the groundnut varieties allocated to the sub plots.

All the agronomic practices were carried out as par requirement of the treatments. Data were collected to weed attributes, growth and yield characters of groundnut. Data

generated were subjected to ANOVA using GenStat. Economic analysis was also conducted to determine the most profitable means of managing weeds in the study area.

The results of the experimental sites indicated that manual hoe weeding at 3 and 6 weeks after sowing recorded the highest weed control efficacy index and lowest weed dry mater at Banjulinding while pendimethalin at 1.5kg a.i ha^{-1} followed by quizalofop-p-ethyl at 1.5kg a.i ha^{-1} recorded the highest weed control efficacy index and lowest weed dry mater at UTG Faraba Banta. Lowest weed density and weed control efficiency was recorded by the weedy check in both locations. Similarly, the unweeded treatment recorded the lowest stand count at harvest, number of branches and canopy height in both locations. Higher pod and kernel yield were recorded by pendimethalin at 1.5kg a.i ha^{-1} followed by quizalofop-p-ethylat 1.5kg a.i ha^{-1} in Banjulinding. However, pendimethalin at 1.5kg a.i ha^{-1} followed by supplementary hoe weeding at 6 weeks after sowing gave higher pod yield while pendimethalin at 1.0kg a.i ha^{-1} followed by quizalofop-p-ethyl at 1.0 kg a.i ha^{-1} recorded higher kernel yield at UTG Faraba Banta. Across the locations, Samnut 24 recorded the highest percent of establishment, canopy height and stand count at harvest. This resulted to higher pod and kernel yield. Maximum net revenue and benefit cost ratio where recorded by pendimethalin at 1.5kg a.i ha^{-1} at Banjulinding and UTG Faraba Banta.

5.2 CONCLUSION

From the outcome of the results, it could be concluded that application of pendimethalin at 1.5kg a.i ha^{-1} followed by quizalofop-p-ethyl at 1.5kg a.i ha^{-1}, pendimethalin at 1.5kg a.iha^{-1} followed by supplementary hoe weeding at 6 weeks after sowing and manual hoe weeding at 3 and 6 weeks after sowing had led to the

production of highest pod and kernel yields of groundnut. Economically,pendimethalin at 1.5kg a.iha^{-1} followed by supplementary hoe weeding at 6 weeks after sowing combined with Samnut 24 had produced higher net revenue and benefit cost ratio than other weed management strategies. Across the two locations, Samnut 24 recorded the highest pod yield and kernel yield than the other three groundnut varieties. This variety out yielded other varieties making it more economical.

5.3 RECOMMENDATIONS

Based on the results obtained, the author is therefore, recommending the choice of adopting pre-emergence application of pendimethalin at 1.5kg a.iha^{-1} followed by supplementary hoe weeding at 6 weeks after sowing for weed control in groundnut in the study area.Samnut 24 out yielded other varieties and had exhibited superior growth and economic return and could therefore be recommended in the study area.It could also be suggested that a multi-location trials over many seasons in The Gambia could be tried.

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APPENDICES

Appendix i. Meteorological Data showing Annual Rainfall during 2018 Rainy Season at Banjlinding (Yundum Station)

Rainfall in MM						
Date	June	July	August	September	October	
1	0	0	0	0	0	
2	0	0	29.9	21.9	10	
3	0	5.9	33.6	1.1	0	
4	0	0	0	6	0	
5	0	0	4.1	4.6	0	
6	0	29.7	12.4	32.8	0	
7	0	54.5	1.8	3.8	17.8	
8	0	39.6	7.8	0	0	
9	0	0	6.1	0	0	
10	0	13	35	0	0	
11	0	0	0	0	0	
12	0	0	0	3	0	
13	0	0	0	0	0	
14	0	0	0	0	0	
15	0	0	0	0	0	
16	0	0	3.8	0	0	
17	0	0	0	12.9	0	
18	0	0	4	56	0	
19	0	52.1	0	56	0	
20	0	0	0	2	0	
21	0	0	0	0	0	
22	0	12.6	33.9	28.4	0	
23	0	0	22.7	3	0	
24	0	0	0	0	0	
25	0	18.1	12.5	0	0	
26	0	0	0	0	0	
27	24.4	0	33.8	15.4	0	
28	0	0	6.2	0	0	
29	0	0	27.9	24.6	0	
30	0	0	20	14.3	0	
31		0	0			
Total	24.4	225.5	295.5	285.8	27.8	859

Source: The Gambia meteorological office, Banjul (2018)

Appendix ii. Meteorological Data showing Annual Rainfall during 2018 Rainy Season at UTG Faraba Banat (Sibanor)

	Rainfall in MM					
Date	June	July	August	September	October	
1	0	0	0	4	0	
2	0	0	22	0	0	
3	0	10.5	18	11	16.6	
4	0	3.5	0	0	19.8	
5	0	0	0	13.9	0	
6	0	42.2	3.6	39.3	0	
7	0	89.1	10.7	5.3	0	
8	0	0	43.6	0	0	
9	0	0	22	18.5	0	
10	0	27.5	53	5	0	
11	0	0	0	0	0	
12	0	20	0	1.6	0	
13	0	20	0	0	0	
14	0	0	0	0	0	
15	0	0	0	0	12	
16	0	0	58.6	0	1	
17	0	1.8	0	81.6	0	
18	0	0	5.9	0	0	
19	0	3.2	0	0	0	
20	0	0	0	0	0	
21	0	0	0	0	0	
22	0	4	16	20	0	
23	0	1.4	33.3	0	0	
24	0	2	0	3.7	0	
25	0	0	19.5	8.9	0	
26	0	0	0	0	0	
27	47.5	0	29.2	0	0	
28	0	9	10.5	0	0	
29	0	0	45	0	0	
30	0	0	15.8	0	0	
31		0	0		0	
	47.5	234.2	406.7	212.8	49.4	950.6

Source: The Gambia meteorological office, Banjul (2018)

Appendix iii. Critical Limits for Interpretation Level of Soil Analytical Parameters

Parameter	Rating			
	Low	Medium	High	Units
Ca	<2	2-5	>5	$cmol(+)kg^{-1}$
Mg	< 0.3	0.30-1.0	>1.0	"
K	<0.15	0.15-0.30	>0.30	"
Na	<0.1	0.1-0.30	>0.30	"
CEC	<6	6-12	>12	"
BS	<50	50-80	>80	"
Org. C	<10	10-15	>15	gKg^{-1}
Total N	<0.1	0.1-0.2	>0.2	"
Avail. P	<10	10-20	>20	$mgKg^{-1}$

Source: Esu (1990) and Enzor *et al.* (1989)

Appendix iv. Critical Limits for Interpretation Levels of Soil pH

Soil Reaction	pH Level
Ultra acid	<3.5
Extremely acid	3.5-4.4
Very Strongly acid	4.5-5.0
Strongly acid	5.1-5.4
Moderately acid	5.5-6.0
Slightly acid	6.1-6.5

Source: Esu (1990) and Enzor *et al.* (1989)