EFFECTS OF VARIETY AND PRE-EMERGENCE HERBICIDES RATES ON WEED CONTROL AND YIELD OF GROUNDNUT (*Arachis hypogaea* L.) IN YOLA, NORTH EASTERN NIGERIA

KOROMA, S.A.[1]*, JAKUSKO, B.B.[2] MOHAMMED, I.[3] AND ABDU, T.[4]

[1]Department of Agriculture, Song Local Government Area, Adamawa State, Nigeria
[2]Department of Agricultural Technology, Federal Polytechnic Mubi, Adamawa State, Nigeria
[3]Department of Crop Production and Horticulture, Modibbo Adama University of Technology, Yola, Adamawa State, Nigeria [4]Deparment of Agricultural Technology, Federal Polytechnic Bali, Taraba State, Nigeria

ABSTRACT

Field trial was conducted during the 2017 and 2018 rainy seasons at the experimental farm site of the Department of Crop Production and Horticulture, Moddibo Adama University of Technology, Yola to study the effects of weed control treatments on the control of weeds in two groundnuts (*Arachis hypogaea* L.) varieties. The experiment was laid out in a split-plot design with SAMNUT 23 and "KAMPALA" groundnut varieties assigned to the main plots and three rates of pre-emergence herbicides applied in the sub-plots plus supplementary hoe weeding (SHW) at 6 weeks after sowing (WAS), and weed-free check and weedy check as controls. The treatments were replicated three times. The results showed that SAMNUT 23 variety recorded significantly higher seed yield/plot, seed yield/ha and 100 kernel weight than "KAMPALA". Similarly, weed parameters measured had statistically similar number of broad leaves, grasses and sedges, total weed density, weed dry weight, weed control efficiency and weed index between the two groundnut varieties. Application of pre-emergence herbicides treatments showed significant differences among the weed control strategies used. Weed free check recorded significantly the lowest values for weed population, weed dry weight and highest weed control efficiency compared to weedy check treatment that recorded the lowest values for these parameters at all crop growth stages. Among the pre-emergence herbicides rates, Metolachlor at 0.75,1 .0, 1.25 and Pendimethalin at 1.0 kg a.i./ha + SHW at 6WAS were the treatments that gave more efficient weeds control. Based on the results, both SAMNUT 23 and KAMPALA varieties of groundnut can be profitably grown in the study area and Metolachlor at 0.75,1 .0, 1.25 and Pendimethalin at 1.0 kg a.i./ha + SHW at 6 WAS can be used as an alternative to two-hoe weeding (weed free check) for effective weed control in groundnut in Yola, Nigeria.

Keywords: Butachlor, Groundnut, "KAMPALA", Metolachlor, Pendimethalin, SAMNUT 23
***Correspondence:** akeweta@gmai.com, 08085020704

INTRODUCTION

Groundnut (*Arachis hypogaea* L.), also known as peanut is one of the world's most important oil seed crop [1] ranking the 13th most important food crop and the 4th oil seed crop in the world [2]. It is an ancient crop which is believed to have originated from Eastern Bolivia at the foothills of the Andes, where there is a very important centre of variability for the subspecies – *hypogaea* [3]. According to Onwueme and Sinha [4], Portuguese navigators introduced groundnuts from South America to Africa, India, and possibly other areas. Today, the crop is being cultivated in more than 100 Countries of the World [5] and widely grown in the tropics and subtropics [6]. Ajeigbe *et al*. [7] reported that in 2012, the World total land area of 24.6 million hectares was cultivated with groundnuts producing 41.3 metric tons and productivity of 1.676 t/ha. China, India, Nigeria, United States of America and Myamar were the leading groundnut producing countries in the World. It further stated that Asia with 11.6 million hectares (47.15 %) and Africa with 11.7 hectares (47.56 %) hold maximum global area under groundnut cultivation. Developing countries in Asia, Africa and South America account for over 97% of World groundnut area and 95% of global total production. However, the productivity of Asia (2.217 t/ha) and Africa (0.929 t/ha) is very poor as compared to America's 3.632 t/ha [8]. INC [9] reported that World peanut production reached over 41 million metric tons in 2019/20 and China accounted for 38% of the world peanut crop, followed by India with 15%. The next 20% was produced by Nigeria (8%), the USA (6%), Senegal (3%) and Argentina (3%).

Groundnuts is used for human consumption, feed for livestock and in industries for manufacturing of pharmaceuticals and confectioneries. In developing countries such as Nigeria where the cost of animal protein is very high, groundnut serves as a good alternative source of animal protein [10]. In the farming system of Nigeria, groundnuts feature in intercrop with cereals as well as in crop rotation due to its ability to fix atmospheric nitrogen thereby improving soil fertility [11].

Despite the numerous and tremendous benefits of groundnuts to humans and the livestock, a lot of factors limit its cultivation. According to Ajeigbe *et al*. [7], several challenges including rainfall variability and drought, poor soil fertility, biotic and abiotic constraints and constraint to input supply have been noted to limit groundnut production in Nigeria. According to Jat *et al.* [12], groundnut crop is highly susceptible to weed infestation because of its slow growth in the initial stages up to 40 days, short plant height and underground pod bearing habit.

Commonest weeds found in groundnut crop comprise of diverse plant species from grasses to broad-leaf weeds and sedges, and cause substantial yield losses between 15-75% [12]. Among these problems, weeds infestation is the most critical factor that limits groundnut cultivation. Sathya-Priya *et al.* [13] stated that, weeds interfere with pegging, pod development and harvesting of groundnut causes loss in groundnut yield. Singh & Oswalt [14] reported that 100% losses in groundnut yield at ICRISAT Center Kano was caused by weeds and Zimdhal [15] observed that groundnut yield decreased with time of weeds interference, and the type of weeds species. It is therefore important that weeding should be completed before pegging.

In most developing countries, manual weeding is the major method for weeds control. According to Adigun & Lagoke [16], the traditional method of weed control, namely, hoe weeding is the commonest method of weed control practiced by farmers in the Sudan savanna zone of Nigeria. This method is not only labour intensive, expensive and strenuous, and can also cause mechanical damage to growing branches and roots of plants. In addition to high cost and labour availability is uncertain, thus making timeliness of weeding difficult to attain, thus leading to greater yield loss. Critically, viewing the mechanical and manual methods of weed control in groundnut crop; besides being less effective, costly, time demanding and the need to be repeated at frequent intervals, chemical weed control is a better option and forms an integral part of modern crop production. Zimdhal [15] stressed that, the high loss in groundnut yield has created a wide scope of using herbicides in groundnut crop. Chemical weed control has revolutionized farmers approach to weed control in the world. It is one of the recent developments in crop production. It is more adapted to large scale crop production than other weed control methods and it is labour saving [17]. Also, herbicide use has been reported to be more profitable than hoe-weeding in the production of various crops in Nigeria [18]. Some common herbicides used in the control of weeds in groundnut crop fields include pre-emergence herbicides such as metolachlor, butachlor, pendimethalin, oxyfluofen, etc. and post emergence herbicides such as bentazon, imazethapyr, quizalofop ethyl, phenoxaprop-p-ethyl etc. [12, 19].

In a review by Sathya-Priya *et al.* [13], pre-emergence application of soil active herbicides could be appropriate not only in minimizing early weed control, but also for reducing demand for labour during peak period of cultivation and to avoid at least one or two inter-cultivations during the first 3-4 weeks after sowing (WAS) to control weeds. He further stated that 30-55% of the weeds can be controlled by pre-emergence herbicides. However, where combined with one hoe weeding, up to 85% of the weeds are controlled. Various rates of pre and post emergence herbicides have been recommended for use to control weeds in groundnuts by different scholars. Garko *et al.* [20] recommended the application of 1.0 kg a.i./ha followed by fluazifob-p butyl at 1.0 kg a.i./ha; and Metolachlor at 1.0 or 2.0 kg a.i./ha followed by supplementary hoe weeding for weed control in groundnut at Bagauda and Bayero University, Kano, Nigeria as the two treatments produced significantly more pods/plant and heavier pod yield/ ha. Nano & Janmejai [21] also reported that the application of S-Metolachlor and Pendimethalin at 1.0 kg a.i. ha^{-1} each supplemented with hand weeding at 5 WAS significantly (P≥001) reduced the broadleaved weeds, sedges and weed dry weight and the benefit gained from the two treatments was greater than the value recorded by weedy check by 216% and 198% respectively. S-metolachlor at 1.0 kg a.i. ha^{-1} supplemented with hand weeding at 5 WAS treatment resulted in highest grain yield and economic benefit. Soumya *et al.* [22] reported that Butachlor 50% EC at the rate of 1000 mls/ ha effectively controlled weed population and recorded the highest growth values of weeds among all pre-emergence herbicides treatments; while Kanagam *et al.* [23] reported that the pre-emergence application of Metolachlor at 1.0 kg a.i./ha reduced weed population and dry matter production of grasses, sedges and broadleaved weeds in groundnut.

It should be noted that every location of the World possesses peculiar weed problems and hence the most suitable herbicides for every crop found in each location need to be determined through research. According to James *et al.* [24], no single herbicide controls all weed species and Gabriel *et al.* [25] rightly pointed out that farmers encounter different types of weeds on their farms and the method(s) of controlling these weeds and the problem(s) associated with each weed species differ from one location to the other. Therefore, selected herbicides, such as Butachlor, Metolachor and Pendimethalin at varying rates would be used for this trial.

In view of the above to solve the problem of effective weed control in groundnut, this research was conducted with the objective of studying the effect of different pre-emergence herbicides rates (Butachlor, Metolachlor and Pendimethaline) for weed control in groundnut in Yola, northeastern Nigeria.

MATERIALS AND METHODS

Experimental site

The experiment was conducted at the Research and Teaching farm of the Department of Crop Production and Horticulture, Modibbo Adama University, Yola during the 2017 and 2018 rainy seasons. The experimental site lies between Latitude $12^0 30' 13.8''$ and $12^0 30' 14.0''$ and longitude $09^0 21' 14.3''$ and $09^0 21' 16.3''$ [26]. Yola is located at altitude 200 m above sea level within the Sudan savanna ecological zone. It has an annual mean rainfall of 900 mm to 1100 mm [27].

Experimental treatments and design
The treatments consisted of two groundnut varieties (SAMNUT 23 and "KAMPALA") and three pre-emergence herbicides (metolachlor, butachlor and pendimethalin) at three different rates - 0.75 kg a.i./ha + supplementary hoe weeding (SHW) at 6 weeks after sowing (WAS), 1.0 kg a.i./ha + SHW at 6 WAS and 1.25 kg a.i./ha + SHW at 6 WAS, and weed-free check (hoe-weeding at 3 and 6 WAS) (control check) and weedy check. The treatments were laid out in a split plot design with groundnut varieties sown in the main plot, while the herbicide treatments were applied in the sub-plot and these were replicated three times. The plot size was 2 m x 3 m (1.875 m^2 net plot area) placed at the distances of 0.5 m between main and subplots and 1.0 m between replicated blocks (Figure 1)

Sources of groundnut seeds
The groundnut variety SAMNUT 23 was obtained from Adamawa Agricultural Development and Investment Limited (AADIL), Yola while "KAMPALA'' was obtained from Dumne local market in Song LGA, Adamawa State.

SAMNUT 23
SAMNUT 23 is an early-maturing (90-100 days) and contains high oil (53%). The kernels are large in size and completely red in color and it is a spreading type of groundnut.

''KAMPALA''
''KAMPALA'' is variegated type of groundnut with large kernels. It has a maturity period of 100 – 110 days.

Sources of agrochemicals
Agrochemicals (Butachlor, Metolachlor Pendimethalin and Apron-plus) were obtained from Adamawa Agricultural Development and Investment Limited (AADIL), Yola.

Cultural practices
Land preparation: The land was cleared, ploughed, harrowed at an interval of 2 weeks, leveled and divided into plots and replicated blocks as designed.
Fertilizer application: NPK (15:15:15) fertilizer was applied by broadcast at the rate of 60 kg/ ha at sowing [33].
Seed treatment, sowing and spacing: The groundnut kernels were treated with AllStar ® 40DS at the rate of 0.07kg a. i./50kg seeds/ ha and sown at the spacing of 25cm x 75cm in the plots. The seeds were sown on 8th and 13th June, 2017 and 2018.
Weed control: The three pre-emergence herbicides (butachlor, metolachlor and pendimethalin) were applied using a 20-liter Knapsack sprayer with ash colour nozzle on the plots at the designated rates as soon as groundnut varieties were sown. This was followed by a supplementary hand hoe weeding at 6 WAS, except the plots treated with zero (0 kg a.i./ha) of the herbicides as recommended by [7]. The control treatment was hoe-weeded at 3 and 6 WAS.
Pests and diseases control: Pests and diseases were not observed on groundnut and hence no control measures were carried out during the study.
Harvesting: Harvesting was promptly carried out as soon as the leaves colours have turned yellowish. The crop was harvested on 3rd October in 2017 and 10th October in 2018. Groundnut plants within the net plot area were harvested to represent yield/ plot and computed to yield/ ha.

Data collection
Weed flora: Weed species of the whole experimental field was obtained by collecting and identifying the types of weeds that were found on the experimental site. This was done by throwing a 0.5m x 0.5m quadrant five times along the two diagonals of the experimental field and identifying the types of weeds caught in the quadrant.
Weed density: Weed density was obtained by randomly throwing a 0.5m x 0.5m quadrant three times at 4, 8 and 12 WAS and counting the number of broadleaf weeds, grasses and sedges that were up to 10 cm high in each plot and their averages obtained. The number of broadleaf weeds/m^2, grasses/m^2 and sedges/m^2 were then obtained by using the formula below while the total weed density/m^2 was obtained by summing up the number of broadleaf weeds/m^2, grasses/m^2 and sedges/m^2.

$$\text{Number of weed type/m}^2 = \frac{\text{number of weed type}}{0.50\ x\ 0.50\ m2} x 1\ \text{m}^2$$

$$\text{Total weed density} = \frac{\text{Total number of weed types}}{0.50\ x\ 0.50\ m2} x 1\ \text{m}^2$$

Weed dry weight (g): The weed dry weight was obtained by collecting fresh weeds in the center of each plot using a 50 cm x 50 cm quadrant at 4 WAS and at harvest, oven dried to a constant weight, weighed with a digital weighing balance (Camry Model: EK 5350) and computed per hectare.
Weed control efficiency (WCE) (%): The weed control efficiency of the treatment was calculated at harvest using the formula below:

$$\text{Weed control efficiency (\%)} = \frac{\text{Dry matter of weeds in unweeded plot} - \text{Dry matter of weeds in treated plot}}{\textit{Dry matter of weeds in unweeded plot}} x\ 100$$

Weed index: Weed index was calculated by using the following formula:

$$\text{Weed Index} = \frac{\text{Yield from the weed free check} - \text{Yield from the treated plot}}{\text{Yield from the weed free check}}$$

100 seeds weight per plot (g): The weight of 100 seeds per net plot was obtained by randomly counting

100 groundnuts seeds from the seed lot of groundnut plants in each net plot and weighed using an electric top loading balance in the laboratory.

Seed yield per plant (g): Seed yield per plant was obtained by peeling and weighing the dry pods harvested from the net plot area divided by the number of stands harvested

Seed yield per hectare: Seeds yield/ha was computed from seed yield/plot and recorded using the formula

$$\text{Seed yield (kg/ha)} = \frac{\textit{Seed}\ \text{weight}\ \textit{per plot}(kg)}{\textit{Net plot Area}(m2)} X\ 10{,}000m^2$$

Data analysis

Data collected from the experiment were subjected to analysis of variance (ANOVA) for split-plot design and Duncan's Multiple Range Test (DMRT) at 5% of probability was used to separate the means. The Statistix 10 software was used for the ANOVA.

RESULTS AND DISCUSSION

The most predominant weeds observed in the experimental site in the two rainy seasons include *Acanthospernum hispidium, Ageratum conyzoides L., Tridax procumbens., Polycapaea corymbosa* L., *Commelina benghalensis* L., *Ipomea eriocarpa* R.Br., *Euphorbia hirta* (L.), *Senna obtusifolia., Crotalaria macrocarlyx* Benth., *Sida acuta and Boerhavia diffusa* L., *Dactyloctenium aegyptum* (L.), *Eleusine indica*, (L.), *Cyperus esculentus., Cyperus rutundus* L. and *Cyperus tuberosus* (Table 1). The weed flora composed of 70 % broadleaf weeds, 20 % grasses and 10 % sedges. Grass weeds have been reported to affect groundnut more than broadleaf weeds while sedge weeds have the lowest effects. According to Wilcut *et al.* [34], annual and perennial grasses are more competitive and detrimental to peanuts yield than annual broadleaf weeds.

The weed parameters studied included number of broadleaf weeds, grasses, sedges, total weed density, weed dry weight, weed control efficiency/m^2 at 4, 8 and 12 WAS (Tables 2-7) and the weed index at harvest of groundnut (Table 8). Among parameters on Tables 2-7, both groundnut varieties had statistical similar means in the two rainy seasons. Weed index in Table 8 was also indicated statistical similar groundnut varieties mean in the two rainy seasons indicating that variety had neither contributed to increased nor decreased yield of groundnut in the study.

On the other hand, the effect of pre-emergence herbicides treatment was significant on weed parameters. Weed free check treatment recorded, the lowest significant weed population (number of broad weeds, grasses, sedges and total weed density/m^2), weed dry weights, highest weed control efficiency at the crop growth stages and weed index at harvest than weedy check treatment that recorded the highest weed population, weed dry weight, lower weed control efficiency and higher weed index. This indicates that weed free check was effective in reducing weed population and biomass which subsequently resulted into higher weed control efficiency and lower weed index.

Among herbicides treated plots, pendimethalin at at 0.75 kg a.i./ha + SHW at 6 WAS produced the highest weed population and weed index next to weedy check. Other herbicide treatments that received the lowest weed index included Pendimethalin at 1.25 kg a.i./ha + SHW at 6 WAS, Metolachlor at 1.0 kg a.i./ha + SHW at 6 WAS and Metolachlor at 0.75 kg a.i./ha + SHW at 6 WAS. These treatments recorded the lowest weed index possibly due to the low total weed density and high weed control efficiency obtained at various sampling periods during the crop growth. Weed index determines the reduction in yield due to weed infestation and interference, thus it is an ideal parameter to judge the weed control effectiveness of the herbicides' treatments. In a similar study, Dzomeku [35] reported that lowest weed index was attained with farmer practice (weeding at 3 and 6 WAP), but other five treatments gave acceptable weed index under up to 25%. The treatments included Pendimethalin at 0.15 kg a.i./ha + hand weeding at 4 WAP, Haloxyfop at 0.03 kg a.i./ha + one hand weeding at 7 WAP, Propaquizafop at 0.02 kg a.i./ha + one hand weeding at 7 WAP, Bentazon at 0.14 kg a.i./ha at 4 WAP + one hand weeding at 7 WAP and Pendimethalin + Haxylofop applied at 4 WAP.

The effect of variety on seed yield (g) per plant was not significant in 2017 and 2018 Wet Seasons (Table 10). However, there was a significant difference ($P \leq 0.05$) among herbicides on seed yield per plant in the two seasons. In 2017 Wet Season, weed free check gave the highest seed yield (g/plant) followed by Metolachlor at 1.0 kg a.i./ha + hoe weeding at 6WAS while the lowest seed yield per plant was recorded by Weedy check. In 2018 Wet Season, weed free check also recorded the highest seed yield per plant followed by Pendimethalin at 1.0 kg a.i./ha + hoe weeding at 6 WAS and the weedy check recorded the lowest seed yield per plant. An interaction was observed between variety and pre-emergence herbicides on seed yield per plant in 2018, but not in 2017 Wet Season. The interaction between variety and pre-emergence herbicides on seed yield per plant in 2018 is presented in Table 9. The interaction between SAMNUT 23 and Weed free check recorded the highest seed yield followed by the interaction between SAMNUT 23 and Pendimethalin at 1.0 kg a.i./ha + hoe weeding at 6 WAS. The lowest seed yield per plant were recorded by the interaction between KAMPALA and Weedy check and between SAMNUT 23 and Weedy check.

The effect of variety on seed yield (g/plot) was not significant in the two seasons (Table 9). However, the effect of pre-emergence herbicides was highly significant (P≤0.01) on seed yield/plot in the two seasons. In 2017, Weed free check gave the highest seed yield/plot followed by Metolachlor at 1.0 kg a.i./ha + hoe weeding at 6WAS which was at par with all other pre-emergence herbicides rates except Weedy check which had the lowest seed yield/plot. In 2018 Wet Season, weed free check gave the highest seed yield/plot followed by Pendimethalin at 1.0 kg a.i./ha + hoe weeding at 6WAS. This is again followed by Pendimethalin at 1.25 kg a.i./ha while the lowest seed yield/plot was recorded from the Weedy check.

The interaction between variety and pre-emergence herbicides on seed yield/plot was found in 2018, but not in 2017 Wet Season. In 2018, SAMNUT 23 interacted with Weed free check to record the highest seed yield/plot followed by the interaction between SAMNUT 23 and Pendimethalin at 1.0 kg a.i./ha + hoe weeding at 6 WAS (Table 13) while the lowest seed yield/plot was obtained from KAMPALA and Weedy check.

The effect of variety on seed yield/ha was significant in (P≤0.05) 2018 but not significant in 2017 (Table 9). In 2018 SAMNUT 23 recorded the higher seed yield 593.12 (kg/ha) while KAMPALA had the lower seed yield (kg /ha). There was also highly significant difference (P≤0.01) among pre-emergence herbicides on seed yield/ha in 2017 and 2018 Wet Seasons. In both 2017, Weed free check got the highest seed yield of 1916.92 followed by Metolachlor at 1.0 kg a.i./ha + hoe weeding at 6WAS while Weedy check recorded the lowest seed yield /ha. In 2018 Wet Season, weed free check also had the highest seed yield of 1009.6 kg/ha followed by Pendimethalin at 1.0 kg a.i./ha + hoe weeding at 6WAS. The lowest seed yield/ha was obtained from Weedy check.

Seed yield (g) per plant, Seed yield (g) per plot and Seed yield (kg) per hectare were numerically and significantly affected by variety and the combined means. In all cases, SAMNUT 23 had higher values compared to KAMPALA variety. The outstanding performance of SAMNUT 23 over KAMPALA could be attributed to the genotypic variation between the two varieties. This result is similar to the report by Abdul-Rahman & Daniel [36] who observed that SAMNUT 23 had highest mean grain yield in 2012 and 2013 as compared to SAMNUT 22 and one improved local variety studied in transitional rain forest and Savanna grassland agro-ecologies of Sierra Leone. They considered SAMNUT 23 to be highly yielding than SAMNUT 22 and the improved local variety concluding the SAMNUT 23 is more efficient in manufacture of assimilates and partitioning of the reproductive sink.

One hundred (100) seed weight was significantly affected by the variety in both years and the combined means. In all instances, SAMNUT 23 recorded the highest 100 seed weight as compared to KAMPALA variety possibly due to its high oil content. According to N2AFRICA [37], SAMNUT 23 has an outstanding oil content (53%) among groundnut varieties in Nigeria while Nkafamiya *et al.* [38] reported that KAMPALA Mubi and KAMPALA Michika contain 37.40 ± 3.20% and 24.60 ± 1.82% oil percentages respectively. In a similar study, Mouri *et al.* [39] reported that the weight of 100 seeds of BARI cheenabadam-8 was higher than BINA cheenabadam-6 due to genotypic differences of the varieties.

CONCLUSION

Based on the outstanding performance of Metolachlor at 1.0, 0.75, 1.25 and Pendimethalin at 1.0 kg a.i./ha + SHW at 6 WAS, either of these herbicides is recommended for effective weed control in any of the groundnut used in Yola, Nigeria.

ACKNOWLEDGEMENTS

We wish to acknowledge Professor Gworgwor, N.A. of the Department Crop Production, University of Jos for his contributions and untired less criticisms towards the success of project work, and to Dr. Stephen A. Koroma who release his thesis for the production of this journal paper.

Table 1: Weeds flora found in the experimental site of groundnut in Yola in 2017 and 2018

S/No	Botanical name	Common name	Family
1	*Acanthospermum hispidum*	Bristly starbur	ASTERACEAE
2	*Ageratum conyzoides* Linn.	Goat weed	ASTERACEAE
3	*Vernonia ambigua* Kotschy & Peyr	Iron weed	ASTERACEAE
4	*Tridax procumbens* L.	Tridax or coat buttons	ASTERACEAE
5	*Polycarpaea corymbosa* L.	Old man’s cap	CARYOPHYLLACEAE
6	*Cleomeviscosa* L.	Spider plant or Consumption weed	CLEOMACEAE
7	*Cyanotis lanta* Benth.	-	COMMELINACEAE
8	*Commelina benghalensis* L.	Wandering Jew, Tropical Spiderwort	COMMELINACEAE
9	*Ipomoea eriocarpa* R. Br.	Tiny morning glory	CONVOLULACEAE
10	*Euphorbia hirta* L.	Snake weed or Asthma herb	EUPORBIACEAE

11	*Hyptis suaveolens* (L.) Poit.	Pignut	LAMIACEAE
12	*Leucas martinicensis* R.	Whitewort	LAMIACEAE
13	*Senna obtusifolia*	Java bean or Sickle pod	LEGUMINOCEAE:
14	*Crotalaria macrocalyx* Benth.	Rattle pod	LEGUMINOSAE
15	*Desmodium scorpiurus* (Sw.) Desv.	Scorpion ticktrefoil	LEGUMINOSAE
16	*Sida corymbosa* R.E Fries.	-	MALVACEAE
17	*Sida acuta*	Common Wire weed	MALVACEAE
18	*Boerhavia diffusa* L.	Pig weed	NYCTAGINACEAE
19	*Corchorus tridens* Linn.	Wild jute	TILIACEAE
20	*Mitracarpus villosus* (SW.) DC.	Tropical girdlepod	RUBIACEAE
21	*Salvinia molesta* Michel	Water fern	SALVINIACEAE
	Grasses		
1	*Dactyloctenium aegyptum* (L.) Willd	Crowfoot-grass	POACEAE
2	*Eleusine indica* (L) Gaertner	Goose grass	POACEAE
3	*Phalaris minor* RetZ	Little Kernel Canary grass	POACEAE
4	*Pennisetum pedicellatum* Trin.	Deenanath grass or Feather Pennisetum	POACEAE
5	*Eragrostis tremula Hochst.ex Steud*	Love grass	POACEAE
6	*Setaria pumila (*Poir.*)*	Yellow Foxtail	POACEAE
	Sedges		
1	*Cyperus esculentus*	yellow nudsedge	CYPERACEAE
2	*Cyperus rotundus* L.	purple nudsedge	CYPERACEAE
3	*Cyperus tuberosus* R.	Nutgrass	CYPERACEAE

Table 2: Effects of pre-emergence herbicides on number of broadleaf weeds/m^2 at 4, 8 and 12 WAS of two groundnuts varieties in Yola during rainy seasons of 2017 and 2018

Treatments	**Number of broadleaf weeds/m^2**					
	4 WAS	**8 WAS**	**12WAS**	**4 WAS**	**8WAS**	**12WAS**
		2017			2018	
Variety (V)						
SAMNUT 23	35.41	28.15	20.80	18.11	7.43	8.55
‘‘KAMPALA’’	22.65	22.00	26.47	17.76	6.86	7.89
SE (±)	2.416	2.757	5.666	2.655	1.342	0.627
Herbicide rate (H)						
Butachlor 0.75 kg a.i./ha + SHW@ 6WAS	60.58^{b}	7.92^{b}	21.83^{b}	23.38^{abc}	0.01^{b}	5.58^{b}
Butachlor 1.0 kg a.i./ha + SHW @ 6WAS	42.83^{bc}	3.33^{b}	15.33^{b}	18.33^{bc}	0.01^{b}	4.67^{b}
Butachlor 1.25 kg a.i./ha + SHW @ 6WAS	21.67^{de}	1.67^{b}	16.08^{b}	16.87^{bc}	0.01^{b}	64.7^{b}
Metolachlor 0.75 kg a.i./ha + SHW@ 6WAS	31.42^{cd}	9.50^{b}	12.67^{b}	28.83^{ab}	0.01^{b}	4.08^{b}
Metolachlor 1.0 kg a.i./ha + SHW @ 6WAS	17.42^{de}	5.00^{b}	10.50^{b}	20.17^{abc}	0.01^{b}	2.75^{b}
Metolachlor 1.25 kg a.i./ha + SHW @ 6WAS	7.83^{e}	0.42^{b}	33.92^{b}	11.08^{cd}	0.01^{b}	1.08^{b}
Pendimethalin 0.75 kg a.i./ha + SHW@ 6WAS	13.58^{de}	5.00^{b}	44.80^{b}	18.03^{bc}	0.01^{b}	1.13^{b}
Pendimethalin 1.0 kg a.i./ha + SHW @ 6WAS	12.33^{de}	11.25^{b}	8.67^{b}	18.92^{bc}	0.01^{b}	1.92^{b}
Pendimethalin 1.25 kg a.i./ha + SHW @ 6WAS	7.33^{e}	0.42^{b}	6.83^{b}	10.83^{cd}	0.01^{b}	1.67^{b}
Weedy Check (No weeding)	100.00^{a}	230.00^{a}	147.92^{a}	32.25^{a}	78.67^{a}	61.53^{a}
Weed free Check (SHW @ 3 and 6WAS)	4.33^{e}	1.33^{b}	2.17^{b}	0.01^{d}	0.01^{b}	1.25^{b}
SE (±)	7.210	5.999	10.376	4.406	4.600	5.360
Interaction						
Interaction (V x H)	NS	**	NS	NS	NS	NS

SHW = Hoe Weeding WAS= Weeks After Sowing NS= Not Significant ** = Significant at 1% level

Means followed by the same letter (s) within the same treatment group are not significantly different at 5% level of probability according to Duncan's Multiple Range Test (DMRT)

Table 3: Effects of pre-emergence herbicides on the number of grasses/m^2 at 4, 8 and 12 WAS of two groundnuts varieties in Yola during rainy seasons of 2017 and 2018

Treatments	Number of grasses/m^2					
	4WAS	8WAS	12WAS	4WAS	8WAS	12WAS
		2017			2018	
Variety (V)						
SAMNUT 23	6.37	4.88	2.67	9.92	4.81	4.17
''KAMPALA''	2.89	2.03	3.53	8.07	6.12	3.47
SE (±)	1.745	1.152	0.413	3.542	1.221	0.210
Herbicide rate (H)						
Butachlor 0.75 kg a.i./ha + SHW@ 6WAS	5.67^{abc}	2.50^{b}	1.67^{b}	6.65^{c}	0.01^{b}	1.92^{b}
Butachlor 1.0 kg a.i./ha + SHW @ 6WAS	5.42^{abc}	1.67^{b}	2.25^{b}	9.33^{c}	0.01^{b}	0.58^{b}
Butachlor 1.25 kg a.i./ha + SHW @ 6WAS	3.75^{bc}	1.67^{b}	2.25^{b}	0.42^{c}	0.01^{b}	3.32^{b}
Metolachlor 0.75 kg a.i./ha + SHW@ 6WAS	2.50^{c}	0.75^{b}	1.08^{b}	7.17^{c}	0.01^{b}	1.92^{b}
Metolachlor 1.0 kg a.i./ha + SHW @ 6WAS	0.00^{c}	0.84^{b}	0.75^{b}	6.08^{c}	0.01^{b}	1.17^{b}
Metolachlor1.25 kg a.i./ha + SHW @ 6WAS	1.00^{c}	0.42^{b}	1.92^{b}	3.00^{c}	0.01^{b}	1.92^{b}
Pendimethalin 0.75 kg a.i./ha + SHW@ 6WAS	11.08^{a}	1.25^{b}	7.50^{a}	24.67^{b}	-0.55^{b}	3.40^{b}
Pendimethalin 1.0 kg a.i./ha + SHW @ 6WAS	4.08^{abc}	0.42^{b}	1.33^{b}	8.17^{c}	0.01^{b}	3.83^{b}
Pendimethalin 1.25 kg a.i./ha + SHW @ 6WAS	7.00^{abc}	1.25^{b}	1.58^{b}	8.58^{c}	0.01^{b}	1.17^{b}
Weedy Check (No weeding)	10.42^{ab}	26.67^{a}	12.25^{a}	26.00^{a}	60.58^{a}	25.00^{a}
Weed free Check (SHW @ 3 and 6WAS)	0.00^{c}	0.58^{b}	1.50^{b}	0.01^{c}	0.01^{b}	1.09^{b}
SE (±)	2.478	2.064	1.702	3.542	3.905	2.500
Interaction (V x H)	NS	**	NS	NS	NS	NS

SHW = Hoe Weeding WAS= Weeks After Sowing NS= Not Significant ** = Significant at 1% level. Means followed by the same letter (s) within the same treatment group are not significantly different at 5% level of probability according to Duncan's Multiple Range Test (DMRT)

Table 4: Effects of pre-emergence herbicides on number of sedges/m^2 at 4, 8 and 12 WAS of two groundnuts varieties in Yola during rainy seasons of 2017 and 2018

Treatments	Number of sedges/m^2					
	4WAS	8WAS	12WAS	4WAS	8WAS	12WAS
		2017			2018	
Variety (V)						
SAMNUT 23	9.71	9.04	4.00	3.53	2.80	2.00
''KAMPALA''	10.94	10.94	5.61	6.67	5.72	1.13
SE (±)	2.983	4.089	0.984	1.323	1.083	0.922
Herbicide rate (H)						
Butachlor 0.75 kg a.i./ha + SHW@ 6WAS	1.58^{cd}	4.58^{b}	5.92^{b}	5.51^{c}	0.01^{b}	0.83^{b}
Butachlor 1.0 kg a.i./ha + SHW @ 6WAS	3.67^{cd}	4.17^{b}	3.00^{bcde}	0.31^{c}	0.01^{b}	4.44^{b}
Butachlor 1.25 kg a.i./ha + SHW @ 6WAS	0.33^{d}	0.83^{b}	0.25^{e}	0.01^{c}	0.01^{b}	0.83^{b}
Metolachlor 0.75 kg a.i./ha + SHW@ 6WAS	1.26d	1.67b	5.25bcd	2.51c	0.01b	0.25^{b}
Metolachlor 1.0 kg a.i./ha + SHW @ 6WAS	1.25^{d}	1.26^{b}	1.92^{bcde}	0.26^{c}	0.01^{b}	2.67^{b}
Metolachlor 1.25 kg a.i./ha + SHW @ 6WAS	3.33^{d}	3.34^{b}	0.83^{de}	0.01^{c}	0.01^{b}	1.55^{b}
Pendimethalin 0.75 kg a.i./ha + SHW@ 6WAS	20.75^{b}	12.08^{b}	3.92^{bcde}	7.87^{b}	-0.54^{b}	0.19^{b}
Pendimethalin 1.0 kg a.i./ha + SHW @ 6WAS	18.25^{bc}	5.00^{b}	5.25^{bcd}	15.50^{a}	0.01^{b}	0.84^{b}
Pendimethalin 1.25 kg a.i./ha + SHW @ 6WAS	14.33^{bcd}	2.50^{b}	5.50^{bc}	5.00^{bc}	0.01^{b}	0.84^{b}
Weedy Check (No weeding)	53.42^{a}	73.75^{a}	19.67^{a}	20.25^{a}	47.25^{a}	10.50^{a}
Weed free Check (SHW @ 3 and 6WAS)	0.00^{d}	1.00^{b}	1.33^{cde}	1.42^{c}	0.01^{b}	0.25^{b}
SE (±)	5.873	7.921	1.591	2.032	2.315	1.476
Interaction (V x H)	NS	NS	NS	NS	**	NS

SHW = Hoe Weeding WAS= Weeks After Sowing NS= Not Significant ** = Significant at 1% level
Means followed by the same letter (s) within the same treatment group are not significantly different at 5% level of probability according to Duncan's Multiple Range Test (DMRT)

Table 5: Effects of variety and pre-emergence herbicides on total weed density/m^2 at 4, 8 and 12WAS of groundnuts in Yola during rainy seasons of 2017 and 2018

Treatments	**Total weed density/m^2**					
		2017			**2018**	
	4WAS	**8WAS**	**12WAS**	**4WAS**	**8WAS**	**12WAS**
Variety (V)						
SAMNUT 23	51.49	44.07	27.47	31.56	15.04	14.72
''KAMPALA''	36.51	34.97	30.98	32.50	15.7	12.49
SE (±)	5.656	1.302	1.407	6.194	3.328	1.128
Herbicide rate (H)						
Butachlor 0.75 kg a.i./ha + SHW@ 6WAS	50.33^b	15.00^b	29.12^{bc}	37.54^{bcde}	0.03^b	8.33b
Butachlor 1.0 kg a.i./ha + SHW @ 6WAS	51.92^b	9.17^b	20.58^{bcd}	31.80^{bcde}	0.03^b	9.69b
Butachlor 1.25 kg a.i./ha + SHW @ 6WAS	25.75^{bcde}	4.17^b	18.58^{bcd}	17.30^{def}	0.03^b	8.83b
Metolachlor 0.75 kg a.i./ha + SHW@ 6WAS	35.18^{bc}	11.92^b	19.00^{bcd}	38.51^{bcd}	0.03^b	6.25b
Metolachlor 1.0 kg a.i./ha + SHW @ 6WAS	22.42^{cde}	7.10^b	13.17^{bcd}	26.51^{cde}	0.03^b	6.59b
Metolachlor 1.25 kg a.i./ha + SHW @ 6WAS	8.83^{de}	4.17^b	36.67^b	14.09^{ef}	0.03^b	4.55b
Pendimethalin 0.75 kg a.i./ha + SHW@ 6WAS	45.41^b	18.33^b	25.50^{bc}	50.59^b	1.1^b	4.72b
Pendimethalin 1.0 kg a.i./ha + SHW @ 6WAS	34. 66^{bcd}	16.68^b	15.25^{bcd}	42.59^{bc}	0.03^b	6.59b
Pendimethalin 1.25 kg a.i./ha + SHW @ 6WAS	28.66^{bcde}	4.17^b	13.91^{bcd}	24.42^{cde}	0.03^b	3.68b
Weedy Check (No weeding)	163.84^a	330.42^a	179.85^a	79.50^a	186.5^a	97.08a
Weed free Check (SHW @ 3 and 6WAS)	4.33^e	2.92^b	5.00^d	1.44^e	0.03^b	2.59b
SE (±)	9.410	7.605	6.686	7.419	8.075	4.844
Interaction (V x H)	NS	**	NS	NS	NS	NS

SHW = Hoe Weeding WAS= Weeks After Sowing NS= Not Significant ** = Significant at 1% level
Means followed by the same letter (s) within the same treatment group are not significantly different at 5% level of probability according to Duncan's Multiple Range Test (DMRT)

Table 6: Effects of variety and pre-emergence herbicides on weeds dry weight (g/m^2) at 4, 8 and 12WAS of groundnuts in Yola during rainy seasons of 2017 and 2018

Treatments	**Weeds dry weight (g/m^2)**					
		2017			**2018**	
	4WAS	**8WAS**	**12WAS**	**4WAS**	**8WAS**	**12WAS**
Variety (v)						
SAMNUT 23	55.76	7.83	107.28	35.02	38.01	62.73
''KAMPALA''	26.86	50.19	113.48	21.59	14.33	24.50
SE (±)	10.633	15.261	13.730	7.796	11.941	14.730
Herbicide rate (H)						
Butachlor 0.75 kg a.i./ha + SHW@ 6WAS	87.28^b	15.40^b	62.05^b	16.57^{bcde}	0.01^b	16.48^b
Butachlor 1.0 kg a.i./ha + SHW @ 6WAS	23.57^{bc}	10.02^b	42.60^b	13.68^{cde}	0.01^b	10.67^b
Butachlor 1.25 kg a.i./ha + SHW @ 6WAS	13.83^c	4.15^b	39.55^b	7.52^{de}	0.01^b	13.20^b
Metolachlor 0.75 kg a.i./ha + SHW@ 6WAS	35.37^{bc}	11.45^b	56.23^b	37.40^{bc}	0.01^b	16.77^b
Metolachlor 1.0 kg a.i./ha + SHW @ 6WAS	15.78^c	6.34^b	37.87^b	32.90^{bcd}	0.01^b	13.52^b

Metolachlor 1.25 kg a.i./ha + SHW @ 6WAS	3.27^{c}	6.27^{b}	22.20^{b}	14.32^{cde}	0.01^{b}	14.62^{b}
Pendimethalin 0.75 kg a.i./ha + SHW@ 6WAS	38.17^{bc}	31.22^{b}	98.37^{b}	38.82^{b}	0.01^{b}	18.84^{b}
Pendimethalin 1.0 kg a.i./ha + SHW @ 6WAS	32.20^{bc}	20.92^{b}	53.35^{b}	32.27^{bcd}	0.01^{b}	21.62^{b}
Pendimethalin 1.25 kg a.i./ha + SHW @ 6WAS	26.80^{bc}	8.63^{b}	46.03^{b}	27.63^{bcd}	0.01^{b}	14.80^{b}
Weedy Check (No weeding)	170.77^{a}	598.00^{a}	745.50^{a}	89.82^{a}	287.75^{a}	331.42^{a}
Weed free Check (SHW @ 3 and 6WAS)	2.37^{c}	2.75^{b}	10.45^{b}	0.44^{e}	0.01^{b}	7.87^{b}
SE (±)	23.178	30.275	35.478	9.379	23.826	21.975
Interaction (V x H)	NS	*	NS	NS	**	**

SHW = Hoe Weeding WAS= Weeks After Sowing NS= Not Significant * = Significant at 5% level ** = Significant at 1% level

Means followed by the same letter (s) within the same treatment group are not significantly different at 5% level of probability according to Duncan's Multiple Range Test (DMRT)

Table 7: Effects of variety and pre-emergence herbicides on weed control efficiency at 4, 8 and 12WAS of groundnuts in Yola during rainy seasons of 2017 and 2018.

Treatments	**Weed control efficiency (%)**					
		2017			**2018**	
	4WAS	**8WAS**	**12WAS**	**4WAS**	**8WAS**	**12WAS**
Variety (V)						
SAMNUT 23	71.41	89.06	84.72	74.76	90.82	88.06
''KAMPALA''	75.02	88.55	81.66	59.92	90.83	81.44
SE (±)	4.055	0.713	2.060	4.161	2.150	0.972
Herbicide rate (H)						
Butachlor 0.75 kg a.i./ha + SHW@ 6WAS	68.8^{d}	97.37^{ab}	91.48^{ab}	76.67^{bc}	92.78^{b}	92.78^{ab}
Butachlor 1.0 kg a.i./ha + SHW @ 6WAS	84.15^{abcd}	98.32^{ab}	78.750^{b}	80.50^{abc}	93.65^{b}	96.15^{ab}
Butachlor 1.25 kg a.i./ha + SHW @ 6WAS	90.10^{abc}	99.32^{a}	94.07^{a}	89.72^{ab}	90.42^{b}	95.85^{ab}
Metolachlor 0.75 kg a.i./ha + SHW@ 6WAS	69.32^{cd}	97.33^{ab}	92.050^{ab}	69.58^{cd}	92.38^{b}	90.42^{ab}
Metolachlor 1.0 kg a.i./ha + SHW @ 6WAS	85.03^{abcd}	98.47^{ab}	$94. 70^{a}$	66.88^{cde}	95.15^{b}	93.38^{ab}
Metolachlor 1.25 kg a.i./ha + SHW @ 6WAS	92.57^{ab}	98.40^{ab}	96.40^{a}	84.93^{abc}	93.85^{b}	94.65^{ab}
Pendimethalin 0.75 kg a.i./ha + SHW@ 6WAS	70.82^{cd}	94.25^{c}	83.93^{ab}	52.52^{e}	90.13^{b}	90.13^{b}
Pendimethalin 1.0 kg a.i./ha + SHW @ 6WAS	73.22^{bcd}	95.68^{bc}	91.90^{ab}	54.43^{de}	90.93^{b}	90.45^{a}b
Pendimethalin 1.25 kg a.i./ha + SHW @ 6WAS	76.70^{bcd}	98.23^{ab}	93.32^{ab}	66.27^{cde}	90.45^{b}	90.93^{ab}
Weedy Check (No weeding)	0.00^{e}	0.00^{d}	0.00^{c}	0.01^{f}	0.00^{c}	0.01^{c}
Weed free Check (SHW @ 3 and 6WAS)	98.55^{a}	99.47^{a}	98.53^{a}	99.18^{a}	98.47^{a}	97.47_{a}
SE (±)	7.537	0.880	5.319	6.98	5.020	2.884
Interaction (V x H)	NS	NS	NS	NS	NS	NS

SHW = Supplementary Hoe Weeding WAS = Weeks After Sowing NS = Not Significant

Means followed by the same letter (s) within the same treatment group are not significantly different at 5% level of probability according to Duncan's Multiple Range Test (DMRT)

Table 8: Effects of variety and pre-emergence herbicides on weed index of groundnuts in Yola during rainy seasons of 2017 and 2018

Treatments	**Weed index (%)**	
Variety (V)	**2017**	**2018**
SAMNUT 23	29.6	54.19
''KAMPALA''	34.92	42.33
SE (±)	6.980	3.755
Herbicide rate (H)		
Butachlor 0.75 kg a.i./ha + SHW@ 6WAS	26.98^{bc}	48.85^{bc}

Butachlor 1.0 kg a.i./ha + SHW @ 6WAS	28.78[bc]	53.27[bc]
Butachlor 1.25 kg a.i./ha + SHW @ 6WAS	22.62[c]	60.13[b]
Metolachlor 0.75 kg a.i./ha + SHW@ 6WAS	28.03[bc]	47.10[bc]
Metolachlor 1.0 kg a.i./ha + SHW @ 6WAS	22.43[c]	50.08[bc]
Metolachlor 1.25 kg a.i./ha + SHW @ 6WAS	38.13[bc]	47.13[bc]
Pendimethalin 0.75 kg a.i./ha + SHW@ 6WAS	45.15[b]	52.63[bc]
Pendimethalin 1.0 kg a.i./ha + SHW @ 6WAS	41.65[b]	44.67b[c]
Pendimethalin 1.25 kg a.i./ha + SHW @ 6WAS	28.58[bc]	42.22[c]
Weedy Check (No weeding)	72.68[a]	84.97[a]
Weed free Check (SHW @ 3 and 6WAS)	0.00[d]	0.01d
SE (±)	6.567	5.771
Interaction (V x H)	NS	NS

SHW = Hoe Weeding, WAS= Weeks After Sowing, NS= Not Significant, Means followed by the same letter (s) within the same treatment group are not significantly different at 5% level of probability according to Duncan's Multiple Range Test (DMRT)

Table 9: Effect of variety and pre-emergence herbicides on seed yield/plot, seed Yield/ha and 100 seed weight of groundnuts in Yola during rainy seasons of 2017 and 2018

	Seed yield (g/plot)		**Seed yield (kg/ha)**		**100 Seed weight (g)**	
Variety (V)	**2017**	**2018**	**2017**	**2018**	**2017**	**2018**
SAMNUT 23	809.52	360.94	1409.00	593.120a	59.79a	49.11a
KAMPALA	720.97	244.46	1158.20	405.21b	43.93b	43.77b
SE (±)	49.087	22.000	96.386	27.907	0.622	0.374
Herbicide rate (H)						
Butachlor 0.75 kg a.i/ha + HW@ 6WAS	828.70b	300.66bcd	1380.50bcd	524.10bcd	53.63a	46.02
Butachlor 1.0 kg a.i/ha + HW @ 6WAS	805.30b	253.17cd	1342.40bcd	421.90cd	53.70a	43.82
Butachlor 1.25 kg a.i/ha + HW @ 6WAS	803.70b	230.03d	1465.80bc	383.30d	54.45a	46.10
Metolachlor 0.75 kg a.i/ha + HW@ 6WAS	682.00b	292.27bcd	1376.50bcd	487.10bcd	54.03a	49.58
Metolachlor 1.0 kg a.i/ha + HW @ 6WAS	908.70b	272.90bcd	1480.50b	498.60bcd	51.38ab	44.45
Metolachlor 1.25 kg a.i/ha + HW @ 6WAS	729.30b	296.19bcd	1182.90bcd	503.80bcd	51.72ab	45.52
Pendimethalin 0.75 kg a.i/ha + HW@ 6WAS	657.30b	257.55bcd	1062.90d	429.30cd	45.68c	43.37
Pendimethalin 1.0 kg a.i/ha + HW @ 6WAS	826.00b	378.98b	1271.50bcd	631.60b	48.13bc	45.97
Pendimethalin1.25 kg a.i/ha + HW @ 6WAS	686.00b	354.61bc	1120.90cd	591.10bc	47.50bc	48.22
Weedy Check (No weeding)	312.70c	90.43e	519.00e	151.60e	54.17a	48.86
Weed free Check (HW @ 3 and 6WAS)	1178.0a	602.43a	1916.90a	1009.60a	56.07a	48.93
SE (±)	88.844	42.488	109.940	65.218	1.759	2.478
Interaction (V x H)	NS	*	NS	*	NS	NS

HW = Hoe Weeding, WAS= Weeks After Sowing, NS= Not Significant, * = Significant at 1% level
Means followed by the same letter (s) within the same treatment group are not significantly different at 5% level of probability according to Duncan's Multiple Range Test (DMRT)

REFERENCES

1. DWIVEDI, S.L., CROUCH, J.H., NIGAM, S.N., FERGUSON, M.E. & PATERSON, A.H. (2003). Molecular Breeding of Groundnut for Enhanced Productivity and Food Security in the Semi-Arid Tropics: Opportunities and Challenges. *Advanced Agronomy*, **80:** 153-221.
2. SURRENDRANATHA, E.C., SUDHAKAR, C. & ESWARA, N.P. (2011). Aflatoxin Contamination in Groundnuts Induced by *Aspergillus flavus* type Fungi: A Critical Review. *International Journal of Applied Biology and Pharmaceutical Technology*, **2:** 2-9.
3. KRAPOVICKAS, A. (1968). The Origin, Variability and Spread of Groundnuts, in Peanut – Culture. and Uses: *American Peanut Research and Education Association*, 17-42pp
4. ONWUEME, I.C. & SINHA, T.D. (1991). *Field Crop Production in Tropical Africa: Principles and Practice.* Published by C.T.A, Ede, The Netherlands. 324-336pp.
5. SHARMA, K.K. & MATHUR, B.P. (2006). Peanut (*Arachis hypogea* L.). *Methods in Molecular Biology*, **343:** 347-358.
6. NIGAM, S.N., DWIVEDI, S.L. & GIBBONS, R.W. (1991). Groundnuts Breeding Constraints, Achievements and Future Possibilities. *Plant Breeding Abstracts*, **61**(10): 1127-1136.
7. AJEIGBE, H.A., WALIYAR, F., ECHEKWU, C.A., AYUBA, K., MOTAGI, B.N., ENJAYEDU, D. & INUWA, A. (2014). *A farmer's Guide to Groundnut Production in Nigeria.* International Crops Research Institute for Semi-Arid Tropics. Patencheru 502324 Telangana India. 36pp.
8. FAO STAT (2014). FAO 2012 Data and Preliminary 2013 Data for 5 Major Commodity Aggregate. 8-10pp.
9. INTERNATIONAL NUTS AND DRIED FRUITS [INC] (2020). Nuts and Dried fruits Yearbook, 2019/2020. Carrer de la Fruita Seca, 4 Poligon Tecnoparc 43204 Reus, Spain. http/www.nutfruit.org. 80pp.
10. ASIBUO, J.Y., AKROMAH, R., ADO-DAAPAH, H.K. & SAFO-KANTAKA, O. (2008). Evaluation of Nutritional Quality of Groundnuts (Arachis hypogeal L.) from Ghana. *African Journal of Agric. And Nutritional Development*, **8**(2): 133-150.
11. BALA, H.B.M., OGUNLELA, V.B., TANIMU, B. & KUCHINDA, N.C. (2011). Response of Two Groundnut (*Arachis hypogaea* L.) Varieties to Sowing Date and N.P.K. Fertilizer Rate in Semi-Arid Environment: Growth and Growth Attributes. *Asian Journal of Crop Science*, **3**(3): 141-150.
12. JAT, R.S., MEENA, H.N., SINGH, A.L., JAYA, N.S. & MISRA, R.S. (2011). Weed Management in Groundnuts (*Arachis hypogaea* L.) in India - A REVIEW. *Agricultural Reviews,* **32**(3): 155 – 171.
13. SATHYA-PRIYA, C., CHINNUSAMY, C., MANICKASUNDARAM, P. & BABU, C. (2013). A Review of Weed Management in Groundnuts (Arachis hypogeal L.) Dept. of Agronomy, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu India. *International Journal of Agricultural Science and Research* (IJASR), **3**(1): 163-167.
14. SINGH, F. & OSWALT, D.L. (2005). Groundnut Production Practices. *Skill Development Series Number 3* ICRISAT Pantancheru, Andra Pradesh. 3pp.
15. ZIMDHAL, R.L. (2004). *Weed-Crop Competition: A Review*. Ames, IA: Blackwell Publishing Professional, 49-50pp.
16. ADIGUN, J.A. & LAGOKE, S.T.O. (2003). Weed Control in Transplanted Rainfed and Irrigated Tomatoes in the Nigerian Savanna. *Nigerian Journal of Weed Science*, **16:** 23-29.
17. ANONYMOUS (1994). Weed control Recommendations for Nigeria. *Series* 3. Department of Agriculture, Federal Ministry of Agriculture, Nigeria 1p.
18. ADIEGUN, J.A., LAGOKE, ST.O., KUMAR, V. & ERINLE, I.D. (1993). Weed Management Studies in Transplanted Tomato in the Nigerian Savanna. *Samaru Journal of Agricultural Resources*, **10:** 29 – 39.
19. CHATTHA, M.R., JAMI, M.U. & MAHMOOD, T.J. (2007). Yield and Yield Components of Mugbean as Affected by various Weed Control Methods under rain-fed Conditions of Pakistan. *International Journal of Agriculture and Biology,* **9:** 121-124.
20. GARKO, M.S., MOHAMMED I.B., YAKUBU, A.I. & MOHAMMED, Z.Y. (2016). Performance of Groundnuts (*Arachis hypogaea* L.) Varieties as Influenced by Weed Control Treatments in Kano State Nigeria. *International Journal of Scientific and Technology Research*, **5**(03) March, 2016; 134-140pp.
21. NANO, A.D. & JANMEJAI, S. (2018). Assessment of Weed Management Practices on Weed Dynamics, Yield Components and Yield of Faba Bean (*Vicna faba* L.) in Eastern Ethiopia.

Turkish Journal of Agriculture - Food Science and Technology, **6**(5): 570-580.

22. SOUMYA, K.S., BALUKESWAR, H. & ARTI, G. (2017). Effects of Pre-Emergence Herbicides on Physiological Parameters and Yield of Groundnut (*Arachis hypogaea* L.). *Journal of Pharmacognosy and Phytochemis*try, **6**(6): 98-104.
23. KANAGAM, P., CHINNAMUTHU, C. R., CHINNUSAMY, C. & SHANMUGASUNDARAM, R. (2005). Alternative Approach to Manage the Post-Emergence Weeds through Pre-Emergence Herbicides in Irrigated Peanut. In: *National Biennial Conference*, ISWS, PAU, April 6-9, 97-98 pp.
24. JAMES, E.A., CHARLES, H. & GLEEN, W. (2003). Weed Control in Field Nurseries. United States Department Agriculture 2017 ISHS international Symposium on Growing Media, Soilless Cultivation, and Compost Utilization in Horticulture, Horticulture, Portland. *Hort Technology*, January – March, 2003 (13)1.
25. GABRIEL, O.A., KASALE, A.A., FESTUS, A.A. & SAHEED, A.M. (2015). Metolachlor Effects on Pea Growth and Development in Georgia, Ladoke-Akintola University of Technology. P.M.B. 4000, Ogbomoso, Nigeria. *International Journal of Agricultural Crop Science*, **8**(5): 674-681.
26. ANONYMOUS (2017). Etrex GPS Observation, Yola, Nigeria 1p.
27. ADEBAYO, A.A. & TUKUR, A.L. (1999). *Mean Annual Rainfall of Adamawa State in Maps*. First Edition. Paraclete Publishers Yola, Nigeria. 23-26pp.
28. PETER, B., KO, W. & KENJI, H. (2012). *Herbicides Classes in Development: Mode of Action, Targets, Genetics, Engineering Chemistry*. Springer Sciences and Business Media 364pp.
29. DESHMUK, D.D. & DEV, D.V. (1995). Nodulation in Groundnut Cultivars during Kharif under Different Package of Practices. *Madras Agricultural Journal*, **82**(5): 354-357.
30. JAIN, V.K., CHAUHAN, Y.S., BHARGAVA, M.K. & SHARMA, A.K. (2000). Chemical Weed Control in Soybean (*Glycine max*). *Indian Journal of Agronomy*, **45**(1): 153-157.
31. NAYAK, M.P., VYAS, M.D. & MANDOLI, K. S. (2000). Efficacy of Pendimethalin in Soybean (*Glycine max*). *Indian Journal of Agronomy*, **45**(1): 162-165.
32. KUSHWAH, S.S. & KUSSHWAHA, H.S. (2001). Influence of Weed Control Methods on Growth, Yield and Economics of Rainfed Soybean (*Glycine max*) at Farmer's Field. *Indian Journal of Agronomy*, **46**(3): 511-515.
33. SASSAKAWA (2000). *Agronomic Practices and Training Manual for Farmers in Northern Nigeria*. Sassakawa Global 2000 14pp.
34. WILCUT, J.W., ALAN, C.Y., GRICHAR, J. & GLEEN, R.W. (2015). The Biology and Management of Weeds in Pea (L.). *Advances in Peanut Science*, 207-223. 2222. Retrieved from http://apresinc.comwp-content>uploads>2015/12>12APS-Chapter-6 on August 17, 2019.
35. DZOMEKU, I.K. (2017). Evaluation of Herbicides for Weed Control Efficacy in Groundnuts (*Arachis hypogaea* L.) in Guinea Savannah. *UDS International Journal of Development*, **3**(2) Retrieved from http://www.udsijd.org on November 15, 2018**.** 15pp.
36. ABDUL-RAHMAN, T. & DANIEL, D.Q. (2014). Performance of Groundnut (*Arachis hypogaea* L.) Varieties in Two Agro-ecologies in Sierra Leone. *Journal of Agricultural Research*, **9**(19): 1442-1448.
37. N2AFRICA (2014). Better Groundnut Through Good Agricultural Practices for Farmers in Nigeria. *Leaflet* Retrieved from www.cabi.org/ashc on June 14, 2018. 16pp.
38. NKAFAMIYA, I.I., MAINA, H.M., OSEMEAHON, S.A. & MODIBBO, U.U. (2010). Percentage of Oil Yield and Physiochemical Properties of Groundnut (*Arachis hypogaea* L.). *African Journal of Food Science*, **4**(7): 418-421. Retrieved from http:// academicjournals.org/ajfs on December, 18 2017.
39. MOURI, S.J., SARKAR, M.A.R., UDDIN, M.R., SARER, U.K., KAYSAR, M.S. & HOQUE, M.M.I. (2018). Effect of Variety and Phosphorus on the Yield Components and Yield of Groundnut (*Arachis hypogaea* L.) *Progressive Agriculture*, **29**(2): 117-126.