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WEEDING REGIME EFFECT ON WEED GROWTH AND YIELD OF GROUNDNUT (*Arachis hypogaea* L.) VARIETIES IN A MOIST SAVANNA OF NIGERIA

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ABSTRACT

The effect of weeding regime and groundnut varieties on weed growth and groundnut yield were investigated at Minna, Nigeria in 2015 and 2016 rainy seasons. The treatments consisted of three groundnut varieties (SAMNUT 21, SAMNUT 22, SAMNUT 24) and three weeding regimes (weedy check, one hoe weeding and two hoe weeding) in a factorial arrangement laid in a randomized complete block design with three replications. Result clearly showed that the dominant weed species identified among the groundnut varieties were Tridax procumbens Linn., Vernonia galamensis (Cass.) Less., Euphorbia heterophylla Linn., Desmodium scorpiurus (Sw.) Desv. and Spigelia anthelmia Linn. Across weeding regimes, early maturing SAMNUT 24 had more pods per plant and higher kernel yield in 2015, while medium maturing SAMNUT 21 and SAMNUT 22 varieties had greater kernel yield in 2016. Generally, SAMNUT 21 produced heavier kernels than other varieties evaluated. Irrespective of the varieties, one hoe weeding at 3 WAS, and two hoe weeding at 3 and 6 WAS gave better weed control, more pods, heavier kernels and higher kernel yield of groundnut when compared with weedy check. This study suggest that depending on the growing conditions, sustainable weed control and productivity of groundnut can be achieved with these varieties together with one or two hoe weeding, in the moist savanna agro-ecology of Nigeria.

Key words: Weeding regime, Varieties, Groundnut yield, Weed growth, Moist savanna

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is the sixth most important oilseed crop widely cultivated on over 26.4 million hectares of land globally, among smallholder farmers under rain-fed conditions in most parts of Asia and Africa (Zekeri and Tijjani, 2013). However, weeds are generally a strong yield-limiting factor in rain–fed groundnut production; in most semi-arid and subtropical regions of the world including Nigeria. Yield losses in groundnut due to uncontrolled weeds has been reported in the range of 74 to 92 % (Abouziena *et al.* 2013) and 30 to 60% under poor cultural practice (Ajeigbe *et al.*, 2014). To reduce weed infestation in groundnut, farmers generally rely on hoe weeding. This method is widely practice and remains the predominant weed control method in Nigeria (Imoloame, 2014) and among groundnut farmers in most tropical countries (Ibrahim *et al.*, 2014). Though hoe weeding is expensive and labour intensive, groundnut farmers often prefer this method for weed control. Reason is that most of the herbicides available are expensive and have toxic residual effect; and the low literacy level among farmers in turn translates into inappropriate herbicides use (Toure *et al.*, 2011; Ibrahim *et al.*, 2014).

Groundnut is a weak competitor with weeds, because of its initial slow growth during the first 3 to 6 weeks after sowing (WAS) (Ibrahim *et al.*, 2014). Several varieties of groundnut are widely cultivated in most of the semi-arid and subtropical regions of the world, as small holder crops under rain fed situation (Ajeigbe *et al.*, 2014). These varieties are known to exhibit several genetic variations. For example, one group of groundnut varieties released and commonly grown in the savannas of Nigeria, are the SAMNUT varieties. However, their ability to maintain high yield under different weed competition is so far limited. A weed competitive crop is claimed to be tolerant to weeds, and has the ability to maintain high yield under different weed competition, and also have the ability to suppress weed growth and reduce the production of weed seeds (Toure *et al.*, 2011). Integrated weed management tactics is the commonly accepted best approach for effective weed management in most crops (Toure *et al.*, 2011). In most cases, farmers in sub-Sahara Africa weed their farmland two to three times (by hoeing), depending on weed pressure (Toure *et al.*, 2011). In groundnut, such weeding are carried out before flower initiation and during pegging (Ajeigbe *et al.*, 2014). To our knowledge, information regarding the weed competitive ability of SAMNUT groundnut varieties released in Nigeria is limited.

Therefore, the objective of this study was to determine the weed suppressive ability, yield and yield attributes of three groundnut varieties as affected by weeding regimes in the southern Guinea savanna location in Nigeria.

MATERIALS AND METHODS

Site Description:

A field study was conducted during the 2015 and 2016 rainy seasons of 2015 and 2016 at the Teaching and Research Farm of the Department of Crop Production, Federal University of Technology, Gidan Kwano (Lat. $9^0 31' 735$N; Long. $6^0 27'$ 240E; 208m above sea level), Minna, Nigeria. The experimental site falls within the Southern Guinea Savanna ecology with mean annual rainfall of 1200 mm, minimum daily temperature of 22 °C and maximum mean temperature that ranges between 36 – 40 °C, with shallow to very deep soils that are developed from basement complex rocks (Adeboye *et al.*, 2011). The site has a mono-modal rainfall pattern, with the rainy season starting in April and ending in October. The monthly means of maximum (Max.), minimum (Min.) temperatures and rainfall (mm) were collected from Nigerian Meteorological Agency, Minna Airport. Soil samples were taken from the upper layer of 0 – 15 cm, bulked and sub-samples were subjected to routine soil chemical analysis to determine the characteristics of the soil of the experimental site for the period of the experiment at Minna in 2015 and 2016.

Treatments and Experimental Design

The treatments consisted of factorial combination of three varieties of groundnut (SAMNUT 21, SAMNUT 22, SAMNUT 24) and three weeding regimes (weedy check, one hoe weeding (1HW) at 3 weeks after sowing (WAS), and two hoe weeding (2 HW) at 3 and 6 WAS). These treatments were laid out in a randomized complete block design (RCBD) and replicated three times. Seeds of SAMNUT varieties were obtained from the Seed Production Unit, Institute for Agricultural Research, Samaru-Zaria, Nigeria. SAMNUT 21 is medium – maturing (115 – 120 days). It is resistant to groundnut rossette and foliar disease. It has a high kernel and forage yields and quality, and good oil content (51%). SAMNUT 22 is also medium maturing (115 – 120 days), resistant to groundnut rosette disease, and tolerant to cercospora leafspots. It has high kernel and forage yields, with moderate oil content (45%). SAMNUT 24 is early maturing (80 – 90 days), with vigorous growth habit, rosette resistant, good kernel and haulm yields, and high oil content (53 %).Two seeds of groundnut were manually sown at an intra-row spacing of 20 cm and inter-row spacing of 75 cm, respectively. Fertilizer dose of 300 kgha^{-1} $P_2 0_5$ was applied in the form of single super phosphate (18 %). The whole of the fertilizer was applied to each plot at land preparation. Weeds were manually controlled as per the treatments imposed. The plants were protected against insect pest attack, bacterial disease; fungi infection by treating the seeds with Apron star 42WS (20% w/w thiamethoxam, 20% w/w metalaxyl-M and 20% w/w difenoconazole) at the rate of 2.5 g per 1 kg of groundnut seed at sowing; on June 02, 2015 and May 29, 2016, respectively.

Data collection:

Data on weed species composition, their occurrence index and weed biomass was recorded from four randomly selected quadrats of 50 x 50 cm (0.25 m^2) placed randomly within each plot at 3, 6 and 9 WAS. Weeds observed within each quadrat were identified, counted, and cut at soil level, bulked and oven dried at 70 ^{0}C to a constant weight to record their biomass using a digital Mettler balance. Weed occurrence index was calculated as the ratio of number of plots where a given species occurred, to the total number of experimental plots sampled, multiply by 100 as described by Silva *et al.* (2013)

To assess the yield and yield attributes, groundnut crop in each plot was harvested from an area of 4 x 1.5 m (6 m^2) - two groundnut crop rows 4 m long). Harvesting was carried out at physiological maturity of groundnut. That is when the leaves and inner ribs of groundnut had changed colour to brown. Harvesting was carried out by the manual lifting of the entire groundnut in the net plot. The mean number of pods per plant was determined by counting the total number of pods from five randomly selected groundnut plants and divide by five. Mean kernel weight was determined by measuring three samples of air dried kernels that were sampled from the kernel lot from each of the treatment and divide by 3, expressed in gram (g). Kernel yield per plot was recorded after picking, decorticating and sun drying to a constant weight. The weight of the kernel from each plot was expressed in kgha^{-1}. The groundnut above ground part left after the pods had been picked was sundried to a constant weight and expressed in kgha^{-1} as the haulm yield.

Statistical analysis:

Data collected were subjected to analysis of variance, using the general linear model procedure of Statistical Analysis System (SAS) version 9. The Least Significant Difference (LSD) test at 5% level of probability was applied to compare the difference between the treatment means.

RESULTS AND DISCUSSION

Maximum temperatures were recorded in April 2015 and March 2016; while minimum temperature occurred in the month of March in 2015 and April in 2016 (Table 1). Total monthly rainfall (mm) peaked in June and August 2015; and August and September in 2016 (Table 1). The soil of the study area was sandy loam, slightly acidic with low organic carbon, available phosphorus, moderate total nitrogen and calcium (Table 2). Forty-three weed species were observed across the treatments in this study (Table 3). On the basis of occurrence index the most dominant weed species recorded across the treatments at 3, 6 and 9 WAS in both years were *Tridax procumbens* Linn., *Vernonia galamensis* (Cass.) Less., *Euphorbia heterophylla* Linn., *Desmodium scorpiurus* (Sw.) Desv., *and Spigelia anthelmia* Linn. These species were generally broadleaved weeds. However grass like *Brachiaria deflexa* (Schumach.) C.E. Hubbard ex Robyns and sedge weed like *Fimbrystilis littoralis* Gaudich were also dominant, except at 3 WAS in 2015 (Table 3). The dominant weed species infesting groundnut varieties in this study were generally the broadleaved weeds. In an earlier study, it had been reported that broadleaved weeds are the dominant weed species that infest groundnut (El Naim *et al.*, 2011). In addition, the weed species found in this trial are adapted to conditions that favour groundnut cultivation. In the case of the other dominant weed species like *B. deflexa* (grass) and *F. littoralis* (sedge), this may be attributed to variation in the weather condition, especially variation in rainfall amounts and distribution, and the previous cultural practices in the field. The previous study indicated that variation in dominant weed species in a site may be influenced by rainfall, agronomic practices, previous and current crops grown (Toure *et al.*, 2011). Furthermore, the alternating wet and dry conditions also influenced weed species diversity depending on the competitive ability of the crop varieties (Mahajan *et al.*, 2014).

Weed biomass was not significantly ($P \geq 0.05$) influenced by varieties, but however, differed between weeding regime (Table 4). Except at 3 WAS in 2016, weed biomass was significantly less under both 1 HW and 2 HW at each sampling time in 2015 and 2016, respectively. The effective weed suppression obtained in both 1 HW and 2 HW, translated into vigorous crop growth and yield due to efficient water and nutrient uptake, and light interception for dry matter accumulation (Ibrahim *et al.*, 2014). The number of groundnut pods produced per plant varied among the varieties in 2015 only (Table 5). The highest number of pods per plant was noted in SAMNUT 24. This result suggests that groundnut varieties responded differently to the production of their yield and yield attributes. SAMNUT 24 proved to be better yielding than the other varieties in 2015 rainy season. This finding was a demonstration of the difference in the genetic make-up, as well as the genotype and environment interaction among the groundnut varieties. On the other hand, weeding regime significantly ($P \leq 0.05$) affected the number of groundnut pods produce per plant (Table 5). In 2015, in plots with 2HW, the number of pods produced was higher than the other treatments. In 2016, plots with 1 HW had the highest number of pods, which was similar to plots with 2 HW compared to the weedy check. The result suggests better crop performance under good weed control (Ibrahim *et al.*, 2014). This finding is also in consonance with Osei *et al.* (2013)who stated that yield of groundnut does not only depend on this parameter as a yield improving attribute but on other factors such as the inherent soil fertility status and adequate weed management.

Table 1: Temperature and rainfall data for 2015 and 2016 at Minna, Nigeria.

	2015			2016		
	Temperature (°C)		Rainfall (mm)	Temperature (°C)		Rainfall (mm)
Month	Max.	Min.		Max.	Min.	
January	34.0	23.0	0.0	35.1	20.6	0.0
February	33.0	23.0	0.0	37.9	22.9	0.0
March	38.0	27.0	22.9	38.0	25.9	40.0
April	39.0	27.0	0.8	37.2	25.7	47.8
May	35.0	26.0	110.7	34.0	23.8	123.6
June	32.0	24.0	235.3	31.1	22.8	196.0
July	32.0	24.0	119.2	30.3	22.4	170.2
August	29.0	23.0	305.3	29.8	22.4	307.6
September	30.0	23.0	178.3	30.6	21.7	425.2
October	32.0	25.0	85.3	33.8	23.1	200.0
November	35.0	25.0	0.0	33.6	23.4	0.0
December	33.0	22.0	0.0	0.0	0.0	0.0
Mean	**33.5**	**24.3**	**88.2**	**31.0**	**21.2**	**125.9**

Source: Nigerian Meteorological Agency, Minna Airport

Table 2: Physical and chemical properties of the experimental sites (Soil layer 0 – 15 cm)

Soil properties	2015	2016
Sand (g kg $^{-1}$)	845	785
Silt (g kg $^{-1}$)	60	90
Clay (g kg $^{-1}$)	95	125
Textural class	Sandy loam	Sandy loam
Organic carbon (g kg $^{-1}$)	1.6	2.0
Total nitrogen (g kg $^{-1}$)	0.1	0.2
Available phosphorus (mg kg $^{-1}$)	5.0	8.0
Soluble potassium (Cmol kg $^{-1}$)	0.9	0.6
Calcium (Cmol kg $^{-1}$)	2.7	4.0
Magnesium (Cmol kg $^{-1}$)	0.9	3.7
Exchangeable acidity (Cmol kg $^{-1}$)	0.2	0.2
pH (water)	6.5	6.9

Table 3: Weed species composition and their occurrence index averaged across three weeding regimes and three

		Occurrence index				
	Scientific name	3 WAS		6 WAS		9 WAS
Common name		2015	2016	2015	2016	2015
Broadleaved species						
Billy goat weed	*Ageratum conyzoides* Linn.	-	7.4	14.8	22.2	7.4
Coat buttons	*Tridax procumbens* Linn.	96.3	48.1	85.2	33.3	74.1
Iron weed	*Vernonia galamensis* (Cass.) Less.	48.2	40.7	33.3	14.8	26.6
Water primerose	*Ludwigia hyssopifolia* (G. Don) Exell	18.5	-	18.5	3.7	14.8
Spurge weed	*Euphorbia heterophylla* Linn.	44.4	55.6	44.4	59.3	22.2
Stone breaker	*Phyllanthus niruri var. amarus* (Schum. & Thonn.) Learndri	7.1	-	44.4	-	25.9
Scorpion tickrefoil	*Desmodium scorpiurus* (SW.) Desv.	33.3	48.1	25.9	37.0	33.3
	Tephrosia pedicellata Bak.	-	25.9	3.7	3.7	7.4
	Hyptis lanceolata Poir.	25.9	-	14.8	-	25.9
Mint weed	*Hyptis suaveolense* Poit.	11.1	7.4	11.1	3.7	3.7
Wild tea bush	*Leucas martinicensis* (Jacq.) W.T Aiton	-	-	3.7	-	-
Worm bush	*Spigelia anthelmia* Linn.	33.3	37.0	22.2	25,9	14.8
Cord leaf burbark	*Triumpheta cordifolia* A. Rich.	7.4	18.5	3.7	-	-
Bastard vervain	*Stachytarpheta jamaicensis* (Linn.) Vahl.	-	-	11.1	-	37.0
Morning glory	*Ipomoea triloba* Linn.	-	48.1	-	29.6	-
Water primerose	*Ludwigia decurrens* Walt.	-	37.0	-	-	-
Tropical spiderwort	*Commelina benghalensis* L.	-	11.1	-	11.1	-
Little hog weed	*Portulaca oleracea* Linn.	-	7.4	-	7.4	-
Sickle pod	*Senna obtusifolia* Irwin & Barneby	-	3.7	-	-	-
Calopo	*Calopogonium mucunoides* Desv.	-	-	-	7.4	-
Garden spurge	*Euphorbia hirta* Linn.	-	-	-	3.7	-
Bristly starbur	*Acanthospormum hispidum* DC.	-	-	-	3.7	-
	Celosia leptostachya Benth.	-	-	-	3.7	-
Wildecape goose berry	*Physalis angulata* Linn.	-	-	-	3.7	-
	Oldenlandia corymbosa Linn.	-	-	-	-	-
False mallow	*Malvastrum coromandelianum* (Linn.) Garcke	-	-	-	-	-
Coffee Senna	*Senna ocidentalis* (L.) Link	-	-	-	-	-
Tropical button weed	*Dioda sarmentosa* Sw.	-	-	-	-	-
Ginger-leaf morning glory	*'Ipoemoea asarifolia* (Desr.) Roem & Schult.	-	-	-	-	-
	Schwenckia americana L.	-	-	-	-	-
Black night shade	*Solanum nigrum* L.	-	-	-	-	-
Grass species						
Tropical crabgrass	*Digitaria ciliaris* (Retz.) Koel.	100.1	-	26.6	-	3.7
Annual brachiaria	*Brachiaria deflexa* (Schumach.) C.E. Hubbard ex Robyns	-	11.1	18.5	77.8	44.4
Bahama grass	*Cynodon dactylon* (Linn.) Pers.	-	14.8	-	-	3.7
	Digitaria gayana (Kunth.) Stapf ex A. Chev.	-	-	-	-	3.7
Digitgrass	*Digitaria horizontalis* Willd.	-	40.7	-	-	-
Ditch millet	*Paspalum scrobiculatum* Linn.	-	-	-	48.1	-
Catailgrass	*Setaria pumila* (Poir.) Roem & Schult.	-	-	-	-	-
Sedge species						
Purple nutsedge	*Cyperus rotundus* Linn.	33.3	-	77.8	7.4	81.5
Fimbry	*Fimbristylis littoralis* Gaudich	-	29.9	74.1	48.1	74.1
Asian spike sedge	*Kyllinga squamulata* Thorm.ex Vahl	-	-	-	-	25.9
	Rhynchospora corymbosa (Linn.) Britt.	-	-	-	-	3.7
Yellow nutsedge	*Cyperus esculentus* Linn.	-	-	-	-	-

groundnuts in 2015 and 2016 rainy seasons.

Table 4: Effect of weeding regime on weed biomass in some groundnut varieties

Treatment	Weed biomass (gm⁻2)					
	3 WAS[1]		6 WAS		9 WAS	
	2015	2016	2015	2016	2015	2016
Variety (V)						
SAMNUT 21	1.8	4.5	20.3	28.8	99.2	14.1
SAMNUT 22	1.6	3.6	22.3	18.3	71.9	6.5
SAMNUT 24	2.2	3.1	17.4	15.6	89.4	7.2
LSD (0.05)	0.8	2.8	12.1	13.6	81.5	10.5
Weeding regime (W)						
Weedy check	2.6	4.0	36.4	58.8	131.6	27.2
One hoe weeding (3WAS)	1.6	3.6	13.1	3.3	83.3	0.4
Two hoe weeding (3 and 6 WAS)	1.5	3.7	10.5	0.7	45.6	0.2
LSD (0.05)	0.8	2.8	12.1	13.6	81.5	10.5
Interaction V×W	NS	NS	NS	NS	NS	NS

WAS - weeks after sowing; [2]NS - not significant; [3]LSD - least significant difference

Table 5: Effect of weeding regime on number of pods, kernel weight, kernel yield and haulm yield of some groundnut varieties

Treatment	Pods per plant		100 kernel weight (g)		Kernel yield (kg ha⁻¹)	
	2015	2016	2015	2016	2015	2016
Variety (V)						
SAMNUT 21	12.0	27.0	43.5	53.8	483.5	2320.4
SAMNUT 22	17.0	26.0	42.7	47.8	695.8	2235.0
SAMNUT 24	23.0	30.0	34.3	38.5	915.1	1765.1
LSD (0.05)	3.5	7.4	3.2	4.5	115.4	387.4
Weeding regime (W)						
Weedy check	16.0	23.0	40.4	43.5	600.5	1613.7
One hoe weeding (3WAS)	16.0	31.0	39.8	47.9	733.5	2445.1
Two hoe weeding (3 and 6 WAS)	21.0	30.0	40.3	48.7	760.4	2261.7
LSD (0.05)	3.5	7.4	3.2	4.5	115.4	387.4
Interaction V×W	NS[2]	NS	NS	NS	NS	NS

LSD - least significant difference; [2]NS - not significant;

Kernel weight in this study exhibited significant ($P \leq 0.05$) difference among the varieties in both years (Table 5). SAMNUT 21 consistently produced the heaviest kernels, which was followed by SAMNUT 22 compared to SAMNUT 24 being the lightest. This result indicates variation in the genetic make-up of the varieties and their interaction with the environment (Ibrahim *et al.*, 2014). The heaviest kernel produced by SAMNUT 21 suggests its ability to effectively partition and utilize growth factors towards seed formation than the other two varieties. In addition, the effect of weeding regime on kernel weight was significant ($P \leq 0.05$) in 2016 only (Table 5). In this year, groundnut kernel was heaviest under 2 HW plots, which was in turn similar to 1 HW plot compared to the weedy-check plot. This result may be attributed to good weed control under 1 HW and 2 HW, which encouraged nutrients availability and effective partitioning of photosynthates from source to sink, which also in turn translated into the higher accumulation of photosynthates in the seeds (Abouziena *et al.*, 2013).

Kernel yield of all the tested groundnut varieties differed significantly ($P \leq 0.05$) in both years (Table 5). Kernel yield was highest with the early maturing SAMNUT 24 in 2015, while the medium maturing SAMNUT 21 and SAMNUT 22 produced similar higher kernel yield than SAMNUT 24 in 2016.The response of groundnut varieties to climatic factors explained the variation in kernel yield obtained. Our result support that of Bala *et al.* (2011) who stated that variation in yield and yield attributes among groundnut varieties are affected by climatic factors during the crop growth stages. This could have influenced the performance of these groundnut varieties in this study. For example, the early maturing SAMNUT 24 could have already completed pod-filling, such that kernel yield was not significantly affected in 2015. In contrast, the climatic factors might have favoured the medium maturing SAMNUT 21 and SAMNUT 22, over the early maturing variety in 2016. These explained the reason for optimum kernel yield obtained with the two medium maturing varieties, over the early maturing variety.

Kernel yield was significantly ($P \leq 0.05$) higher with 1 HW and 2 HW plots compared to weedy check plot in 2015 and 2016, respectively (Table 5). The high kernel yield obtained under 1

HW and 2 HW were attributed to the reduction in weed competition, which in turn encouraged greater use of available growth factor and the higher number of pods produced per plant. Our result is similar to those of Santo *et al.* (2016) who observed highest kernel yield under weed-free treatment and attributed the result to reduced crop-weed competition, which translated into efficient resource use and more pods production per plant per unit area.

CONCLUSION AND RECOMMENDATION

From this study, it can be concluded that irrespective of the varieties and the weeding regime, broadleaved weeds were the dominant weeds associated with groundnut, especially *Tridax procumbens* Linn., *Vernonia galamensis* (Cass.) Less., *Euphorbia heterophylla* Linn., *Desmodium scorpiurus* (Sw.) Desv., *and Spigelia anthelmia* Linn. Weed suppression among the groundnut varieties was similar. The early maturing SAMNUT 24 variety, produced more pods per plant and kernel yield in one year, and the medium maturing varieties SAMNUT 21 and SAMNUT 22 produced greater kernel yield in another year. Generally, SAMNUT 21 produced the heaviest kernels. One hoe weeding at 3 WAS, and two hoe weeding at 3 and 6 WAS, reduced weed pressure and produced a similar greater number of pods per plant, heavier kernels and highest kernel yield. These varieties could be integrated with one or two hoes weeding to achieve effective and sustainable weed control in groundnut production in this agro-ecology of Nigeria.

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