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Intra-Row Spacing and Weed Control Influence Growth and Yield of Groundnut (*Arachis hypogea* L.)

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ABSTRACT

The production of groundnut (*Arachis hypogea* L.) is limited by high weed infestation causing high yield losses in Nigeria. Field trials were, therefore, conducted to evaluate the effect of intra-row spacing and weed control methods on growth and yield of groundnut at the Teaching and Research Farm of the Federal University of Agriculture, Abeokuta in the forest-savannah transition zone of South west Nigeria during the cropping seasons of 2008 and 2009. Two intra-row spacings (15 and 25 cm) were evaluated which constituted the main plot treatments, while five weed control treatments (pre-emergence application of commercial formulation of metolachlor + prometryne (Codal) at 1.6 kg a.i/ha alone and the same treatment followed by supplementary hoe-weeding (SHW) at 6 weeks after sowing (WAS) and at 2.4 kg a.i/ha, 2 hoe-weedings at 3 and 6 WAS and weedy checks where weeds were not removed throughout the crop life cycle. All the treatments in different combinations were arranged in a split- plot design with four replicates. Intra-row spacing of 15 cm resulted in significant reduction in weed growth compared to the intra row spacing of 25 cm as reflected in weed cover score, and dry weights at 9 and 12 WAS as well as cumulative weed dry matter production in both years. In addition, inter-row spacing of 50 cm caused significant improvement in crop growth as reflected in the crop vigour score, canopy height and canopy diameter and number of root nodules, with subsequent increase in pod yield per hectares. Similarly, All the weed control treatments caused significant reduction in weed cover score at 9 and 12 WAS, weed dry weights at 6, 9 and 12 WAS and cumulative weed dry matter production compared to the weedy check in both years The most effective treatments were the combination of intra-row spacing of 15 cm and the use of pre-emergence application of metolachlor + prometryne at 1.6 kg a.i./ha followed by one supplementary hoe-weeding at 6 WAS. Such treatments had effective weed control with consequent high groundnut pod yield comparable to those of two hoe-weedings. In this study, unchecked weed growth throughout the crop life cycle resulted in about 75.4 and 82.6% reductions in potential yield of groundnut in 2008 and 2009 seasons. Intra-row spacing of 15 cm and pre-emergence application of metolachlor + prometryn at 1.6 kg a.i/ha followed by supplementary hoe weeding at 6 WAS is therefore recommended for weed control alternative to frequent hoe weedings to can cut down on labour input particularly where labour is limiting and land under cultivation is large.

Introduction

Groundnut (*Arachis hypogaea* L.) is one of the most important economic oil crop in the world. It is the 13th world most important food crop and fourth important oil seed crop after soybean, cottonseed and rape seed (FAO, 2007). Groundnut is grown in 26.4 million hectares across the globe with a total production of 37.1 million metric tons and average production of 1690 kg/ha (FAO, 2006). The production of groundnut is concentrated in Asia and Africa, where the crop is grown mostly by smallholder farmers under rain-fed conditions with limited inputs. Nigeria is the fourth largest producer of groundnut after China, India and USA. It is estimated that over 2 million hectares are planted by groundnut in Nigeria (Gako *et al*., 2016).

Groundnut is grown mainly for its seed oil content, food and animal feed (Young, 1996). It plays an important role in the dietary requirements of resource poor women and children because of its high contents of protein and carbohydrate. Its seeds contain 48-50% oil, 24-26% protein, and 10-20% carbohydrate (Obi *et al*., 2008). Groundnut kernels are consumed directly as raw, roasted or boiled kernels while the oil extracted from the kernel is used as culinary oil. The haulm is also an important by-products that can be used to supply feed to livestock (Arslan, 2005). These multiple uses of groundnut plant makes it an excellent cash crop and for foreign trade in several developing and developed countries. As a legume crop, groundnut increases soil fertility by adding nitrogen to the soil. It fixes 49-297 kg atmospheric N/ha through its rhizobium bacteria in root nodule (Haque, 1989). Its nitrogen fixing ability and vigorous growth in adverse environments, especially in N-deficient soils, is particularly advantageous in subsistence agriculture (Rahman, 2003).

Groundnut production, marketing and trade served as major sources of employment, income and foreign exchange prior to petroleum oil boom in Nigeria. The groundnut sector provided the basis for the agro-industries development and contributed significantly to the commercialization, monetization and integration of the natural rural sector (Taphee and Jongur, 2014). However, over the years, its production in Nigeria has suffered major setbacks from various constraints such as groundnut rosette epidemics and folia diseases, aflatoxin contamination and lack of sufficient and consistent supply of seed of improved varieties. This has significantly affected productivity and thus production and substantially led to lose of its share in the domestic, regional and international markets. Although a range of groundnut varieties with various attributes including resistance to rosette and folia diseases have now been developed, however groundnut production in Nigeria is still limited by a number of factors which include preponderance of low yielding varieties, low soil fertility, and lack of knowledge of improved cultural practices as well as weed management problems, resulting in low yields of 800 kg/ha compared to 3000 kg/ha under good management practices (El-Naim and Ahmed, 2010). The high impact of weed competition on crop performance makes weed management an important issue in groundnut. Weed constitute a major limitation to groundnut production in Nigeria (EL Naim *et al*., 2010), resulting in field losses ranging from 13 to 100% depending on the season, cultivars, weed composition and duration of crop-weed competition (Rajendran and Louduraj, 1999; Etejere *et al*. 2013). This is because groundnut is a low-growing crop that shades rows slowly. The slow shading between plants and rows as well as less crop canopy during the first 6 weeks of growth by groundnut allows emergence of weed over a longer time early in the season (Sathya *et al*., 2013). This also favours strong competition with weeds causing significant reduction in yield (Akobundu 1987). To regain its competitiveness, groundnut yield would have to increase substantially, using yield enhancing technologies including good agronomic practices and improved weed control methods.

The conventional method of weeding by hoe is not only expensive, labour-intensive and back breaking, but can also cause mechanical damage to young growing brittle branches, roots and groundnut pegs. Apart from the high cost of labor, its availability is also unpredictable especially at the peak period of farming operation, thus making precision of weeding difficult to attain (Adigun and Lagoke 2003; Adigun, 2004). The mass exodus of the available farm labour to the urban areas and rising wages necessitates a less labour-intensive and more effective weed control method to attract more producers and to increase their area of production. Chemical weed control with the use of herbicides is considered to show more promise than hoe-weeding as it would reduce labour requirement and its attendant costs, facilitates efficient weed control and increase productivity and profitability in groundnut production. A wide range of herbicides such Alachlor, metholachlor, terbutryn, bentazone, imazethapyr, chlorbomuron, 2, 4-DB (2, 4–Dichlorophenoxy butyric acid), fluorodifen and trifluralin has been used for weed control in groundnut (Adigun, 2004; Adigun *et al*., 2016), they have however been reported to give only a selective weed control in the crop. Moreover, they do not give a season long weed control and repeated use of herbicides for weed control resulted in an increasing number of herbicide-resistant weed biotypes and shifts in weed species population (Adigun *et al.*, 1994; Adigun, 2004).

A number of studies have shown that increased crop densities would decrease the magnitude of the effect of weed competition with crops (Chauhan and Johnson, 2011; Buehring *et al*., 2002; Bhagirath *et al*., 2013). Also intra-row spacing has been reported to determine plant density which is a good measure of weed management through canopy management. Similarly, in groundnut, yield increase with better competition against weeds was obtained by growing the crop in narrow rows. Osipitan *et al*. (2013) also observed that cowpea grown in higher population reduced weed dry matter production significantly with consequent yield increase, an effect attributed to earlier and more vigorous shading and better competitive advantage in denser crop population.

Although several studies have been conducted to determine the optimum plant spacing for groundnut there is currently limited reports on the effects of intra-row spacing and weed control methods in groundnut. Hence the objective of the present study is to evaluate the effect of intra-row spacing and weed control methods on growth and yield of groundnut in the humid tropics of South Western Nigeria during in the cropping seasons of 2008 and 2009.

Materials and Methods

Description of Experimental Site

Field trials were conducted during the cropping seasons of 2008 and 2009 to evaluate the influence of intra-row spacing and weed control methods on growth and yield of groundnut (*Arachis hypogeae* L.) and associated weeds at the Teaching and Research Farm of the Federal University of Agriculture, Abeokuta (7^0 15′ N, 3^0 23′ E 159 m above sea level) in the Forest Savanna Transition Zone of South Western Nigeria. Soil samples were taken randomly from a depth of 0-15 cm at the experimental site after land preparation and before planting for physico-chemical analysis (Table 1). The weather records (Table 2) during the period of study were measured at a meteorological station 0.25 km from the experimental site. Common weed species and their level of occurrence at the experimental site were determined during the course of the experimentation (Table 3).

Treatments and Experimental Design

There were two main plot treatments of intra-row spacing (15 and 25 cm) with inter-row spacing of 75 cm. The sub-plot treatments consisted of five main plot treatments of weed control which included pre-emergence application of commercial formulate mixture of metolachlor + prometryne at 1.6 kg a.i/ha alone (without supplementary hoe weeding; SHW) and the same treatment followed by supplementary hoe-weeding at 6 weeks after sowing (WAS), metolachlor + prometryne at 2.4 kg a.i/ha, 2 hoe-weedings at 3 and 6 WAS in addition to weedy checks (weeds were not removed throughout the crop life cycle). All the treatments in different combinations were laid out in a split plot design with four replications.

Land preparation and Crop Management

The land was ploughed and disc harrowed at two-week interval. Single super phosphate (SSP) fertilizer a the rate of 54kg/ha was applied a week after planting. Gross and net plot sizes were (3 × 4.5) m^2 and (1.5 × 3.0) m^2 respectively. Seeds of high yielding early maturing groundnut (cv. SAMNUT 14) were sown at the rate of two to four seeds per hole and later thinned to two plants per stand. Herbicide was applied one day after sowing groundnut using knapsack (CP3) sprayer in a spraying volume of about 250 litres/ha using a deflector green nozzle at a pressure of 2 kg/cm^2. Recommended insecticide and fungicide were applied once at the onset of flowering as agronomic practice.

Parameters measured and data analysis

Table 1. Physico-chemical characteristics of experimental soil in 2008 and 2009.

Soil properties (0-15 cm depth)	**2008**	**2009**
Physical properties		
Sand (%)	81.7	83.8
Silt (%)	10.2	0.8
Clay(%)	8.2	15.4
Textural class	Loamy sand	Loamy sand
Chemical properties		
p^H (H_2O) (1:2)	6.8	4.2
Organic carbon (%)	5.20	4.82
Total nitrogen (%)	0.21	0.18
Available phosphorus (ppm)	19.10	20.30
Potassium (mg/kg)	11.71	7.51

Table 2. Meteorological data during the experiment in 2008 and 2009

	Total rainfall (mm)		**Relative humidity**		**Temperature (^{0}C)**	
	2008	2009	2008	2009	2008	2009
August	196.2	162.1	71.7	80.7	26.5	26.7
September	118.0	151.6	69.7	75.6	29.5	35.0
October	110.4	180.1	67.2	74.7	26.7	26.9
November	56.6	64.6	60.0	68.0	26.1	26.0
December	16.5	10.4	58.5	63.7	26.2	26.2

Source: Department of Agro Meteorology and Water Resources Management, Federal University of Agriculture, Abeokuta, Ogun state

Table 3. Common weed species found on the experimental sites and their level of infestation during the period of crop growth in 2008 and 2009.

Weed species	**Level of infestation**	
	2008	**2009**
Broad leaved	*	**
Aspilia Africana (L)	**	***
Commelina benghalensis (L)	**	**
Chochorus olitorus Linn)	**	**
Euphorbia heterophylla (L)	* *	***
Gomphrena celozoides mart.	**	***
Talinum triangulare (Jacq.) Wild.	**	***
Tridax procumbens Linn.	* *	**
Tithonia diversifolia (Helms) A	**	**
Grasses		
Andopogon gayanus Kunth var.	*	**
Imperata cylindrica Linn.	**	***
Eleusine indica (L) Gaertn	**	***
Panicum maximum Jacq.	*	***
Sedges		
Cyperus rotundus Linn	**	**
Cyperus esculentus (L)	***	***

*** High infestation (60 – 90 %) * Low infestation (1 – 39 %)
** Moderate infestation (40- 60 %) - Not noticeable

Weed cover score at 9 and 12 WAS, weed dry weights at 6, 9 and 12 WAS, cumulative weed dry matter production, crop vigour score, canopy height, canopy diameter, number of root nodules, number of pods per plant, pod yield/ha and 100 kernel weight were the tested parameters used to evaluate the effect of the investigated treatments. Crop vigour score was taken by visual observation based on scale 0-10, where 0 represented plots with crops completely killed and 10 represented plots with the most vigorous growth and healthy crop. Similarly, weed cover score was taken by visual observation on the scale of 0 to 10, where 0 was assigned to plots without any weed and 10 assigned to plots with full weed cover (Ismail *et al*., 2001). All parameters were taken and subjected to analysis of variance using (ANOVA) using GENSTAT discovery package to determine the level of significance of the treatments. The treatment means were compared using least significant difference (LSD) where 'F' values show significance

Results

Effect of intra-row spacing and weed control methods on weed cover score, weed dry weight and cumulative weed dry matter production

Intra-row spacing had significant effect on weeds control as reflected in weed cover score, and dry weights at 9 and 12 WAS as well as cumulative weed dry matter production in 2008 and 2009 (Table 4). In all cases, there was significant reduction in weed cover score with decrease in intra-row spacing from 25 to 15 cm in both years. Similarly, weed dry weights were

reduced significantly at 15 cm compared with 25 cm intra-row spacing in both years. In addition, cumulative weed dry matter production was reduced by 16 and 13% at 15 cm compared with 25 cm intra-row spacing in 2008 and 2009, respectively.

All the weed control treatments caused significant reduction in weed cover score at 9 and 12 WAS, weed dry weights at 6, 9 and 12 WAS and cumulative weed dry matter production compared to the weedy check in both trials conducted under this investigation (Table 4). At 9 and 12 WAS in both years, application of metolachlor + prometryn at 1.6 kg a.i/ha followed by supplementary hoe weeding at 6 WAS and 2 hoe weeding treatment had similar weed cover score significantly lower than those obtained with metolachlor + prometryn at 1.6 kg a.i/ha and metolachlor + prometryn at 2.4 kg a.i/ha each applied alone. Similarly, the hoe-weeded plots and those treated with metolachlor + prometryn at 1.6 kg a.i/ha followed by supplementary hoe-weeding at 6 WAS had significantly lower weed dry weights at 6, 9 and 12 WAS and cumulative weed dry matter production than pre-emergence application of metolachlor + prometryn at 2.4 kg a.i/ha or low rate of the herbicide at 1.6 kg a.i/ha in both years. The interaction of intra-row spacing and weed control methods was not significant on weed infestation throughout the period of observation in both years.

Effect of intra-row spacing and weed control methods on growth and yield of groundnut

Intra-row spacing had significant effect on growth and yield of groundnut as reflected in the crop vigour score, canopy height and canopy diameter in both years, and number of root nodules in 2009 as well as number of pod per plant and pod yield in both years (Tables 5 and 6). In all cases, groundnut planted at 15 cm intra-row spacing produced significantly higher crop vigour score, canopy height, canopy diameter and number of root nodules than those planted at 25 cm inter-row spacing. Similarly, higher groundnut pod yield was obtained at 15 cm compared to 25 cm intra-row spacing in both years. Conversely, number of pod per plant was significantly increased with increase in intra-row spacing from 15 to 25 cm in both years.

All the weed control method produced significantly higher crop vigour score, canopy height, canopy diameter, number of pods per plant, 100 kernel weight and pod yield compared to the weedy check in both years of experimentation (Tables 5 and 6). Except for pre-emergence application of metholachlor + prometryn at 1.6 kg a.i/ha in 2008, all the weed control methods resulted in significantly higher stand count compared to the weedy check (Table 5). Pre-emergence application of metholachlor + prometryn at 1.6 kg a.i/ha followed by supplementary hoe weeding at 6 WAS resulted in better crop vigour similar to 2 hoe weeding and better than the herbicides applied alone at 2.4 kg a.1/ha or at lower rate of 1.6 kg a.i/ha. Similarly, all the weed control treatments produce similar canopy height significantly higher than those obtained in the weedy check at 9 WAS in 2008. There was no significant difference in growth and yield obtained with pre-emergence application of

Table 4. Effect of intra-row spacing and weed control methods on weed cover score, weed dry weight and cumulative weed dry matter production in 2008 and 2009.

Treatments	**Weed cover score**				**Weed dry weight (g/m^2)**						**Cumulative weed dry matter (kg/ha)**	
	Weeks after sowing											
	9		**12**		**6**		**9**		**12**			
	2008	**2009**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**	**2008**	**2009**
Intra-row spacing (cm)												
15	4.6	4.5	6.1	5.7	320	282	345	224	275	372	2350	2120
25	4.9	5.2	6.6	6	434	297	362	288	296	399	2730	2385
LSD	0.1	0.4	0.2	0.3	18.5	10.4	16.8	23.0	15.4	16.4	142.3	116.5
Weed control methods												
Metolachlor + prometryn at 1.6 kg a.i/ha	4.3	4.8	6.1	6.1	378	277	305	164	304	375	2468	2040
Metolachlor + prometryn at 1.6 kg a.i/ha + SHW at 6 WAS	3.1	4.0	5.5	4.1	330	200	245	76	226	260	2003	1340
Metolachlor + prometryn at 2.4 kg a.i/ha	4.3	4.6	6.1	6.8	359	262	358	289	328	379	2613	2100
2 Hoe weedings at 3 and 6 WAS	3.5	3.4	5.6	4.5	320	200	274	230	189	314	1958	1935
Weedy check	6.5	7.4	8.1	7.5	498	420	585	522	381	594	3660	3840
LSD	0.4	0.6	0.5	0.4	30.8	19.3	29.5	38.5	28.4	29.8	212.5	183.3
Interaction	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Table 5. Effect of intra-row spacing and weed control methods on growth and yield of groundnut

Treatments	**Stand count**		**Crop vigour**		**Canopy height (cm)**		**Canopy diameter (cm)**	
	2008	2009	2008	2009	2008	2009	2008	2009
Intra-row spacing (cm)								
15	91.1	106.5	6.0	6.6	44.0	52.0	41.6	39.5
25	72.1	67.4	5.8	6.3	41.9	50.8	40.2	38.6
LSD	5.3	6.2	0.1	0.1	1.9	1.8	0.7	0.7
Weed control methods								
Metolachlor + prometryn at 1.6 kg a.i/ha	81.7	90.9	5.5	6.9	42.3	51.3	41.0	40.5
Metolachlor + prometryn at 1.6 kg a.i/ha + SHW at 6 WAS	74.9	95.2	6.8	7.3	44.8	61.4	44.0	38.6
Metolachlor + prometryn at 2.4 kg a.i/ha	89.4	94.0	6.0	6.8	46.0	53.5	40.6	41.0
2 Hoe weedings at 3 and 6 WAS	84.8	86.9	6.5	6.5	42.1	49.0	42.4	43.1
Weedy check	77.4	67.8	5.0	4.8	39.4	41.8	38.9	31.9
LSD	9.4	11.2	0.5	0.1	4.3	5.2	2.4	1.7
Interaction	ns	ns	ns	ns	ns	ns	ns	ns

Table 6. Effect of intra-row spacing and weed control methods on growth and yield of groundnut

Treatments	**Nodule count/plant**		**Number of pods/plant**		**Pod yield (kg/ha)**		**100 kernel weight**	
	2008	2009	2008	2009	2008	2009	2008	2009
Intra-row spacing (cm)								
15	35.5	78.3	7.5	7.1	1508	1365	40.9	30.4
25	36.0	60.6	10.7	11.7	834	577	42.0	31.0
LSD	ns	3.5	0.9	1.1	155.3	83.4	ns	ns
Weed control methods								
Metolachlor + prometryn at 1.6 kg a.i/ha	36.9	65.3	10.2	8.1	926	978	43.8	34.9
Metolachlor + prometryn at 1.6 kg a.i/ha + SHW at 6 WAS	25.9	73.4	12.3	9.8	1210	1204	45.7	35.4
Metolachlor + prometryn at 2.4 kg a.i/ha	40.0	79.6	9.7	7.0	908	910	39.6	33.3
2 Hoe weedings at 3 and 6 WAS	31.4	68.4	11.9	17.1	1241	1044	42.8	34.9
Weedy check	44.5	60.4	3.9	2.8	305	209	35.3	15.1
LSD	11.0	5.7	1.4	2.3	160.4	115.4	1.7	2.2
Interaction	ns	ns	ns	ns	ns	ns	ns	ns

metholachlor + prometryn at 2.4 kg a.i/ha and lower rate of the herbicide at 1.6 kg a.i/ha in both years.

In this study, pre-emergence application of metolachlor + prometryn at 1.6 kg a.i/ha followed by supplementary hoe weeding at 6 WAS resulted in significantly higher canopy height at 9 WAS in 2009 and canopy diameter at 9 WAS in both years than other weed control treatments. Also among the various weed control treatments, maximum number of root nodules were obtained with pre-emergence application of metolachlor + prometryn followed by supplementary hoe weeding at 6 WAS and higher rate of the herbicide at 2.4 kg a.i/ha applied alone at 9 WAS in 2008. Pre-emergence application of metolachlor + prometryn at 1.6 kg a.i/ha followed by supplementary hoe weeding at 6 WAS also appears to be the most consistent in term of number of pods per plant, 100 kernel weight and groundnut yield in both years. This treatment resulted in significantly higher number of pods per plant and pod yield similar to two hoe weedings and better than the herbicide applied alone at 2.4 kg a.1/ha or at lower rate of 1.6 kg a.i/ha in both years. In this study, unchecked weed growth throughout the crop life cycle resulted in 75.4 and 82.6% reduction in groundnut pod yield in 2008 and 2009, respectively. The interaction of intra-row spacing and weed control methods was not significant on growth and yield of groundnut throughout the period of observation in both years.

Discussion

In this study, groundnut pod yield and yield attributes were generally higher in 2008 than in 2009. The lower yield and yield attributes recorded in 2009 compared to 2008 may be attributed to higher weed infestation recorded in the former than in the later. Generally weeds were relatively less aggressive and lower in density in 2008 compared to 2009, probably as a result of the lower total amount of rainfall during the period of crop growth in 2008 compared to 2009 (Table 2). The rainfall, temperature and relative humidity are highly favourable for weed growth and competition. Baskin and Baskin (2001) also observed that weed seed germination, growth and competitiveness are influenced directly or indirectly by environmental factors such as temperature, moisture and light. The higher number of root nodules recorded in 2009 compared to 2008 may be attributed to higher soil moisture occasioned by the higher total amount of rainfall in the former than in the later (Table 2). This situation must have enhanced easy proliferation of groundnut root in the soil profile and hence higher number of root nodules.

The reduction in weed growth at 15 cm compared with 25 cm intra-row spacing was probably due to groundnut seeded in narrow plant spacing being more competitive with weeds and achieving faster and better canopy cover than groundnut seeded in wide plant spacing (Carroll et al., 2005). Better canopy cover with narrow plant spacing must have inhibited weed seed germination and enhanced better suppression of weeds. Hence, reduced weed dry weights was observed at 15 cm compared with 25 cm intra-row spacing in both years. The effectiveness of closer spacing to achieve better weed control has earlier been reported by several workers (Osipitan et al., 2013; Adigun et al., 2017; Na-Allah et al., 2017). Adigun and Aderibigbe (2011) observed that spacing of 30 cm resulted in significantly lower weed cover score than those of 45 cm intra-row spacing. Similarly, Na-Allah et al. (2017) reported that intra-row spacing of 20 cm significantly reduced weed dry matter than 30 cm intra-row spacing.

The effective weed control at narrow intra-row spacing of 15 cm resulted in increased growth and yield of groundnut in both years. This may be attributed to the reduced weed competition for resources such as light, nutrient, space and water achieved by the smothering effect of groundnut on late emerging weeds at narrow compared to wide plant spacing. These results are in agreement with that of Na-Allah et al. (2017) where cowpea spaced at 20 cm suppressed weed growth with consequence higher crop growth and yield than spacing of 30 cm. There were two obvious advantages in the close spacing. First, there was early and better canopy formation for effective weed smothering and suppression, coupled with higher plant population for enhanced productivity. The increase in pod number per plant in wide intra row spacing, however, may be the result of availability of better resources to the individual plants. Also narrow spacing might cause mutual shading which may cause floral abscission and pod dropping in the canopy strata. Nevertheless, in both years of this study, narrow intra-row spacing gave higher pod yield using higher plant population advantage which more than compensated for the reduction in pod yield of individual plants.

The significant reduction in weed growth with the various weed control method as compared to the weed check in both years confirms the effectiveness of these weed control methods in giving various level of weed control in groundnut production as earlier reported by Adigun et al. (2016). The effectiveness of metolachlor + prometryn at 2.4 kg a.i/ha or lower rate of the herbicide at 1.6 kg a.i/ha in reducing weed growth may be attributed to their mode of action in inhibiting protein synthesis and other processes vital for weed-plant development. Similar effect of various weed control methods on weed control in groundnut was also reported by Sukhadia et al. (2000) and Adigun et al. (2017).

Better weed control observed with pre-emergence application of metolachlor + prometryn at 1.6 kg a.i/ha followed by supplementary hoe-weeding at 6 WAS than the herbicide applied alone either at 2.4 kg a.i/ha or at lower rate of 1.6 kg a.i/ha may be attributed to the initial weed control by the herbicide and supplementary hoe weeding both of which helped the crop to establish and smother the weeds coming in the second flush or later in the season. This result also indicates that pre-emergence application of metolachlor + prometryn either at 2.4 kg a.i/ha or at lower rate of 1.6 kg a.i/ha both require supplementary hoe weeding for season long weed control because of their short persistence. This was apparent from the comparable weed cover score at 9 and 12 WAS and weed dry weights at 6 and 12 WAS as well as cumulative dry matter production obtained with either rate of the herbicide in both years. This confirms the earlier reports of Akobundu, (1987) and Adigun et al., 2016 that most pre-emergence herbicide treatments gave early weed control of emerging weed seedlings but lost efficacy early thereby allowing late emerging broadleaf weeds to re-infest plots. The need for supplementary hoe weeding of pre-emergence herbicide application for season long weed control in various arable crop production have earlier been emphasized (Lagoke et al., 2014; Osipitan et al., 2013; Adigun et al., 2017). Adigun et al., 2016 also reported that application of probaben and butachlor at 2.0 kg a.i/ha followed by supplementary hoe weeding at 6 WAS gave better weed control than either herbicide applied alone in groundnut while Imolaome, (2014) reported that metolachlor at 2.0 kg a.1/ha applied alone could not give season long weed control in soybean.

Comparable weed dry weights, cumulative weed dry matter production and groundnut yield obtained in plots treated with pre-emergence application of metolachlor + prometryn at 2.4 and 1.6 kg a.i/ha in both years, suggest that reduction in rate of metolachlor + prometryn application from 2.4 kg a.i/ha to 1.6 kg a.i/ha does not result in reduced weed control efficiency or yield of groundnut. Moreover, such practice is environmental friendly and economically viable as cost of weed control will be reduced with reduction in application rates as earlier reported by Kirkland et al. (2000). This result have corroborated that of Hamill and Zhang (1995) who achieved corn yields similar to full rate treatments when reduced rates of metribuzine were used. Holms et al. (2000) also achieved adequate weed control in wheat with rate reductions of 33-66%, depending on the location. In this study, pre-emergence application of metolachlor + prometryn at 1.6 kg a.i/ha followed by supplementary hoe-weeding at 6 WAS has some merit because it consistently reduced weed growth with consequent good crop growth and similar yield to the hoe-weeded control. Better growth and yield obtained with this treatment can be attributed to the initial weed control of the herbicides as well as the relatively effectiveness of the supplementary hoe weeding in controlling subsequent weeds that emerged, thereby sustaining effectiveness in weed control throughout the period of crop growth. This result have corroborated those of Adigun et al. (2017) and Osipitan et al. (2013) that pre-emergence application of herbicides such as metolachlor + prometryn and Butachlor followed by hoe weeding at 6 WAS gave excellent weed control and maximum yield in groundnut and cowpea, respectively.

Conclusion

Based on the findings of this study, it can be concluded that groundnut planted at 15 cm intra-row spacing caused significant reduction in weed growth with subsequent higher groundnut pod yield than those of 25 cm intra-row spacing. In addition, pre-emergence application of metolachlor + prometryn at 2.4 kg a.i/ha was not better than application of the herbicide at lower rate of 1.6 kg a.i/ha for effective weed control and increased yield of groundnut either in narrow (15 cm) or wide (25 cm) intra-row spacing. However, the use of intra-row spacing of 15 cm as cultural weed control method with integration of pre-emergence application of metolachlor + prometryn at lower rate of 1.6 kg a.i/ha followed by supplementary hoe weeding at 6 WAS gave effective weed control with consequent high groundnut yield comparable to the hoe-weeded control and better than either rate of the herbicide applied alone. The effectiveness of this treatment in both years is an indication that, they can be used in weed control alternative to two or three hoe weedings to can cut down on labour input particularly where labour is limiting and land under cultivation is large.

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