ISSN:
Print - 2277 - 0755
Online - 2315 - 7453

Journal of Agricultural Science and Environment

INFLUENCE OF INTER-ROW SPACING AND WEED CONTROL METHODS IN GROUNDNUT (*Arachis hypogeal* (L.)

J. A. ADIGUN, O. R. ADEYEMI, S. T. O., LAGOKE, P. M. OLORUNMAIYE, O. S. DARAMOLA AND A. O. BABATUNDE

Department of Plant Physiology and Crop Production,
Federal University of Agriculture, Abeokuta, Abeokuta, Nigeria

Corresponding Author: josadig2007@yahoo.com

ABSTRACT

Weed competition has been identified as one of the major obstacles in crop production. The production of groundnut is limited by high weed infestation resulting in yield losses ranging from 50 - 80% in Nigeria. Hence, the need to evaluate integrated weed control in its production. Field trials were therefore conducted at the Teaching and Research Farm of the Federal University of Agriculture, Abeokuta (7^{o} 20' N, 3^{0} 23' E) to evaluate the influence of inter-row spacing and weed control methods on growth and yield of groundnut during the wet seasons in 2009 and 2010. The experiment was a Randomised Complete Design (RCBD) laid out in a split plot with three replications. The main plot treatment consisted of three inter-row spacings of 60 cm, 75 cm and 90 cm while the subplots included five weed control treatments of commercial formulation of metolachlor plus promethyne mixture (codal) at 1.0 kg a.i/ha, codal at 1.0 kg a.i./ha followed by supplementary hoe weeding at 6 weeks after sowing (WAS), codal at 2 kg a.i./ha, hoe weeding at 3, 6 and 9 WAS and a weedy check. Inter-row spacings of 60 cm and 75 cm reduced weed growth with consequent higher yields compared to the inter-row spacings of 90 cm in the early season of 2009. Application of codal at 1.0 kg a.i./ha followed by supplementary hoe weeding at 6 WAS combined with 60cm inter-row spacing gave effective weed control and higher groundnut pod yield than hoe-weeded control in both years of experimentation.

Keywords: codal, groundnut, inter-row, spacing, weeding

INTRODUCTION

Groundnut (*Arachis hypogeal*) is a major oil seed crop widely grown in many countries of the world. It is the most abundant oil seed in the semi-arid tropics (Adeeko and Ajibola, 1990). It is a valuable source of industrial and edible vegetable oil as well as rich source of protein for human and animal nutrition, world- wide. The world annual production of groundnut has been put at 33.9 million tonnes from 25.2 million ha of land (FAO, 2005). The importance of this crop in Nigeria lies not only in its role as a potential foreign exchange earner, but also in its use as a source of oil (45-50%) and protein (25%). Of the estimated 59g of crude protein available per head per day in Nigeria, groundnut reportedly contributed 5% (Olayide, 1972). In addition, groundnut has an important usage in the livestock industry as feed supplement. Another important feature of groundnut is that it fixes atmospheric

nitrogen through symbiosis with root nodule bacteria. In so doing, the crop could be used to amend the low levels of soil nitrogen in the forest- savannah transition zone.

Groundnut production is limited by various factors such as the use of low yielding varieties, pests and diseases as well as weed management problems (Adigun, 2004). Unrestricted weed infestation in groundnut has been reported to cause between 51-88% yield reduction (Lagoke *et al.,* 1981; Adigun and Lagoke, 1994; Adigun, 2004). A number of studies had shown that increase in plant density would decrease the possibility of the effect of weed competition with crops and increased light interception with crops; thereby leading to increased crop growth and earlier canopy closure with consequently increase in crop yield (Adigun, 2001; Dalley, *et al.,* 2004; Osipitan *et al*., 2013; Adigun *et al*., 2014).

High cost of labour and herbicides have resulted in the abandonment of many farms. Integrated weed control method is a veritable way of achieving a season-long weed control in groundnut fields (Lagoke *et al* .,1981; Usman, *et al*., 2002).

A number of preemergence herbicides have been evaluated for weed control in groundnut. These include, alachlor, metolachlor, terbutyne, prometryne, bentazone and imazethpyr Lagoke, et al 1981; Adigun and Lagoke, 1994. However, differences in weed floral and their pattern of emergence during crop growth influence the performance of herbicides in addition to other factors. Lagoke, *et al* (1981) reported effect tive weed control and pod yield comparable to that of hoe weeding with pre-emergence application of alachlor and metolachlor alone or mixed with terbutryne in the Northern Guinea Savanna.

Presently, there is paucity of information on the effect of weed control and inter-row spacing on the growth and yield performance of groundnut. The objectives of this study therefore, was to evaluate the effect of commercially formulated product of prometryne and metolachlor (codal) and row-spacing on weed control and productivity of groundnut.

MATERIALS AND METHODS

Field trials were conducted at the Teaching and Research Farm of Federal University of Agriculture, Abeokuta (7° 20' N, 3° 23' E) in the forest savannah transition zone of South-Western Nigeria in the early wet seasons of 2009 and 2010. The rainfall pattern was a bimodal type with 2 peaks in June and September. The experimental plot was cropped with cassava two years prior to the trial and subsequently left fallow for a year. Soil samples were taken for analysis of its physico-chemical properties as stated in Table 1a.

Weed flora at the experimental site before the commencement of the study included: *Panicum maximum* (L.) Jacq, *Imperata cylindrical* (Linn.) *Pennisetum purpureum* (L) *Commelina benghalensis* (L.), *Euphorbia hirta* (Linn.) *Euphorbia heterophylla* (L.), *Tithonia diversifolia* (L.) *and Cyperus rotundus* (L.). Other weed species present in the experimental sites and their level of occurrence are indicated in Table 1b above.

In 2009 the main plot treatments consisted of three inter-row spacing of 60 cm, 75 cm and 90 cm on intra-row spacing of 30 cm while the sub plot treatments were made up of five weed control methods of pre-emergence application of commercial formu-

lation of metolachlor plus prometryn mixture (codal) at 1.0kg a.i/ha, codal at 1.0kg/ha followed by supplementary hoe-weeding at 6 WAP, codal at 2.00kg a.i/ha, hoe weeding at 3, 6 and 9 WAP and weedy check. In 2010, the treatments were modified involving only two treatments of 60 and 75cm inter-row spacings having observed that the two spacing performed better than 90 cm spacing in 2009. In both years, all treatments were Randomised Complete Block Design laid out in a split plot with three replications. The groundnut variety used was Samnut 11 RMP 91, a semi- erect type of 130-150 maturity days.

The land was ploughed twice at two weeks interval followed by harrowing. The plots were laid out and pegged and later sown with decorticated groundnut seeds, three seeds per hole. Herbicides were applied with CP3 (Knapsack) sprayer in a spraying volume of 200-240 l/ha using a green deflector nozzle at a pressure of 2.1 kg/cm^3. All herbicides were applied pre-emergence one day after sowing groundnut. The emerged seedlings were later thinned to two plants per stand 14 days after planting. Single Super Phosphate (SSP) fertilizer was applied five days after planting at the rate of 45 kg/ha P_2O_5. Insect pests' population were controlled using cypermetryn at the rate of 30 mls/10 litres of water at 6 and 9 WAS.

Data were collected on weed density, weed biomass, and weed cover score. Weed density was determined by using a 1 m^2 quadrat placed at random in each plot at 3, 6 and 9 weeks after sowing (WAS). Weed samples in each quadrat were separated into broadleaves, grasses and sedges counted and weighed. The weed samples were later ovendried at 70^{o}C for 48 hrs. At 3, 6 and 9 WAS the weed cover score was determined using visual rating base on 0-10 scale where 10 represents full weed cover and 0 represented no weed cover. At 9 WAS, groundnut stand count, crop vigour score and total dry matter content were determined. 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 growing and healthy crop

At harvest, groundnut pod yield and weight of seeds per 100 pods were determined. Data collected were later subjected to analysis of variance and means were compared using Fishers Least Significant Difference (LSD) at 5% level of probability using the SAS statistical software package.

Table 1a: Physico-Chemical Properties of the Soil used in the Experiment

Soil properties	Level of composition (2009)	Level of composition (2010)
pH (water)	5.80	5.80
Sand	71.80	72.70
Silt	12.40	10.70
Clay	15.80	16.60
Organic carbon	2.40	2.54
Available P	8.75	8.74
Total N	0.19	0.18
Total K	0.49	0.48

Table 1b: Common weed species found at the experimental sites and their level of infestation in 2009 and 2010 wet seasons

Weed species	2009	2010
Broad leaves		
Euphorbia heterophyllia Linn	***	***
Euphorbia hirta (L)	*	*
Talinum triangulare (Jacq) Wild	***	***
Chromolaena odorata (L)	*	*
Tridax procumbens Linn	**	**
Senna hirsuta (Linn) Irwin	*	*
Amaranthus spinosus (L.)	**	**
Amaranthus viridis (L.)	*	*
Acanthospermum hispidium DC	**	**
Boerhavia coccinea Mill	***	***
Boerhavia diffusa L.	**	**
Hyptislanceolata poir	*	*
Tithonia diversifolia (Hemsl.) A. Gray	*	*
Grasses		
Rottboellia cohinchinesis (Lour) Clayton	*	*
Imperata cylindrical L.	**	**
Pennisetum purpureum L.	**	**
Commelina benghalensis L.	**	**
Panicum maximum Jacq.	*	*
Cynodon dactylon (L.) Gaertn	*	*
Cynodon dactylon (L.) Gaertn	**	**
Sedges		
Cyperus rotundus (L.)	*	-
Cyperus esculentus (L.)	**	**

*** High infestation (60 – 90 %) ** Moderate infestation (40- 50 %)
* Low infestation (1 – 39 %) - Not noticeable

RESULTS AND DISCUSSION

Effect of inter-row spacing and weed control on weed cover score, weed density and weed dry matter production in groundnut.

Tables 2, 3 and 4 show the effect of inter row spacing and weed control on weed cover score, weed density and weed dry matter production. Inter-row spacing did not have any significant effect ($p \geq 0.05$) on these parameters in the early seasons of 2009 and 2010. However, weed control had significant effect on weed dry matter production both in 2009 and 2010. Among the various weed control treatments, pre-emergence application of codal at 1.0 kg a.i/ha followed by supplementary hoe weeding at 6 WAS as well as hoe-weeding at 3, 6, and 9 WAS caused significant reduction in weed growth compared to the weedy check. The level of weed control with these treatments were comparable to that of codal at 2 kg a.i/ha.

In 2010 wet season, weed control method significantly affected the weed density. The cumulative weed population were significantly reduced with pre-emergence application of codal at 1.0 kg a.i/ha followed by supplementary hoe-weeding with hoe weeding, codal at 2 kg a./ha and hoe weeding at 3, 6 and 9 WAS. There was no significant interaction between the inter row spacing and weed control on weed cover score and weed dry matter production in the early season of 2009 (Table 2) However, there was significant interaction between inter-row spacing and weed control on weed density.

In 2009, the combinations of three hoe weeding at 3, 6 and 9 WAS and 75 cm inter-row spacing significantly reduced weed population in comparison with other treatment combinations. This was similar to the combination of the same hoe weeding and 60 cm inter-row spacing.

In 2009, the 60 cm and 75 cm inter-row spacing apparently had lower values of weed density and weed dry matter than the 90 cm. It follows that better weed control was achieved with the use of inter-row spacing of 60 cm and 75 cm although this was not significantly different from the 90 cm spacing.

Table 2: Effect of Inter-row Spacing and Weed Management on Weed Cover Score, Weed Density and Weed Dry Matter Production in the Early Season of 2009.

	Weed Cover Score		Weed Density Kg/Ha		Dry Weed Weight Kg/ Ha	
Treatment	3 WAP	6 WAP	3 WAP	6 WAP	3 WAP	6 WAP
60cm	3.47	3.80	367.47	338.13	294.88	53.40
75cm	3.00	3.80	281.6	416.53	206.85	99.86
90cm	2.73	3.87	326.13	392.53	251.09	109.55
SE±	NS	NS	NS	NS	NS	NS
WEED CONTROL (WC)						
Codal at 1kg a.i/ha	1.89b	4.11b	234.67bc	354.22b	62.71b	42.02b
Codal at 1kg a.i/ha+Hoe weeding at 6WAP	2.00b	3.33bc	140.00c	310.22b	94.22b	60.03b
Codal at 2 kg a.i/ha	1.11b	2.44cd	137.78c	265.78b	69.69b	35.92b
Hoe weeding at 3, 6 and 9WAP	4.89a	1.78d	405.78b	230.67b	547.96a	31.06b
Weedy Check	5.44a	7.44a	707.11a	751.11a	480.13a	268.98a
SE±	0.63	0.65	105.00	72.32*	180.89*	46.88
SP*WC	NS	NS	NS	258.52*	NS	NS

Note: Means followed by the same letter(s) are significantly different at 5% level of probability (DMRT)

WAP = Weeks after planting, NS = Not significant at 5% level of probability,

* = Not significant at 5% level of probability

Table 3: Interaction of Weed Management and Inter-row Spacing on Weed Density (kg/ha) at 6 WAP in Alabata in the Early Season of 2009.

Spacing(S)	Weed Control (WC)				
	Codal at 1kg a.i/ha	Codal at 1 kg a.i/ha + Hoe weeding at 6 WAP	Codal at 2kg a.i/ha	Hoe weeding at 3, 6 and 9 WAP	Weedy Check
60cm	264.00c	396.00bc	266.67c	285.33c	478.67bc
75cm	353.33c	245.33c	277.33c	184.00c	1022.67a
90cm	445.33bc	289.33c	253.33c	222.67c	752.00ab

Note: Means followed by the same letter(s) are significantly different at 5% level of probability (DMRT)

WAP= Weeks after planting, NS= Not significant at 5% level of probability, *= Not significant at 5% level of probability

Table 4: Effect of Inter-row Spacing and Weed Control on Weed Cover Score and Dry Matter Production in Groundnut Production at Alabata, in 2010.

Treatment	Weed Cover Score		Cummulative Broad-Leaf Weight (Kg/Ha)	Cummulative Grass Weight (Kg/Ha)
	6 WAP	9 WAP		
SPACINGS (S)				
60cm	3.30	3.80	170.00	150.00
75cm	3.50	4.30	151.00	207.00
SE±	0.80NS	0.92NS	7.00NS	4.00NS
WEED CONTROL (WC)				
Codal at 1kg a.i/ha	3.00bc	4.33b	83.00b	73.00b
Codal at 1kg a.i/ha + Hoe weeding at 6 WAP	3.00bc	3.50b	4.00d	8.00c
Codal at 2 kg a.i/ha	2.17c	2.50b	40.00c	4.00bc
Hoe weeding at 3, 6 and 9WAP	4.17a	3.00bc	5.00d	1.00c
Weedy Check	4.50ab	6.83a	687.00a	761.00a
SE±	0.70	0.81	4.00c	15.00
S*W	0.47NS	0.86NS	129.00NS	19.00NS

Note: Means followed by the same letter(s) are significantly different at 5% level of prob ability (DMRT)

WAP= Weeks after planting, NS= Not significant at 5% level of probability, *= Not significant at 5% level of probability

Similar trend was observed in 2010 in which case closer spacing of 60 cm apparently had lower weed biomass and weed coverage than the inter-row spacing of 75 cm. The effectiveness of closer spacing to achieve better weed control had been documented by several workers (Street et al, 1981; Teasday and Frank, 1983; Akobudun, 1987; Adigun, 2001; Adigun, 2011). Street *et al.,* 1981 reported reduced dry matter production with increased cotton density while Adigun, (2001) observed that spacing of 30 cm resulted in significantly lower weed cover score than those of 45 cm intra row spacing in tomato.

In spite of the heavy weed infestation during the wet season the use of pre-emergence application of codal at 1.0 kg a.i/ha followed by supplementary hoe weeding resulted in effective weed control comparable to the hoe weeded control. Although the use of pre-emergence application of codal effectively controlled early emerging weeds, there was the need for supplementary hoe weeding in order to control the late emerging weeds and to enhance groundnut productivity. This findings is in agreement with the observations of Akobudun (1987) that groundnut may require more additional hoe weeding after being weeded for 3, and 6 weeks compared to other grain legumes probably because of its inability to develop canopy cover as quickly as other leguminous crops.

Effect of Inter Row Spacing and Weed Control on the growth and yield of Groundnut

Generally, inter-row spacing had significant effect on crop stand count at 9 WAS and crop vigour in the early season of 2009 and 2010 (Tables 5 and 6). Higher crop dry matter and pod yield as well as lower weed infestation were obtained with inter row spacing at 60 cm and 75 cm compared to 90 cm when adequate weed control was given. Significant effect was also observed in the dry matter production of groundnut and pod yield in 2010. The increase in dry matter production did not really translate into yield in the first year probably due to increase in soil nitrogen in the experimental site which must have increased (60%) the vegetative growth at the expense of pod yield. This finding is in consonant with the work of Dalley *et al., (*2004) who observed that narrowing spacing increases light interception by the crop particularly in the early growing season, thereby leading to increased crop growth rates and earlier canopy closure.

Weed control treatments apparently improved the performance of groundnut with regards to the dry matter production, crop vigour and pod yield (Tables 5 and 6). However, in the early and late seasons of 2009 there were consistently no significant differences among the weed control methods on the stand count and crop vigour.

Codal at 1kg ai/ha supplemented with one hoe weeding at 6 WAS and hoe weeding at 3, 6 and 9 WAS gave superior and season long weed control and higher pod yield when compared to other treatments in both 2009 and 2010 (Tables 5 and 6). Hoe weeding at 3, 6 and 9 WAS distinctively controlled weeds better than other treatments in 2009 while in 2010 codal at 1 kg ai/ha supplemented with hoe weeding resulted in superior dry matter content and pod yield of groundnut. The regular removal of weeds associated with closely-spaced groundnut stands must have reduced intense weed competition thus increasing nutrient availability for uptake by the weed free crop (weeding at 3, 6 and 9 WAP) stands. This invariably reduced the adverse effect of weed-crop competition for nutrients and water.

Table 5: Effect of Inter-row Spacing and Weed Control on Crop Stand Count, Crop Vigour, Dry Shoot Weight and Yield of Groundnut in the Early and late Season of 2009.

Treatment	Stand Count 9 WAP	Crop Vigour 9 WAP	Dry Shoot Weight (g/plant) 12 WAP	Pod Yield (g/plant)	100 Seeds Weight (g)
SPACINGS (S)					
60cm	104.47a	9.00a	18.58	12.95	70.23
75cm	71.07b	7.73a	17.02	12.58	70.24
90cm	60.13c	6.07b	19.36	13.34	67.57
SE±	0.59*	0.50	NS	NS	NS
WEED CONTROL (WC)					
Codal at 1kg a.i/ha	79.33a	7.89a	15.63b	7.48bc	66.11c
Codal at 1kg a.i/ha+ Hoe weeding at 6 WAP	79.00a	8.00a	25.54a	22.52a	76.15a
Codal at 2 kg a.i/ha	79.22a	7.89a	18.06b	11.46b	69.93bc
Hoe weeding at 3, 6 and 9 WAP	79.89a	7.56a	23.81a	20.30a	59.48d
Weedy Check	75.33b	6.67b	8.56c	3.03c	75.06ab
SE±	0.99	0.34	2.48	2.92	2.65
S*W	3.54	NS	NS	NS	NS

Note: Means followed by the same letter(s) are significantly different at 5% level of prob ability (DMRT)

WAP= Weeks after planting, NS= Not significant at 5% level of probability, *= Not significant at 5% level of probability

Table 6: Effect of Inter-row Spacing and Weed Control on Stand Count, Crop Vigour, Dry Shoot Weight, and Yield of Groundnut in 2010.

Treatment	Stand Count/Ha 9 WAP	Crop Vigour 9 WAP	Dry Shoot Weight (g/plant) 9 WAP	Pod Yield (g/plant)	100 Seeds Weight (g)
INTER-ROW SPACINGS (S)					
60cm	221.00a	5.60	132.50	6.61	34.10
75cm	171.00b	5.00	132.50	5.98	31.20
SE±	6.00	0.90	25.61	1.52	0.89
WEED CONTROL (WC)					
Codal at 1kg a.i/ha	201.00a	48.00a	103.20cd	6.31b	32.60
Codal at 1kg a.i/ha+Hoe weeding at 6 WAP	202.00a	5.70a	186.20a	9.46a	35.70*
Codal at 2 kg a.i/ha	204.00a	5.50a	134.30bc	5.29b	32.30
Hoe weeding at 3, 6 and 9 WAP	207.00a	5.80a	169.60ab	8.08a	33.20
Weedy Check	165.00b	4.70b	69.30d	2.48c	29.60
SE±	9.00	0.19	19.99	1.93	10.31

Note: Means followed by the same letter(s) are significantly different at 5% level of probability (DMRT)

WAP= Weeks after planting, NS= Not significant at 5% level of probability, *= Not significant at 5% level of probability

Moreover, abundant supply of nutrients to widely spaced plants (75 cm and 90 cm) might have aided vigorous growth of associated weeds. This probably has accounted for the superior pod yield of inter-row crop spacing of 60 cm combined with application of codal at 1 kg ai/ha supplemented with hoe weeding.

CONCLUSION

High cost of labour and herbicides have resulted in the abandonment of many farms. This has necessitated the urgent need to find an integrated approach that can help to minimise weed infestation and enhance the yield of most arable crops most especially groundnut. This study showed that application of codal at 1.0 kg ai/ha followed by supplementary hoe weeding at 6 WAS combined with inter-row spacing of 60 cm resulted in effective weed control with subsequent groundnut pod yield comparable to the hoe weeded control. Although pre-emergence application of codal at 2.0 kg a.i/ha, produced effective weed control, groundnut pod yield obtained with this treatment was significantly lower than the respective optimum obtainable.

REFERENCES

Adeeko, K. A and Ajibola, O.O. (1990): Processing factor affecting yield and quality of mechanically expressed groundnut oil. *Journal of Agricultural Engineering Research* 45: 31-43

Adigun, J. A. (2001). Influence of intra - row spacing and chemical weed control on growth and yield of chilli pepper in the Nigerian Northern Guinea Savannah. *Nigerian Journal of Horticultural Science* 5:67-73.

Adigun, 2004: Weed control in groundnut with preemergence herbicides in the Forest-Savannah Transition Zone of Western Nigeria. *Journal of Plant Protection*. 21:47-56

Adigun, J. A. and Aderibigbe, S. G. (2011): Influence of population and weed control methods on growth and yield of transplanted rain-fed tomato in South-Western Nigeria. .*Nigerian Journal of Experimental and Applied Biology*. 12 (1):109-117.

Adigun, J. A; Osipitan, O. A.; Lagoke, S. T. O.; Adeyemi, O. R. and Afolami, S. O. (2014). Growth and Yield Performance of Cowpea (*Vigna Unguiculata* (L.) Walp) as influenced by Row-Spacing and Period of Weed interference in South-West Nigeria; 6 (4): 188-198.

Akobudun I. O. (1987) Weed Science in the Tropics. *Principles and Practices*. A Wiley- Interscience 522 pp.

Dalley, C. D., J. J. Kells and K. A Renner, (2004): Effect of glyphosate application timing and row spacing on weed growth in corn (*Zea mays* L.) and soyabean (*Glycine max*). *Weed Technology* 18:177-182

FAO, 2005: Statistical Data Base. Food and Agriculture Organisation of the United Nations, Rome Italy. Available online from the website: http//apps.fao.org/default.html

Lagoke, S. T. O., D. O. Kataria and O. A. Ogungbile (1981). Potential for improved weed control practices in Field Crop Production in the Nigeria savannah zone. Paper presented at the 1st Seminar on Green Revolution in Nigeria, held at IAR, Ahmadu Bello University, Zaria Nigeria in September 1981. 27pp.

Olayide, S. O. (1972). A quantitative analysis of food requirement supplies and de-

mands in Nigeria (1968-1985). Federal Department of Agriculture, Lagos- Nigeria.

Osipitan, O. A.; Adigun, J. A.; Lagoke, S. T. O. And Afolami, S. O. (2013). Effect of interrow spacing and weed control methods on growth and yield of cowpea (*Vigna unguiculata* L. Walp) in South Western Nigeria. *Nigerian Journal Plant Protection*, 27 (1): 97-111.

Street, J. E and Buchanan, G, A, Crowley, R. H and Mcguive, J. A (1981): Influence of cotton (*Gossypium hirsutum*) densities on competitiveness of pig weed (*Amaranthus spp* and sicle pod *(Cassia obtusifolia*). *Weed Science* 29 (3):253-256.

Teasday, J. R and Frank, J. R (1983): Effect of row spacing on weed competitions with snap beans (*Phaseolus vulgaris*). *Weed Science* 31 (1):81-85.

Usman, A; Elemo, K. A; Lagoke, S.T.O. and Adigun, J. A. (2002). Nitrogen and weed management in maize intercropped with upland rice. *Journal of Sustainable Agriculture* 21 (1): 5-16.

(Manuscript received: 23rd April, 2014; accepted: 15th March, 2016)