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Effect of Different Rates of Pendimenthalin on Weed Control in Bambara Groundnut (*Vigna subterranean* L. Verd.) in Semi- Arid Savanna, Nigeria

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A field experiment was conducted in 2014 rainy season at the Teaching and Research Farm of Adamawa State University, Mubi located in Northern Guinea Savanna of Nigeria. Two varieties of Bambara groundnut (Vigna subterranean (L) Verdcout) (barnbos and idon bazaura) were evaluated using six levels of pendimethalin (0.5, 1.0, 1.5, 2.0, 2.5, 3.0 kg a. i./ha) along with hoe —weeded and unweed as checks. These were laid out in a split-plot design with varieties in the main plots, pendimethalin in the sub -plots and replicated three times. The objective was to ascertain the optimum rates of pendimethalin for weed control in bambara groundnut. Genotype had no significant effect on crop performance except 100-grains weight, whereby bambos produced heavier grains than idon bazaura. Application of pendimethalin at 2.00 kg a. i. /ha and higher rates reduced crop vigour and canopy height at 3 weeks after sowing, All rates of pendimethelin produced comparable grain yield with the hoe weeded treatment. The study revealed that pendimenthalin at the rate of 0.5-1.5 kg a. i./ha could possibly be used as alternative to hoe-weeding for weed control in bambara groundnut.

Keywords: bambara groundnut, genotype, pendimethalin, optimum rate.

INTRODUCTION

Bambara groundnut has been ranked as the third most important grain legume, after groundnut (*Arachis hypogaea L.*) and cowpea (*Vigna unguiculata*) in Semi-arid Africa, It is an indigenous African leguminous crop and one of the most important pulses grown on the continent (Doku and karikari, 1969). The crop has been widely cultivated in tropical regions since the seventeenth century. In addition to Sub-Saharan Africa, it is now found in many parts of South America, Asia and Oceania (Baudoin and Mergeai, 2001). The center of origin of Bambara groundnut is probably North Eastern Nigeria and Northern Cameroon. It is found in the wild form from central Nigeria eastwards to southern Sudan, and is now cultivated throughout tropical Africa and to a lesser extent in tropical parts of America, Asia and Australia (Brink *et al.*, 2006). Bambara groundnut was domesticated in the semi-arid zone of West Africa, probably around the headwaters of the Niger River, from where it spread in ancient times to central Africa, and more recently to the Malagasy Republic, Asia and South America (Tweneboah, 2000). Bambara groundnut has high nutritive value with 65% carbohydrate and 18% protein content. (Doku, 1995). “Due to its high protein value it is a

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very important crop for poorer people in Africa who can not afford expensive animal protein (Baryeh, 2001). Bambara groundnut is mainly used for human consumption. The seeds are consumed either when immature or fully ripe and dry (Swanevelder, 1998). They can be eaten fresh, or grilled while immature. In Nigeria the common use of bambara groundnut is to make paste out of the dry seeds, which is then used in the preparation of various fried, or steamed products, such as “Akarra “(bean cake) and “moin-moin” and “okpa” (bean pudding) (Obizoba 1983). Bambara groundnut can also be used in the fortification of cereal foods or improve the nutrient content for both baby and adult foods such as in the preparation of pap and porridge.

Weed poses serious threat to crop production It causes losses in Bambara groundnut . Most farmers in the savanna ecologies of Nigeria depend on hoe weeding as method of weed control. This method is becoming increasingly costly while labour scarcity poses serious problem. This method is also slow and tedious and is associated with drudgery. Therefore there is need to employ other methods of weed control such as use of herbicide which can provide effective and time-efficient method of managing weeds. Herbicide use has been reported to be more portable than hoe weeding in the production of various crops in Nigeria (Shrock and Manaco, 1980, Okereke, 1983, Sintha and Lagoke, 1984, Ogunbile and Lagoke, 1986, Adigun et al., 1993, Roa, 2000, Encarta 2009). Herbicides have been playing important role in world agriculture for the past decades and will for the foreseeable future, continue to do so. Also they destroy weeds on a large scale before or at emergence without disturbing the crop or soil and without heavy dependence on human labour. (Akobundu, 1987). The objective of the study is to ascertain the optimum rate of pendimethalin for the control of weeds in Bambara groundnut.

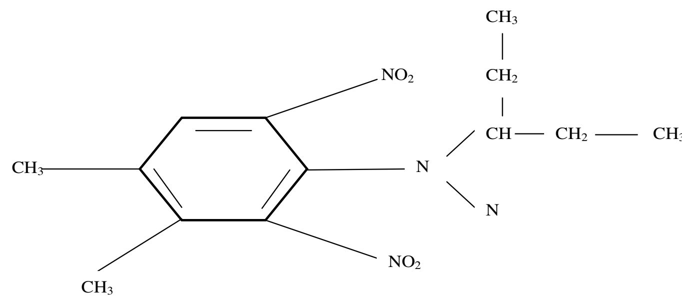
MATERIALS AND METHODS

The Research was conducted in 2014 rainy season at Teaching and Research Farm, of Adamawa State University, Mubi. Mubi lies between latitude 9° 30' to 11° 00N and longitude 12° 00; to 13° 45' E in the Northern Guinea Savanna of Nigeria. In the area, rainfall starts in the month of April and terminates in the month of October with a unimodal peak in the Month of August (ADSU Meteorological Unit, 2011).

The experiment was laid-out in a split-plot design with two Bambara groundnut genotypes in the main plots, while the sub-treatments consisted of six rates of Pendimethalin (0.5, 1. 0, 1.5, 2.0, 2.5, 3.0 kg a. i. /ha) along with hoe-weeded and unweeded checks.

Description of Pendimethalin:

This is a dinitroaniline herbicide used as preplant incorporated, pre-emergence and also as a post emergence herbicide for grass weed control in many crops ranging from Maize, Sorghum, Cowpea, Soya beans to vegetable crops (Adesina *et al*., 1998; Akobundu, 1987). It is used in the control of annual grasses and certain broadleaf weeds which interfere with growth, development, yield and quality of crops by competing for nutrients, water and light. (Adesina *et al*.,1998; Olorunmaiye 2002).



Chemical Structure of Pendimethalin

Pendimethalin	
Molecular formula	$C_{13} H_{19} N_3O_4$
Average mass	281.308 Da
Monoisotopic mass	281. 137543Da
(Wikipedia)	

Description of Genotypes

Bambos: This genotype has large-sized mottle coloured seeds, which bears fewer pods per plant than idon bazaura.

Idon Bazaura: The genotype has small-sized white coloured seeds, and bears plenty pods per plant.

The field was harrowed and leveled manually before sowing, The seeds were sown at the spacing of 20cm x 60cm at 3 seeds per hill and thinned to two plants per stand at 2 weeks after sowing (WAS), on plots measuring 4m x3.6m ($14.4m^2$). Fertilizer was applied at rate of 40 kg $P_2 O_5$ ha^{-1} using single supper phosphate at the time of sowing. Pendimethalin was applied at the rate for each treatment using knapsack sprayer. The hoe weeded treatment was weeded at 3 and 6 WAS. Data collected were subjected to analysis of variance and the means separated using Duncan Multiple Range at 5% level of probability using SAS package (2005).

RESULTS

Genotype had no significant effect on crop Vigour at 3 WAS (Table 1). Application of Pendimethalin at the rate of 0.5 kg a.i./ha exhibited the highest crop vigour at 3 WAS, but was comparable in vigour to that of Pendimethalin at 1.0 and 1.5 kg a.i./ha, the hoe weeded and unwedded

Table 1 Effect of genotype and pendimathalin rate on crop vigour at 3 WAS, Canopy height (cm) at 3 and 6 WAS of Bambara groundnut grown at Mubi, in 2014 rainy season.

Treatment	Crop vigour	Canopy height	
	3 WAS	3 WAS	6 WAS
Genotype			
Bambos	3.54	10.55	17.99
Idon Bazaura	3.	11.37	18.80
SE±	0.262	0.318	0.220
Level of Significance	ns	ns	ns
Pendimethalin Rate (Kg/ha)			
0.5	4.33a	11.58a	18.67
1.0	3.50ab	11.18a	18.71
1.5	3.50ab	11.49a	18.52
2.0	3.00bc	10.76ab	18.44
2.5	3.00bc	9.52b	17.27
3.0	2.33c	9.78b	17.64
Hoe-weeded (Check)	4.17a	11.56a	18.32
Unweed (Check)	4.17a	11.79a	18.60
SE±	0.271	0.430	0.615
Level of Significance	*	*	ns
Interaction			
Gen. X Pendimetahlin	ns	*	ns

Means followed by common letter(s) in each treatment groujp are not significantly different at 5% level of probability using Duncan Multiple Range Test.

*=Significantly different at 5% level of probability

ns= Not significantly different at 5% level of probability.

WAS= weeds after sowing.

Key to vigour score

1= Very poor vigour 4 = Vigorous

2= Poor vigour 5 = Very vigorous

3 = Fairly vigorous

checks. Increasing pendimathalin rates to 2.0, 2.5 and 3.0 kg a.i/ha significantly decreased crop vigour as compared to 0.5 kg a.i./ha rate and the two checks. Application of 3.0 kg a.i./ha pendimathalin produced the least vigorous plants. The result of crop canopy height at 3 and 6 WAS is presented in Table 1. The two genotypes produced plants of comparable canopy height at 3 and 6 WAS. At 3 WAS, unweeded and the hoe-weeded checks, pendimethalin at 0.5, 1.0 and 1.5 kg a. i./ha produced plants of similar canopy height, which were markedly taller than those of 2.5 and 3.0 kg a. i./ha rates. Application of pendimethalin at 2.5 kg a. i./ha recorded plants of least canopy height which were comparable to those of 2.0 and 3. 0 kg a.i/ha rates. Pendimethalin rates had no significant effect on canopy height at 6 WAS. There was significant interaction between genotype and pandimethalin rate on canopy height at 3 WAS.

The interactive effect of genotype and pendimethalin rates on canopy height at 3 WAS is shown in Table 2. In bambos genotype, at 3 WAS, application of 0.5 kg a. i. /ha exhibited the tallest plants that were significantly taller than plants of 2.5 kg a. i. rates only. In Idon Bazaura, the hoe-weeded treatment gave the tallest plants which were only significantly taller than plant exhibited by 3.0 kg a. i. rate. While in bambos shortest plant were recorded by 2.5 kg a. i. pendimethalin rate in idon Bazaura, shortest plants were noted at the 3.0 kg a. i. pendimethalin rate.

Table 2: Interactive effects of genotype and pendimenthalin rates on canopy height (cm) at 3 WAS of Bambara groundnut grown at Mubi in 2014 rainy season.

	Genotype	
Pendimethalin Rate (kg/ha)	**Bambos**	**Idon Bazaura**
0.5	11.48abc	11.70abc
1.0	11.06abc	11.30abc
1.5	11.08abc	11.94ab
2.0	10.22abcd	11.30abc
2.5	8.53d	10.51abc
3.0	9.64cd	9.93bcd
Hoe-weeded (check)	10.97abc	12.24a
Unweeded (check)	11.41abc	12.16a
SE±	0.608	

Means followed by common letter (s) are not significantly different at 5% level of probability using Duncan Multiple Range Test.
WAS= Weeks after sowing

Table 3: Influence of genotype and pendimethalin rate on herbicide injury on bambara groundnut at 3 and 6 WAS growth at Mubi, in 2014.

	Injury Score	
Treatment	**3 WAS**	**6 WAS**
Genotype		
Bambos	2.50	1.96
Idon Bazaura	2.54	1.96
SE±	0.079	0.089
Level of Significance	ns	ns
Pendimethalin Rates (Kg/ha)		
0.5	2.176	2.17bc
1.0	2.50b	2.00cd
1.5	2.67b	1.50cde
2.0	3.50a	2.17bc
2.5	3.67a	2.83a
3.0	3.67a	3.00a
Hoe-weeded (check)	1.00c	1.00e
Unweeded (check)	1.00c	1.00e
SE±	0.212	0.248
Level of Significance	*	*
Interaction		
Gen. X Pendimethalin	ns	ns

Means followed by common letter(s) in each treatment group are not significantly different at 5% level of probability using Duncan Multiple Range Test.
*= Significantly different at 5% level of probability ns=Not significantly different at 5% level of probability
WAS= Weeks after sowing
Key to injury score
1= No injury observed 4=Severe injury
2= Slight injury 5=very severe injury
3=Moderate injury

Table 4. Influence of genetype and pedimethalin rate on 100-gains weight, pod and grain yields of Bambara groundnuts growth at Mubi, in 2014 rainy seaons.

Treatment	100-grains Weight (g)	Pod yield (Kg/ha)	Grain yield (Kg/ha)
Genotype			
Bambos	97.11a	725	478
Idon Bazaura	76.76b	829	534
SE±	2.54	131.83	74.91
Level of Significance	*	ns	ns
Pendimethalin Rate (Kg/ha)			
0.5	70.28c	591	401
1.0	87.87ab	834	578
1.5	90.15ab	734	488
2.0	85.75b	814	537
2.5	87.43ab	916	599
3.0	82.62b	991	536
Hoe-weeded (Check)	97.65a	902	611
Unweed (Check)	85.80b	438	297
SE±	3.36	148.71	98.37
Level of Significance	*	ns	ns
Interaction			
Gen. X Pendimetahlin	ns	ns	ns

Means followed by common letter (s) in each treatment group are not significantly different at 5% level of probability using Duncan Multiple Range Test.
* Significantly different at 5% level of probability
ns= Not significantly different at 5% level of probability

The results of pendimethalin injury on crop injury at 3 and 6 WAS are presented in Table 3. The genotypes did not differ significantly with respect to crop injury at 3 and 6 WAS. At 3 WAS, application of 2.0 to 3.0 kg a. i. /ha pendimethalin exhibited similar and significantly worse crop injury than the 0.5 to 1.5 kg a.i./ha rates. Furthermore, the 0.5 to 1.5 kg a. i. /ha rates had comparable injury effects and were significantly worse than the unweeded and hoe-weeded checks.

At 6 WAS, application of 3.0 kg a. i. /ha pendimethalin had the most severe injury on crop but was similar to the injury caused by applying pendimethalin at 2.5 kg a. i./ha. Application of 0.5 to 2.0 kg a. i. /ha of pendimethalin exhibited comparable but less severe injury than the higher pendimethalin rates. All pendimethalin rates caused significant crop injury compared to the hoe-weeded and unweeded checks. There was no significant interactive effect between genotype and pendimethalin rates at both 3 and 6 WAS.

Bambos genotype recorded appreciably heavier grains than the idon bazaura genotype (Table 4). The hoe-weeded treatment produced heaviest grains which where comparable with those of 1.0, 1.5 and 2.5 kg pendimethalin rates. However, they were significantly heavier than the grains of unweeded check, 0.5 and 2.0 kg a.i./ha pendimethalin rates. The 0.5 kg a.i./ha pendimethalin rate had the least grain weight. There was no significant interaction between genotype and pendimethalin rates. Genotype and pendimethalin rates had no significant effect on pod and grain yields (Table 4). Also genotype and pedimethalin rates showed no significant interactive effect on pod and grain yields.

DISCUSSION

The two genotypes exhibited significant difference only in 100-grains weight out of all the characters measured in the study. This can be attributed to differences in their grain size. The genotype bambos has larger grain size than the Idon bazaura genotype. Grain size is genetically controlled, therefore under optimum growth condition; a genotype will exhibit her potential grain size.

The crop vigour of Bambara groundnut was significantly affected by herbicide treatment at 3 WAS. While application of 0-1.5 kg a. i. /ha pendimethalin had no significant effect on the crop vigour, increasing the rate to 2.0 and above significantly depressed crop vigour compared to the checks. Similarly at 3 WAS, the 0-1.5 kg a. i. /ha pendimethalin exhibited comparable degree of injury on the crop. This implies that the crop could tolerate pendimethalin application up to 1.5 kg a. i. /ha without marked reduction in its vigour or suffering of severe injury. The depression of crop vigour and the increase in severity of the injury inflicted on the crop at higher doses could be attributed to the significant phytotoxic effect of pendimethalin on the crop at higher doses. Similarly, the same reason can be advanced for the reduction in plant height at 2.5 and 3.0 kg a. i. rates at 3 WAS. It has been noted that pendimethalin inhibits Cell division and cell elongation thereby retarding shoot and root growth (Wikepedia) therefore it is to be expected that when pendimethalin rate exceeds tolerable level, it could hamper crop-growth.

Furthermore at 6 WAS, there was no marked difference in the injury caused by pendimethalin to bambara groundnut even when the dose was raised to 2.00 kg a. i. /ha. Also at 6 WAS, all rates of pendemethalin (0.5-3.0 kg a. i. /ha) used in this study had no effect on plant height; this can be attributed to the possibility of the degradation of the herbicide with time as was noted by Imoloame *et al.,* (2011). Similarly Ndahi and Kwaga (2012), Observed that application of 2.00 kg a. i. /ha of pendimethalin showed no injury effect on groundnut. Although hoe- weeded treatment produced the heaviest grains, nevertheless it was at par with grains obtained from the application of 1.0, 1.5 and 2.5 kg a. i./ha rates. This implies that application of pendimethalin at these rates did not exhibit marked phytotoxicity that could reduce grain size significantly.

The differences in pod and kernel yields were not significant under pendimethalin rates. This implies that at the rates used, pendimethalin would not cause significant reduction in yield due to phytotoxicity effect. Therefore at the rates used, pendimethalin application could serve as an alternative method for control of weeds in bambara groundnut. A significant interactive effect of genotype and pendimethalin rates was on canopy height at 3 WAS. At this growth stage, canopy height in bambos was significantly reduced when application rate reached 2.5 kg a.i./ha. However in idon bazaura, pendimethalin did not depress canopy height significantly until the rate of 3.00 kg a.i./ha was reached. It shows that idon bazaura can tolerate higher doses of pendimenthalin than bambos.

CONCLUSION

Potentials exist for the production of bambara groundnut using herbicides as an alternative to hoe weeding, it appears that pendimethalin at the rate of 0.5-1.5 kg a.i. /ha can be used as an alternative to hoe weeding for weed control in Bambara groundnut.

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