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EFFECTS OF VARIETY, CROP ARRANGEMENT AND PERIOD OF WEED INTERFERENCE ON THE PERFORMANCE OF MAIZE GROWN IN MIXTURE IN NORTHERN GUINEA SAVANNAH OF NIGERIA

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ABSTRACT

Field trials on the effects of variety, crop arrangement and period of weed interference on the performance of maize grown in mixture were conducted at the Institute for Agricultural Research farm, Samaru ($11^0$11' N; $07^0$38' E and 686m above sea level) in the Northern Guinea Savanna ecological Zone of Nigeria during the wet season of 2000 and 2001. Extra early maize TZEE-W was used as test crop, two cowpea varieties (Kanannado and Sampea 7): two crop arrangements (alternate row and alternate stand arrangements) and ten periods of weed interference (weed free till 3, 6, 9, 12 weeks after sowing (WAS) and harvest and a corresponding set that were kept initially weed infested till 3,6,9,12 WAS and harvest. Two treatments were left weed free or weed infested throughout the crop life cycle. The treatments were evaluated in a split-plot design with varieties and crop arrangements allotted to main plot and period of weed interference to sub-plot. Varieties, crops arrangement and period of weed interference had significant effect on weed growth and yield parameters of maize. Maize grown in mixture with Kanannado gave lower weed dry matter (WDM), higher crop vigour score (CVS), higher grain yield and 100-grain weight. Maize in alternate row arrangement performs better than maize in alternate stand arrangement. Keeping the crop weed free till 6 WAS and beyond gave better crop performance.

Keywords: maize, variety, crop arrangement, weed interference, mixture.

INTRODUCTION

Maize (*Zea mays* L.) is one of the most important cereal crops in the world next to wheat and rice. It is a major source of food for human beings the leaves serve as component of animal feeds and as a source of income for farmers. It is mostly cultivated in the tropics and gives high yields than most cereals per area of land cultivated. Maize is a major cereal crop in Nigeria and is gradually replacing or competing as a dominant cereal with crops like sorghum and millet in the Nigerian savanna (Skinner, 1987). Maize is grown in mixture with cowpea in the savanna ecological zone of Nigeria.

Mixed cropping is a traditional cropping system among small-scale farmers in the tropics (Mortimore *et al*., 1997). It involves the growing of two or more crops simultaneously on the same piece of land at the same time with or without regard to row arrangement. The crops compete with each other for light, water and nutrients. A lot of advantages are associated with this system. These include the efficient utilization of production factors such as light, nutrients and water, increase in total crop yield and returns per hectare (IITA, 2007). Other advantages include, soil conservation and improvement by maintenance of vegetative cover of ground surface and reduced risk of total or partial loss of yield due to damage by pests and diseases and insurance against complete failure of component crops (Fisher *et al*., 1987; IITA, 2007). A review by Elemo *et al.* (1988), Mutungamiri *et al.* (2001) indicated that the yield potential of mixed cropping systems could be increased substantially through improved management practice. The high cost of labour for hoe weeding owing to the fact that farmers weed up to four times with limited use of herbicide due to lack of sufficient capital and technical know how of farmers in Nigeria has made it necessary to focus research efforts into studying compatible crops to be grown in mixture and the best arrangement that can control weeds better. This study was conducted with the aim of determining the best time to control weed in maize when grown in mixture with cowpea.

MATERIALS AND METHODS

The experiment was conducted during 2000 and 2001 wet seasons at the Institute for Agricultural Research Farm Samaru, Nigeria ($11^0$11'N. 07^0 38' E and 686m above sea level). The soil of the experimental site from 0-30cm depths in both years was sandy loam. Details are presented in Table-1. The treatment consisted of two varieties of cowpea Sampea 7 and Kanannado, one maize variety, TZEE-W (extra-early maize), two crop arrangements alternate row and alternate stand (1:1) and ten periods of weed interference (weed free for initially 3, 6, 9 12 WAS and till harvest and weed infested till initially 3, 6, 9, 12 WAS and till harvest). The treatments were laid out in a split-plot design replicated three times. Tillage operations consisted of ploughing, harrowing and ridging at 0.75m apart. The main plots consisted of cowpea varieties and crop arrangements while the sub plots consisted at 10 periods of weed interference such that plots were kept weed free for 3, 6, 9, 12 WAS and until harvest and weed infested for 3, 6, 9, 12 WAS and until harvest. A plot consisted of eight ridges by 0.75m of 3m lengths. One seeds each of maize and cowpea at 25cm were sown separately per hill in the two arrangements of maize and cowpea.

Data collected were weed dry matter, crop vigour score, plant height, grain yield and 100- grain weight. Data collected were subjected to analysis of variance (ANOVA)

(Snedecor and Cochran, 1967) where significance was observed among treatment means they were evaluated using Duncan Multiple Range Test (DMRT) as described by Duncan (1955).

RESULTS

The crop performed better in 2001 than 2000, while weed infestation was more severe in 2000 than 2001. The prevalent weed species at the experimental site in the two years were *Vernonia galamensis, Crotaria retusa, Euphobia heterophylla, Cynodon dactylon Cyperus* spp, *Rottboelia cochinchinensis* and *Ageratum conyzoides*. Other serious weeds present included *Acanthospermum hirspidum* and *Ipomea aquatica* in 2001.

Effect of treatments on weed dry matter

Table-2 shows the effect of variety, crop arrangement and period of weed interference of weed dry matter. The effect of cowpea varieties was significant on weed dry matter production at 9 WAS in all the years of studies. Kanannado supported the production of lower weed dry matter than Sampea 7 in all the study.

Crop arrangement had significant effect on weed dry matter production in both years of study. Alternate stand arrangement supported the production of higher WDW in both years of study.

Keeping the plot weed free till harvest resulted in lower weed dry weight (WDM) but was comparable to keeping the plot weed free from 6 to 12 WAS and weed infested till 3 to 12 WAS in 2000. Generally keeping the plots weed free till 9 WAS and beyond supported the production of lower (WDM).

Effect of treatment on crop growth

Table-3 shows the effect of variety crop arrangement and period of weed interference on CVS of maize, variety had significant effect on crop vigour score of maize in all the years of study. Maize planted in mixture with Kanannado gave more vigorous plants than Sampea 7.

Crop arrangement did not have significant effect on CVS of maize in all the years of study.

The effect of period of weed interference on CVS of maize was significant in both years of study. Keeping the plots weed free till 6 WAS and beyond and weed infested till 3 WAS in both years of study gave more vigorous plants.

Table-4 shows the effect of variety crop arrangement and period of weed interference on plant height. Variety and crop arrangement did not have significant effect on plant height in both years.

Period of weed interference had significant effect on plant height in 2001 only. Keeping the crop weed free till 6 WAS and beyond produce taller plants while keeping the crop weed infested till 9 WAS and beyond produce shorter plants than all other periods.

Effect of treatment on yield and yield component of maize

Table-5 shows the effect of variety, crop arrangement and period of weed interference on grain yield. Variety had significant effect on grain yield in both years of study. Maize planted in mixture with Kanannado produced higher grain yield than maize planted in mixture with Sampea 7.

Crop arrangement had significant effect on grain yield in 2000. Maize planted in alternate row arrangement produced higher grain yield than maize in alternate stand arrangement.

Period of weed interference had significant effect on grain yield in all the years of study. Keeping the crop weed free till 9 WAS and beyond and weed infested till 3 WAS in 2000, and weed free till harvest and weed infested till 3 WAS in 2001 supported the production of higher grain yield. Keeping the crop weed free till 3 WAS in both years and weed infested till 6 WAS and beyond in 2000 and weed infested till 12 WAS and beyond in 2001 supported the production of lower grain yield.

Table-6 shows the effect of variety, crop arrangement and period of weed interference on 100-grain weight. Variety had significant effect on 100-grain weight. Variety had significant effect on 100-grain weight in both years. Maize planted in mixture with Kanannado produced heavier seeds than maize planted in mixture with Sampea 7 in both years. Crop arrangement did not have significant effect on 100-grain weight in all the years.

Period of weed interference had significant effect on 100-seed weight on both years. Keeping the plot weed free till 6WAS and beyond and weed infested till 3 to 9WAS produce heavier seeds but were comparable to crop kept weed free till 3 WAS and weed infested till 12WAS an 2000 and 12 WAS and harvest in 2001.

DISCUSSIONS

The lower WDW, higher CVS, higher grain yield and heavier 100-grain weight observed in the Kanannado based mixture could be associated to the fact that Kanannado grows prostrate and so had wider canopy to suppress weeds beneath the maize crop than Sampea 7 which grew semi-upright. This agrees, with the report by Akobundu (1984), IITA (2007) that with live mulches weed biomass and weed seed population are greatly reduced, with the weed better suppressed in the Kanannado mixtures, the maize crop had soil nutrient and atmospheric need resulting to better crop establishment and yield. Lower WDW and higher grain yield observed in maize planted in alternate row arrangement could be attributed to the fact that there was better ground cover which helped in smothering weeds, absence of inter-specific competition between crops compared to the alternate stand arrangement consequently higher maize grain yield.

It is apparent that keeping the crop weed infested till 12 WAS. Subsequent weeding will not have effect on the yield. Similarly keeping the plot weed free till 12 WAS, subsequent weeding will not increase yield. Keeping crop weed infested till 6 WAS and beyond

resulted in reduction in yield. This agrees with the reported by several workers (Lagoke, 1978; Kunjo, 1981; Bakut, 1985). The critical period of maize grown in mixture with cowpea is between 3 and 6 WAS. This means that once the canopy of the cowpea develops fully, weed will be suppressed thus reduction in competition between maize crop and weeds.

CONCLUSIONS

The results obtained indicate that planting Kanannado in mixture with maize in alternate row arrangement and kept weed free till 6 WAS will reduce the number of weeding since 6 WAS is the critical period of weed interference in maize. This will therefore reduce the cost of production.

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Table-1. Physico-chemical properties on soil at the experimental sites in Samaru, Nigeria.

Soil properties	Seasons	
	2000	**2001**
Physical		
Sand (%)	46	49
Silt (%)	30	41
Clay (%)	24	10
Textural class	Loam	Loam
Chemical		
Soil pH in water	5.40	5.65
Soil pH in 0.01M $Cacl_2$	5.00	4.40
Organic carbon (%)	0.48	0.48
Available phosphorus (ppm)	13.35	12.05
Calcium	0.68	0.63
Magnesium	0.30	0.31
Potassium	0.35	0.33
Sodium	0.13	0.12
Hydrogen aluminium	0.9	0.11
Cation exchange capacity	5.30	5.60

All soil samples were analyzed in Soil Science Department, Institute of Agricultural Research, Ahmadu Bello University, Zaria.

Table-2. Effect of variety crop arrangement and period of weed interference on weed dry weight in maize grown in mixture at Samaru, Nigeria.

Treatment	Weed dry weight at 9 WAS (kg ha^{-1})	
	2000	**2001**
Variety (V)		
Kanannado	0.95b	0.86b
Sampea 7	1.17a	1.36a
SE+	0.05	0.05
Crop arrangement (A)		
Alternate row	0.97b	1.04b
Alternate stand	1.15a	1.18a
SE ±	0.05	0.05
Period of weed interference (P)		
Weed free till 3WAS[1]	1.85b	1.98
Weed free till 6WAS	1.69b	1.81
Weed free till 9WAS	0.48cd	0.94
Weed free till 12WAS	0.48cd	0.44
Weed free till harvest	0.29d	0.37
Weed Infested till 3WAS	0.43cd	0.49
Weed infested till 6WAS	0.44cd	0.43
Weed infested till 9WAS	0.46cd	0.53
Weed infested till 12WAS	0.51cd	0.28
Weed infested till harvest	3.90a	4.02
SE ±	0.08	0.07
Interaction		
V x A	NS[2]	NS
V x P	NS	NS
A x P	NS	NS
V x A x P	NS	NS

Means followed by the same letter (s) within a column of any treatment group are not significantly different at 5% level of probability using DMRT,
1. WAS = Weeks after sowing
2. NS = Not significant.

Table-3. Effect of variety, crop arrangement and period of weed interference on crop vigour score of maize grown in mixture at Samaru, Nigeria.

Treatment	Crop vigour score at 9 WAS	
	2000	2001
Variety (V)		
Kanannado	8.6a	7.5a
Sampea 7	7.8b	6.8b
SE ±	0.06	0.13
Crop arrangement (A)		
Alternate row	8.3	7.3
Alternate stand	8.1	7.0
SE ±	0.06	0.13
Period of weed interference (P)		
Weed free till 3WAS[1]	8.8bc	7.5b
Weed free till 6WAS	9.6ab	8.7a
Weed free till 9WAS	9.8a	9.0a
Weed free till 12WAS	9.8a	9.0a
Weed free till harvest	9.8a	9.0a
Weed Infested till 3WAS	9.5a	9.0a
Weed infested till 6WAS	9.3b	7.6b
Weed infested till 9WAS	9.3b	6.7c
Weed infested till 12WAS	9.3b	6.7c
Weed infested till harvest	9.0c	6.7c
SE ±	0.10	0.23
Interaction		
V x A	NS[2]	NS
V x P	NS	NS
A x P	NS	NS
V x A x P	NS	NS

[a] Crop vigour score using a scale 0-10, where 0 = completely dead plants and 10 = Very healthy and vigorously growing plants.
Means followed by the same letter(s) within a column of any treatment group are not significantly different at 5% level of probability using DMRT,
1. WAS = Weeks after sowing.
2. NS = Not significant.

Table-4. Effect of variety crop arrangement and period of weed interference on plant height of maize grown in mixture at Samaru, Nigeria.

Treatment	**Plant height 9WAS** (cm)	
	2000	**2001**
Variety (V)		
Kanannado	111.5	121.3
Sampea 7	109.6	107.2
SE ±	2.15	6.19
Crop arrangement (A)		
Alternate row	111.5	120.4
Alternate stand	109.8	108.1
SE ±	2.15	6.19
Period of weed interference (P)		
Weed free till 3WAS[1]	109.3	130.5b
Weed free till 6WAS	113.7	137.0ab
Weed free till 9WAS	112.1	154.1a
Weed free till 12WAS	112.2	155.5a
Weed free till harvest	112.8	157.1a
Weed Infested till 3WAS	113.9	122.8c
Weed infested till 6WAS	114.1	112.5d
Weed infested till 9WAS	104.8	75.4e
Weed infested till 12WAS	106.1	76.8e
Weed infested till harvest	107.5	78.4e
SE ±	3.43	9.78
Interaction		
V x A	NS[2]	NS
V x P	NS	NS
A x P	NS	NS
V x A x P	NS	NS

Means followed by the same letter(s) within a column of any treatment group are not significantly different at 5% level of probability using DMRT,
1. WAS = Weeks after sowing
2. NS = Not significant

Table-5. Effects of variety, crop arrangement and period of weed interference on the grain yield of maize grown in mixture at Samaru, Nigeria.

Treatment	**Grain yield** (kg ha^{-1})	
	2000	**2001**
Variety (V)		
Kanannado	750a	916a
Sampea 7	592b	551a
SE ±	24.5	45.0
Crop arrangement (A)		
Alternate row	724a	764
Alternate stand	618b	702
SE ±	24.5	45.0
Period of weed interference (P)		
Weed free till 3WAS[1]	415c	300c
Weed free till 6WAS	572b	423b
Weed free till 9WAS	636a	445b
Weed free till 12WAS	658a	477b
Weed free till harvest	744a	652a
Weed Infested till 3WAS	661a	538a
Weed infested till 6WAS	553b	390b
Weed infested till 9WAS	422c	383b
Weed infested till 12WAS	349c	313c
Weed infested till harvest	321c	240c
SE ±	35.6	39.8
Interaction		
V x A	NS[2]	NS
V x P	NS	NS
A x P	NS	NS
V x A x P	NS	NS

Means followed by the same letter(s) within a column of any treatment group are not significantly different at 5% level of probability using DMRT,

1. WAS = Weeks after sowing
2. NS = Not significant

Table-6. Effects of variety crop arrangement and period of weed interference on 100-grain weight of maize grown in mixture at Samaru, Nigeria.

Treatment	**100 - grain weight** (g)	
	2000	**2001**
Variety (V)		
Kanannado	28.00a	28.3a
Sampea 7	23.0b	22.0b
SE ±	0.32	0.34
Crop arrangement (A)		
Alternate row	25.3	25.1
Alternate stand	25.4	25.5
SE ±	0.32	0.34
Period of weed interference (P)		
Weed free till 3WAS[1]	20.2b	19.0b
Weed free till 6WAS	21.7ab	21.6a
Weed free till 9WAS	21.7ab	20.6ab
Weed free till 12WAS	22.7a	21.6a
Weed free till harvest	22.7a	21.2a
Weed Infested till 3WAS	21.4ab	21.1a
Weed infested till 6WAS	20.8ab	21.2a
Weed infested till 9WAS	21.1ab	20.3ab
Weed infested till 12WAS	20.0b	16.3b
Weed infested till harvest	19.7c	15.4b
SE ±	4.1	4.0
Interaction		
V x A	NS[2]	NS
V x P	NS	NS
A x P	NS	NS
V x A x P	NS	NS

Means followed by the same letter(s) within a column of any treatment group are not significantly different at 5% level of probability using DMRT,

1. WAS = Weeks after sowing
2. NS = Not significant