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Growth and yield in maize/cassava intercrop as affected by interactions of weed control methods

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Abstract

The response of food crops to integrated weed management involving the used of pre-emergence herbicides, hoe-weeding and live mulch of herbaceous cover plants in a maize/cassava intercrop was investigated at the Teaching and Research Farm of the University of Ilorin between 2002 and 2004. The experiment consisted of eight main treatments and six sub treatments. The main treatments were made of the application of two of pre-emergence herbicides (Primextra and Galex each at 2.5kg a.i./ha alone, or with one or two supplementary hoe-weeding at 6 weeks after planting (WAP) or 6 and 12WAP), a hoe-weeded check (hoeing at 3, 6 and 12WAP) and a weedy control. The sub treatments consisted of five legume cover crops (*Pueraria phaseoloides*, *Stylosanthes guianesis*, *Mucuna pruriens* var. *utilis*, *Mucuna preta* and *Mucuna jaspeada*) and a no legume cover plot as control. Data were collected for the vegetative and reproductive parameters for both crops. Results showed that the various treatment combinations supported good vegetative growth in maize except at 9WAP where plots treated with Galex alone under the mucuna species produced significantly shorter plants as in weedy plots. However, cassava plant height was significantly higher in plots with 3 hoe-weeding under *S. guianensis* cover and Galex + 2HW without legume (NL) cover at 12 and 16WAP respectively, compared to other treatment combimnations. Maize grain yield was significantly higher in the treatment combination involving Primextra with two hoe-weeding under *M. pruriens* var. *utilis* cover for both years while average cassava fresh tuber yield was significantly higher in the combination involving Primextra with two hoe-weeding under *Pueraria Phaseoloides*. Maize grain yield and cassava fresh tuber yield in treatment combinations of the two pre-emergence herbicides alone under the various cover crops produced yields that were not significantly different from what was obtained in weedy plots.

Keywords: maize, cassava, intercrop, interaction, yield, primextra, galex, cover crops

Introduction

In Nigeria and in many other developing nations, intercrop has remained the traditional farming practice. It is a wide spread food crop production system in the humid and sub humid tropics of West Africa (Akobundu 1980; Anuebunwa 1991, Ande et al., 2008). Cassava-based cropping systems are more prevalent because cassava is one of the most important food crops widely grown in several countries in sub Saharan Africa (Ayoola amd Makinde 2008) as it provides employment, income and food for farm families (Ugwu and Ukpabi 2002). Maize on the other hand is the principal cereal crop associated with cassava in the humid tropics due to efficient utilization of resources (Amanulla et al., 2006a). The use of Integrated weed management has been indentified a viable weed control method in smallholder farms (Akobundu 1992, 1996) as it can lead to sustainable food production among other advantages (Chikoye et al., 2004). Integrated weed management involves the combination of two or more weed control practices at lower inputs. A lower corn yield has been reported where mucuna (Velvetbean) was intercropped with corn or cassava (Chikoye et al., 2002), however, a higher maize grain yield has been reported under integrated weed management (Chikoye et al., 2004, 2005) while cassava yield was best in simultaneous cropping with *Pueraria* (IITA, 1997). Little is known about the interactions of weed control practices on the growth and yield of maize and cassava in an intercrop in southern Guinea savanna ecology of Nigeria. The objective of this study, therefore, was to assess the response of maize and cassava in an intercrop to different treatment combinations emanating from the use of two pre-emergence herbicides with or without hoe-weeding under five legume cover plants.

Materials and methods

Experimental site

This study was carried out at the Teaching and research Farm of the University of Ilorin, (8º29´N; 4º35´E) Ilorin, Kwara State, in the southern Guinea savanna ecological zone of Nigerian, between 2002 and 2004. Rainfall distribution pattern of the farm is bimodal; with the first major peak between May and mid-August while the second minor peak is between September and mid-November. The average annual rainfall for Ilorin is 1000-1200mm.

Table 1. Interaction between weed control treatments and legume cover crops on maize plant height (cm) at 9WAP in 2004 at Ilorin, Nigeria

Weed control Treatments	Legume cover crops					
	Puero	Stylo	Mpru	Mpre	Mjas	NL
Primextra	111.9a	98.4a	97.3a	104.5a	62.7b	93.4a
Prim + 1Hw	99.3a	112.9a	117.8a	89.3a	93.8a	107.1a
Prim + 2Hw	102.2a	119.2a	129.3a	100.8a	94.4a	122.0a
Galex	96.2a	102.1a	70.2b	73.6b	50.4b	92.2a
Galex + 1Hw	95.5a	111.8a	100.0a	105.3a	112.5a	123.1a
Galex + 2Hw	81.4a	127.8a	110.8a	78.7b	108.9a	104.5a
3Hw	99.6a	113.2a	116.3a	90.0a	112.6a	91.0a
Weedy	78.0a	40.8b	96.7a	69.1b	84.5a	44.8b

Means bearing the same letter(s) are not significantly different from each other at p=0.05.
Prim = Primextra; Puero = *Pueraria* phaseoloides; Stylo = S*tylosanthes guianensis*; Mpru = *Mucuna pruriens* var. *utilis*; Mpre = *Mucuna preta*; Mjas =*Mucuna jaspeada*; WAP = Weeks after planting; HW= Hoe-weeding

Table 2. Interaction between weed control treatments and legume cover crops on maize plant height (cm) at 12WAP in 2004 at Ilorin, Nigeria

Weed control Treatments	Legume cover crops					
	Puero	Stylo	Mpru	Mpre	Mjas	NL
Primextra	136.2ab	119.3ab	109.3ab	129.5ab	119.0ab	122.0ab
Prim + 1Hw	100.7b	122.8ab	120.2ab	128.0ab	120.5ab	140.0ab
Prim + 2Hw	112.4ab	136.2ab	122.5ab	135.7ab	121.0ab	123.3ab
Galex	123.5ab	109.8ab	106.0ab	122.1ab	100.8ab	110.3ab
Galex + 1Hw	100.5b	115.2ab	112.3ab	120.2ab	135.0ab	159.5a
Galex + 2Hw	96.5b	141.6ab	121.3ab	104.8b	137.0ab	134.3ab
3Hw	107.8ab	125.1ab	138.7ab	113.0ab	129.5ab	131.9ab
Weedy	110.8ab	79.5b	114.5ab	81.5b	115.8ab	109.5ab

Means bearing the same letter(s) are not significantly different from each other at p=0.05. Prim =Primextra; Puero=*Pueraria phaseoloides*; Stylo=S*tylosanthes guianensis*; Mpru=*Mucuna pruriens* var. *utilis*; Mpre=*Mucuna preta*; Mjas=*Mucuna jaspeada*; WAP=Weeks after planting; HW=Hoe-weeding

Table 3. Interaction between weed control treatments and legume cover crops on maize leaf area (cm^2) at 12WAP in 2004 at Ilorin, Nigeria

Weed control Treatments	Legume cover crops					
	Puero	Stylo	Mpru	Mpre	Mjas	NL
Primextra	2506abc	2060abcd	2035abcd	2468abcd	2775abc	2275abcd
Prim + 1Hw	1634abcd	2379abcd	1764abcd	1629abcd	1417c	2916abc
Prim + 2Hw	1903abcd	2129abcd	1444bc	2303abcd	1703abcd	3502abc
Galex	2362abcd	1298c	1694abc	2030abcd	1715abcd	1584abcd
Galex 1Hw	1634abcd	2000abcd	1701abcd	1923abcd	1716abcd	3764ab
Galex 2Hw	927c	3901a	1467abc	1383c	1748abcd	2398abcd
3Hw	1925abcd	2036abcd	2408abcd	2192abcd	2423abcd	2637abc
Weedy	2520abc	571c	1248c	1360c	1750abcd	1379c

Means bearing the same letter(s) are not significantly different from each other at p=0.05.
Prim=Primextra; Puero=*Pueraria phaseoloides*; Stylo=S*tylosanthes guianensis*; Mpru=*Mucuna pruriens* var. *utilis*; Mpre=*Mucuna preta*; Mjas=*Mucuna jaspeada*; WAP=Weeks after planting; HW=Hoe-weeding

Experimental design and treatment

The experiments were designed as randomized complete blocks with a criss-cross arrangement. There were two factors made up of eight weed management as main treatments and six cover crop treatments subplot. Each treatment was replicated three times. The main plot size was 36m × 7.8m while the subplot size was 6m × 7.8m in all the trials. Each subplot was made up of 6 ridges, approximately 1.3m apart, and 6m long. The experimental plots were ridged on 12 July, in 2002 and 22 June 2004. Maize (var. DMRY) and two of the legume cover crops (*P. phaseoloides and S. guianensis*) were planted on 19 July, 2002 and on 24 – 25 June in 2004 while cassava (local var. "Okoyawo") was planted between 16 and 17 August in 2002 and 26 – 29 June in 2004. The herbicide treatments were applied as pre-emergence sprays at the rate of 2.5kg

Table 4. Interaction between weed control treatments and legume cover crops on maize grain yield (kg/ha) in 2002 at Ilorin, Nigeria

Weed control Treatments	Maize grain yield (kg/ha)					
	Puero	Stylo	Mpru	Mpre	Mjas	NL
Prim	636abcdef	839abcde	956abcde	598abcdef	897abcde	865abcde
Prim + 1Hw	1007abcd	759abcde	844abcde	956abcde	780abcde	524cdef
Prim + 2Hw	1170ab	988abcd	1213a	926abcde	1111abc	887abcde
Galex	865abcde	752abcde	785abcde	561bcde	422def	630abcdef
Galex + 1Hw	962abcde	1132ab	497cdef	824abcde	502cdef	1181ab
Galex + 2Hw	694abcdef	1058abcd	978abcd	684abcdef	946abcde	1084abc
3Hw	984abcd	662abcdef	978abcd	686abcdef	1031abcd	892abcde
Weedy	102f	288ef	326ef	80f	192ef	438def

Means bearing the same letter(s) are not significantly different from each other at p=0.05.
Prim = Primextra; Puero=*Pueraria phaseoloides*; Stylo=S*tylosanthes, guianensis*; Mpru=*Mucuna pruriens* var. *utilis*; Mpre=*Mucuna preta*; Mjas=*Mucuna jaspeada*; WAP=Weeks after planting; HW=Hoe-weeding

Table 5. Interaction between weed control treatments and legume cover crops on maize grain yield (kg/ha) in 2004 at Ilorin, Nigeria

Weed control Treatments	Maize grain yield (kg/ha)					
	Puero	Stylo	Mpru	Mpre	Mjas	NL
Primextra	759bc	449bc	449bc	951ab	278bc	465bc
Prim + 1Hw	1058abcd	588bc	1239ab	1383ab	839bc	684bc
Prim + 2Hw	876bc	1218ab	1688a	897ab	1501ab	1143ab
Galex	630bc	572bc	151c	577bc	118c	636bc
Galex + 1Hw	903ab	721bc	401bc	994ab	417bc	801bc
Galex + 2Hw	801bc	865bc	1079ab	951ab	972ab	983ab
3Hw	908ab	727bc	1058ab	951ab	1058ab	598bc
Weedy	128c	108c	1084ab	182c	1186ab	183c

Means bearing the same letter(s) are not significantly different from each other at p=0.05.
Prim=Primextra; Puero=*Pueraria phaseoloides*; Stylo=S*tylosanthes, guianensis*; Mpru=*Mucuna pruriens* var.*utilis*; Mpre=*Mucuna preta*; Mjas=*Mucuna jaspeada*; WAP=Weeks after planting; HW=Hoe-weeding

Table 6. Interaction between weed control treatments and legume cover crops on average (2002 and 2004) grain yield (kg/ha) at Ilorin, Nigeria

Weed control Treatments	Average grain yield (kg/ha)					
	Puero	Stylo	Mpru	Mpre	Mjas	NL
Primextra	697cdef	644cdefg	702cdef	775bcdef	588defg	665cdef
Prim + 1Hw	1033abcd	675cdef	1042abcd	1170abc	809bcdef	604cdefg
Prim + 2Hw	1023abcd	1103abcd	1450a	917bcde	1306ab	1015abcd
Galex	748cdef	662cdef	468efg	569defg	270fg	633cdefg
Galex + 1Hw	932bcde	927bcde	449efg	909bcde	459efg	991bcd
Galex + 2Hw	748cdef	962bcde	1028abcd	817bcdef	959bcde	1034abcd
3Hw	796bcdef	694cdef	1018abcd	799bcdef	1044abcd	745cdef
Weedy	115g	198g	705cdef	131g	689cdef	310fg

Means bearing the same letter(s) are not significantly different from each other at p=0.05.
Prim= Primextra; Puero=*Pueraria phaseoloides*; Stylo=S*tylosanthes, guianensis*; Mpru=*Mucuna pruriens* var.*utilis*; Mpre=*Mucuna preta*; Mjas=*Mucuna jaspeada*; WAP=Weeks after planting; HW=Hoe-weeding

a.i /ha a day after planting of maize, *P. phaseoloides* and *S. guianensis*, using a CP3 sprayer, fitted with a green deflector nozzle, which was calibrated to deliver a spray volume of 240l/ha. *Mucuna pruriens* var. *utilis* , *M. preta* and *M. jaspeada* were planted 4 weeks after planting (WAP) of maize in 2002 and maize and cassava in 2004 between 16 and 18 July in 2002 and 23 July in 2004. The fertilizer N. P K. 20 : 10 : 10 was applied to maize only at the rate of 40kg N, 20kg P_2O_5 and 20kg K_2O per hectare in a single dose by side placement at 6WAP in 2002 and 3WAP in 2004. Plots treated with the pre-emergence herbicides plus one hoe-weeding were weeded 6WAP after herbicides application while those with the same pre-emergence herbicide treatments plus two hoe-weeding were weeded at 6 and 12 weeks after herbicide application. Hoe-weeded plots were weeded at 3, 6 and 12WAP of maize.

Table 7. Interaction between weed control treatments and legume cover crops on cassava plant height (cm) at 12WAP in 2004 at Ilorin, Nigeria

Weed Control Treatments	Legume cover crops					
	Puero	Stylo	Mpru	Mpre	Mjas	NL
Primextra	36.50bc	39.33bc	40.10bc	34.77bc	26.50bc	42.83bc
Prim + 1Hw	43.00bc	79.33ab	58.17ab	44.33bc	58.67ab	67.00ab
Prim + 2Hw	40.17bc	75.50ab	60.00ab	36.33bc	56.17b	79.33ab
Galex	28.57bc	41.50bc	25.33c	26.93bc	31.67bc	54.50bc
Galex + 1Hw	32.67bc	40.17bc	35.33bc	42.17bc	44.33bc	63.67ab
Galex + 2Hw	46.67bc	59.83ab	47.00bc	45.33bc	45.50bc	73.00ab
3Hw	49.77bc	87.00a	52.90bc	51.33bc	44.50bc	54.47bc
Weedy	23.00c	37.33bc	47.00bc	28.50bc	55.67c	40.17bc

Means bearing the same letter(s) are not significantly different from each other at p=0.05.
Prim= Primextra; Puero=*Pueraria phaseoloides*; Stylo=S*tylosanthes, guianensis*;
Mpru=*Mucuna pruriens* var.*utilis*; Mpre=*Mucuna preta*; Mjas=*Mucuna jaspeada*;
WAP=Weeks after planting; HW=Hoe-weeding

Table 8. Interaction between weed control treatments and legume cover crops on cassava plant height (cm) at 16WAP in 2004 at Ilorin, Nigeria

Weed Control Treatments	Legume cover crops					
	Puero	Stylo	Mpru	Mpre	Mjas	NL
Primextra	56.7bc	52.5bc	65.3bc	52.7bc	59.7bc	55.0bc
Prim + 1Hw	78.5bc	108.5ab	60.7bc	66.3bc	80.3b	103.8ab
Prim + 2Hw	70.5bc	110.3ab	88.3ab	82.8ab	104.5ab	113.3ab
Galex	40.0c	82.8ab	42.0c	40.3c	33.5c	91.3ab
Galex + 1Hw	72.2bc	104.7ab	64.0bc	59.4bc	84.7ab	100.8ab
Galex + 2Hw	76.3bc	102.7ab	83.0ab	63.0bc	77.3ab	122.5a
3Hw	77.2bc	106.3ab	72.3bc	84.3ab	87.7ab	88.0ab
Weedy	30.3c	34.3bc	67.5bc	39.0c	55.5bc	41.3c

Means bearing the same letter(s) are not significantly different from each other at p=0.05.
Prim= Primextra; Puero=*Pueraria phaseoloides*; Stylo=S*tylosanthes, guianensis*;
Mpru=*Mucuna pruriens* var.*utilis*; Mpre=*Mucuna preta*; Mjas=*Mucuna jaspeada*;
WAP=Weeks after planting; HW=Hoe-weeding

Data collection and statistical analysis

Maize plant height and biomass were assessed at 3, 6 and 9WAP in 2002 and at 3, 6, 9 and 12WAP in 2004 while maize leaf area was assessed at 6 and 9WAP in 2002 and at 3, 6, 9 and12WAP in 2004.. Cassava plant height and number of leaves were determined at 8, 12, 16 and 20WAP in 2002 and at 8, 12, 16, 20, 36WAP and at cassava harvest in 2004. Maize cobs were harvest at 17WAP in 2002 and at 21WAP in 2004 due to labour constrain while cassava fresh tubers were harvested at 11 months after planting (MAP) in both years. All data collected were subjected to analyses of variance using criss-cross models by GENSTAT package. Significant means were separated by Duncan's Multiple Range Test at 5% probability level.

Results

The results showed that plant height was essentially similar in all the plots except at 9WAP where plots treated with Primextra alone with *M. jaspeada* as cover crop (62.7cm), Galex alone with *M. pruriens* (70.2cm), *M. preta* (73.6cm) and *M. jaspeada* (50.4cm); Galex + 2HW with *M. preta* (78.7cm), weedy plots with *M. preta* (69.1cm) and NL (no-legume) cover (44.8cm) that had maize seedlings which were significantly shorter than those in plots with other treatment combinations (Table 1). Similarly, plots treated with Prim + 1HW, Galex + 1HW and Galex + 2HW, each with *P. phaseoloides* as a cover crop; Galex + 2HW with *M. pruriens* cover; weedy plots with *S. guianensis* and *M. preta* covers follow the same trend at 12WAP (Table 2). Maize plants in plots treated with Galex + 2HW + *S. guianensis* had the highest leaf area (3901cm²) at 12WAP in 2004 which was significantly higher than what was obtained in the other treatment combinations. The effect of integrated weed management on maize biomass was not significant in all the sampling periods in both years. The best grain yield was obtained in the treatment combinations of Prim + 2HW+ *M. pruriens var utilis* (1213 kg/ha and 1688 kg/ha) in 2002 and 2004 respectively (Tables 4 and 5) which also reflected on the average grain yield (1450 kg/ha) (Table 6). This was significantly higher than what was obtained in plots treated with Galex alone + *M. pruriens var. utilis* and *M. jaspeada*. In both years, the number of leaves in cassava was not affected by the interaction between weed control treatments and legume cover crops while cassava plant height was only significant in 2004 at 12 and 16WAP. Plants in the hoe- weeded plots + *S. guianensis* cover at 12WAP (Table 7) and those in the Galex + 2HW plots + NL cover at 16WAP had taller plants

Table 9. Interaction between weed control treatments and legume cover crops on cassava fresh tuber yield (kg/ha) in 2002 at Ilorin, Nigeria

Weed Control Treatments	Legume cover crops					
	Puero	Stylo	Mpru	Mpre	Mjas	NL
Primextra	2975bcd	523bcd	476cd	4386bcd	1241bcd	1538bcd
Prim + 1Hw	5203bcd	2078bcd	2073bcd	8841ab	3429bcd	2650bcd
Prim + 2Hw	12484a	3365bcd	6425ab	12403a	9444ab	5304bcd
Galex	3729bcd	1891bcd	1192bcd	3643bcd	1739bcd	283cd
Galex + 1Hw	7372abc	903cd	3325bcd	7955ab	6632abcd	1849bcd
Galex + 2Hw	9802ab	1791bcd	2078bcd	12788a	7458abc	5935bcd
3Hw	8638ab	3307bcd	5097bcd	12703a	5588bcd	5862bcd
Weedy	987cd	978cd	668cd	3328bcd	630cd	43d

Means bearing the same letter(s) are not significantly different from each other at p=0.05.
Prim= Primextra; Puero=*Pueraria phaseoloides*; Stylo=S*tylosanthes, guianensis*;
Mpru=*Mucuna pruriens* var.*utilis*; Mpre=*Mucuna preta*; Mjas=*Mucuna jaspeada*;
WAP=Weeks after planting; HW=Hoe-weeding

Table 10. Interaction of weed control treatments and legume cover crops on average (2002 and 2004) tuber yield (kg/ha) at Ilorin, Nigeria

Weed Control Treatments	Legume cover crops					
	Puero	Stylo	Mpru	Mpre	Mjas	NL
Primextra	2249g	1501g	511g	2652g	1359g	2532g
Prim + 1Hw	6068de	5114defg	3590fg	8280abcde	4482efg	7260bcde
Prim + 2Hw	11933a	7329abcde	9126abcd	1159g	10886abc	9297abcd
Galex	2099g	4199efg	783g	3635fg	1179g	3555fg
Galex + 1Hw	7532abcde	6717bcde	4424efg	8067abcde	6964bcde	5545defg
Galex + 2Hw	10339abc	6488cdefg	4062eg	11447a	7084bcde	9751abcd
3Hw	9333abcde	7481abcde	5876defg	11345ab	6491bcde	7931abcde
Weedy	649g	521g	2113g	2278g	2436g	556g

Means bearing the same letter(s) are not significantly different from each other at p=0.05.
Prim= Primextra; Puero=*Pueraria phaseoloides*; Stylo=S*tylosanthes, guianensis*;
Mpru=*Mucuna pruriens* var.*utilis*; Mpre=*Mucuna preta*; Mjas=*Mucuna jaspeada*;
WAP=Weeks after planting; HW=Hoe-weeding

than those in the other treatment combinations (Table 8). The interaction between weed control and legume cover treatments in 2002 resulted in similar cassava fresh tuber yields, in plots treated with Prim + 2HW + *P. phaseoloides* and *M. preta* covers (12,484 and 12, 403 kg/ha, respectively) and Galex + 2HW and the hoe –weeded plots, both with *M. preta* (12,788 and 12,703 kg/ha, respectively) (Table 9). Plots treated with Prim + 2HW + *P. phaseoloides* recorded the highest cassava tuber yield (11, 933 kg/ha) for both years and this was significantly different from the yields obtained from other treatment combinations except in plots treated with Galex + 2HW+ *M. preta*. (Table 10).

Discussion

The various treatment combinations used in this study supported good vegetative growth in maize except at 9WAP in plots treated with Galex alone with *M. pruriens, M. preta* and *M, jaspeada* covers where significantly shorter plants were produced as in weedy control with S. guianensis, *M. preta* and NL plots in 2004. This may be attributed to high competition as a result of aggressive climbing habit of the mucuna species. The treatment combinations involving Primextra and *M. pruriens* var. *utilis* with hoe-weeding two times gave significantly higher grain yield in both years compared to the other treatment combinations. The same trend was observed by Chikoye et al., (2004). The effect of the interactions of the various weed control practices used in this study resulted in lower cassava plant height except at 12 and 16WAP where plots with 3 hoe-weeding + *S. guianensis* and Galex +2HW without legume cover respectively, produced significantly higher plant height than others. This shows that the treatment combinations involving the cover crops reduced cassava plant height contrary to what was observed in maize. This result is expected as the cover crops competed with cassava for a longer period of time than maize, all the cover crops except *M. preta* remained in the plots for 24WAP before total senescence. This effect was however overcome by the cassava plants as the average fresh tuber yield was significantly higher in plots treated with Prim +2HW + *P. phaseoloides*. An increase in cassava tuber yield had already been reported with simultaneous cropping of *P. phaseoloides* with cassava (IITA, 1997). The interactive effects of the pre-emergence herbicides without supplementary hoe-weeding with the various legume cover crops produced cassava tubers that were not significantly different from what was obtained in weedy plots. This shows that these treatment combinations were not adequate

for weed suppression for a long season crop as cassava hence low yield.

Conclusion

From this study, the use of the pre-emergence herbicides alone at the rate used under the different legume cover crops produced crop yields that were not significantly different from the weedy plots. However, maize yield in plots treated with Prim+ 2HW+ *M. pruriens* (1450 kg/ha) and cassava yield in plots treated with Prim+ 2HW+ *P. phaseoloides* (11,933 kg/ha) were higher than those obtained from the hoe-weeded control plots under the corresponding legume covers (1018 kg/ha and 9,333 kg/ha, respectively). These treatment combinations are agronomically feasible and farmers can adopt such in the production of maize and cassava in an intercrop in southern Guinea savanna ecology of Nigeria.

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