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Full Length Research Paper

Performance of semi-determinate and indeterminate cowpeas relay-cropped into maize in Northeast Nigeria

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Field trials were conducted in 2005 and 2006 in Tilla (northern Guinea savanna) and Sabon-Gari (Sudan savanna) in northeast Nigeria to determine the performance of two improved cowpea varieties when relay-intercropped with early and late maize, 6 and 8 weeks after planting the maize. Grain yield, number of branches and number of pods per plant were higher for the variety IT89KD-288 than for IT97K-499-35, whether planted sole or relay-intercropped with maize. Grain yield was lower for IT97K-499-35 than for IT89KD-288 when relay-intercropped with maize irrespective of the maturity period of the companion maize crop. This may be due to the indeterminate growth habit and shade tolerance of IT89KD-288 which allowed a higher pod load than IT97K-499-35. However, relay-intercropping with early maize gave higher yield than relay-intercropping into late maize. Also relay-intercropping at 6 weeks after planting maize (WAP) gave a higher yield than relay-intercropping at 8 WAP. This therefore, suggests that introducing cowpea into short statured early maize may mean less competition for light and soil resources compared to taller late maize. Also introducing the cowpea earlier may allow the crop to make full use of soil moisture during the cropping season.

Key words: Cowpea, maize, grain, relay-intercropping, savanna, northeast Nigeria.

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp.) is an important food legume and an integral part of traditional cropping systems in the semi-arid regions of the tropics (Singh et al., 2003). It is used for food and animal feed and improves soil fertility, thus it has become very valuable in areas where land use has become intensified. Cowpea has outstanding features: drought tolerance, shade tolerance, quick growth, and rapid provision of ground cover (Singh et al., 1997). These characteristics have made cowpea an important component of subsistence agriculture in the dry savannas of the sub-Saharan Africa where it is grown as a companion crop with cereals and other food crops (Singh et al., 2003). In the semi-arid zone of West Africa, cowpea is grown both as sole crop and in mixed crop production systems (Blade et al., 1997). Although sole-cropped cowpea produces higher yields when insecticide spray is used, most farmers traditionally practice mixed cropping (Blade et al., 1997; Singh, et al., 2003). Some studies (Andrews, 1974; Steiner, 1982; Ofori and Stern, 1987) have reported that farmers practice mixed cropping to alleviate the effects of low soil fertility and drought, reduce damage from pests and diseases, and assure higher yield stability.

Over the years, the International Institute of Tropical Agriculture (IITA) has developed diverse high yielding cowpea varieties with contrasting growth habit (Singh et al., 1997). Some of these varieties have been evaluated

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Table 1. Average monthly minimum and maximum temperature (°C) in Sabon-Gari and Tilla in 2005 and 2006.

	Sabon-Gari, 2005		Sabon-Gari, 2006		Tilla, 2005		Tilla, 2006	
	Min	Max	Min	Max	Min	Max	Min	Max
January	-	-	16.50	37.60	-	-	20.23	35.03
February	-	-	17.50	37.30	-	-	20.32	38.07
March	-	-	24.52	36.13	-	-	23.19	36.05
April	-	-	28.87	32.40	-	-	23.23	39.42
May	27.10	39.18	27.80	36.90	-	-	21.06	37.13
June	25.50	35.00	22.92	38.15	25.87	35.61	20.50	36.37
July	24.46	32.91	22.31	36.87	23.90	34.93	20.68	34.23
August	23.27	33.09	21.87	33.87	21.19	37.48	20.32	33.00
September	23.63	34.06	21.68	35.97	22.66	34.60	19.97	33.40
October	23.85	35.93	21.27	38.87	21.80	36.58	20.61	35.81
November	21.80	36.73	16.48	38.62	22.18	34.34	20.13	33.57
December	22.82	36.33	23.28	34.07	21.12	32.77	20.16	38.06

under sole- and inter- cropping systems with millet and sorghum in the Sudan savanna zone of Nigeria (Singh et al., 1997; Singh et al., 2003), no work has been reported on their performance when they are relay-intercropped with maize. Maize production has increased tremendously in the Nigerian savannas because of its high yield potential and the crop is becoming important in the drier savannas, in particular where most of the cowpea grown is intercropped with cereals. Because of labour constraints and land scarcity, farmers prefer to relay-intercrop cowpea between 6 and 8 weeks after planting maize (WAP). When intercropped with maize or other cereals, cowpea yield is reduced by shading (Chang and Shibles, 1985; Fukai and Trenbath, 1993). A differential response by cowpea to shading has been reported due to different growth habits (Isenmilla et al., 1981; Nelson and Robichaux, 1997; Terao et al., 1997). The date of introduction into maize crop may also affect the productivity of cowpea. Thus, date of introduction of cowpea into maize is a management practice that may be manipulated to reduce the effect of shading (Olufajo and Singh, 2002). N'tare (1990) reported that the late introduction of early maturing cowpea varieties into millet reduced the grain yield of cowpea in Niger Republic.

Several cowpea varieties have been developed for the Nigerian savannas but little information exists on the performance of these varieties when relay-intercropped with maize. Since most of the varieties were selected in sole cropping system, there is a need to evaluate their performance in the intercropping system that is predominant in the Nigerian savannas. This paper reports the results of experiments conducted in the Sudan (SS) and northern Guinea savannas (NGS) of northeast Nigeria to evaluate the performance of two popular cowpea varieties with contrasting growth habit and maturity period when relay-intercropped with maize on different dates.

MATERIALS AND METHODS

Site description

Field studies were conducted at two locations, Sabon-Gari (10o 48.40' N 12o 27.88' E 458 m asl) in the SS and Tilla (10o 30.78' N, 12o 03.56' E 749 m asl) in the NGS, in northeast Nigeria during the 2005 and 2006 cropping seasons. The two sites have a unimodal rainfall pattern with annual rainfall mean of 976 mm for Sabon-Gari and 1425 mm for Tilla. Sabon-Gari has a growing period of about 120 days. The soil is loam with 8.3 g kg^{-1} organic carbon, 0.98 g kg^{-1} nitrogen, 4.0 mg kg^{-1} phosphorus, 0.32 Cmol (+) kg^{-1} potassium and a pH of 5.4. Tilla has a growing period of about 150 days. The soil is sandy clay with 9.8 g kg^{-1} organic carbon, 1.7 g kg^{-1} nitrogen, 1.6 mg kg^{-1} phosphorus, 0.51 Cmol (+) kg^{-1} potassium, and a pH of 5.65. The temperature and rainfall during the trial period are given in Table 1 and Figure 1.

Treatments

The experiment was set up as a split-split plot design with the date of cowpea introduction into maize as the main plot, cropping systems as subplot, and cowpea variety as sub-subplot. The cropping systems were cowpea relay-intercropped with early maturing maize (TZE COMP5-W), cowpea relay-intercropped with late maturing maize (97 TZL COMP1-W), with sole cowpea as the control. Two cowpea varieties with contrasting growth habit (IT89KD-288, indeterminate; IT97K-499-35 semi-determinate) were introduced into maize crop 6 and 8 weeks after maize was planted. The two cowpea varieties were also sole-planted at the time of introduction into the maize crop to serve as controls.

Planting and cultural practices

Before the first crop was established, the field was disc-harrowed and ridged. In 2005, maize was planted on 10 July at Sabon-Gari and on 05 July at Tilla. In 2006, maize planting was done on 21 June at Sabon-Gari and on 19 June at Tilla. Three maize seeds were planted on ridges 0.75 m apart at an intra-row spacing of 0.50 m and later thinned to 2 plants per hill to give a population of 53,333 plants ha^{-1}. A mixture of Paraquat (1:1-dimethyl- 4, 4'-bipyridinium dichloride; Manufacturer: Syngenta Crop Protection

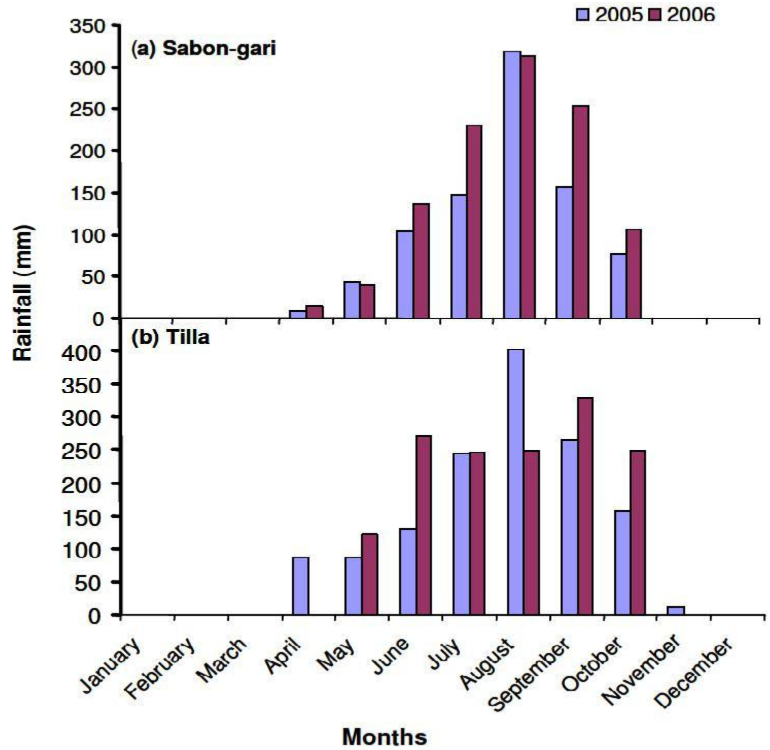

Figure 1. Mean monthly rainfall in Sabon-Gari and Tilla in 2005 and 2006.

Table 2. Dates of introduction of cowpea into maize.

Date of introduction	2005	2006
6 weeks after maize		
Sabon-Gari	21 August	02 August
Tilla	16 August	31 July
8 weeks after maize		
Sabon-Gari	02 September	16 August
Tilla	30 August	14 August

Canada Inc.) at the rate of 276 g a.i.L^{-1} and Primextra (Syngenta Crop Protection Canada Inc.) at the rate 3 L ha-1 was applied as a pre-emergence herbicide to control weeds. Hoe weeding was done at 3 WAP. At planting, fertilizer in the form of NPK 15:15:15 was applied at the rate of 40 kg ha^{-1} to all plots. Nitrogen fertilizer was top dressed in the form of urea at the rate of 60 kg N ha^{-1} at 5 WAP of maize.

Cowpea was planted 6 and 8 weeks after maize (Table 2). Three seeds of cowpea were planted between two hills of maize which is equivalent to 0.50 m between two hills of cowpea. The cowpeas were later thinned to 2 plants per hill to give a population of 53,333 plants per ha. Sole cowpea was planted on ridges 0.75 m apart with intra-row spacing of 0.50 m and two plants per hill to give a cowpea population similar to that of maize. Insect pests of cowpea were controlled by spraying cowpea plants with Best Action (30 g L^{-1} cypermethrin + 250 g L^{-1} dimethoate; Manufacturer: Modern Insecticides Ltd, India)) at the rate of 1L ha^{-1} during floral bud formation, flowering, and podding stages.

Measurements

At harvest five cowpea plants were randomly selected from the two middle rows to determine the number of pods per plant. Branches on the five plants were counted and the total number was divided by five to determine the number of branches per plant. The two central rows were harvested when the first flush of pods were mature and dry. Grain yield was based on all plants that were harvested from the two central rows of each plot and was reported on a 100% dry matter basis.

Data analysis

All data were subjected to an ANOVA using the PROC MIXED procedure (Littell et al., 1996) of SAS (SAS Institute, 1995) with the cowpea variety analyzed as sub-subplot, dates of cowpea introduction as subplot, and cropping systems as main plot. Block was treated as a random effect; dates of cowpea introduction and cowpea varieties were treated as fixed effects in determining the expected mean square and appropriate F test in the analysis of variance. Differences between two treatment means were compared with the t-test based on the SED at 5% level of probability.

RESULTS

Cowpea grain yield

The three-way interactions among the date of introduction of cowpea into maize crop (D), cropping system (C) and variety (V) were significant for cowpea

Table 3. P values for the combined ANOVA for grain yield (kg ha^{-1}), branches plant^{-1}, and pods plant^{-1} of cowpea planted sole and relayed into early and late maturing maize at Sabon-Gari and Tilla in Borno State, northeast Nigeria.

	Grain yield(kg ha^{-1})		Branches plant^{-1}		Pods plant^{-1}	
Effect	**SBG†**	**Tilla**	**SBG**	**Tilla**	**SBG**	**Tilla**
Year (Y)	0.6467	0.0012	0.0001	<.0001	0.0132	0.1867
Cowpea relay date (D)	0.0003	0.2553	0.0315	0.0268	0.0386	0.1398
Y × D	0.5522	<.0001	<.0001	0.7394	<.0001	0.2598
Cropping system (C)	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Y × C	0.0038	0.0011	0.0013	0.0275	0.0429	0.5003
D × C	0.1884	0.4438	0.0067	0.0470	0.6260	0.4130
Y×D×C	0.7671	0.2400	0.0010	0.0094	<.0001	0.2739
Variety (V)	<.0001	<.0001	<.0001	<.0001	<.0001	<.0001
Y × V	0.0003	0.2541	0.0282	0.0684	0.0002	0.1604
D × V	0.0045	0.0214	0.7189	0.1417	0.0171	0.2057
C × V	<.0001	0.2688	0.5661	0.9756	0.5003	0.0646
Y×D×V	0.1961	0.6218	<.0001	0.0513	<.0001	0.0302
Y×C×V	0.0606	0.0009	0.0861	0.0058	0.0952	0.5788
Y×D×C	0.1961	0.6218	<0.0001	0.5136	<0.0001	0.0302
D×C×V	0.0003	0.0912	0.5872	0.6142	0.1576	0.2563
Y×D×C×V	0.0940	0.1282	0.3380	0.6221	0.1338	0.0405

†SBG = Sabon-Gari.

Table 4. Effect of time of cowpea introduction, cropping system and variety on cowpea grain yield (kg ha^{-1}) at Sabon-Gari and Tilla in Borno State, northeast Nigeria.

	6wap			8wap		
Cropping system	**IT89KD-288**	**IT97K-499-35**	**Mean**	**IT89KD-288**	**IT97K-499-35**	**Mean**
Sabon-Gari						
Early maturing maize	1716.4	486.7	1101.5	1162.3	499.6	831.0
Late maturing maize	1301.1	338.0	819.5	986.6	483.0	734.8
Sole cowpea	1325.7	1272.4	1299.1	1340.5	1011.3	1175.9
Mean	1447.7	699.0		1163.1	664.7	
S.E.D(D×C)‡	74.86					
S.E.D (D×V)	60.87					
S.E.D (C × V)	74.86					
S.E.D (D × C × V)	107.17					
Tilla						
Early maturing maize	1266.9	771.9	1019.4	1037.4	867.9	952.7
Late maturing maize	1133.1	449.8	791.5	844.8	510.7	677.7
Sole cowpea	1522.5	1099.8	1311.1	1570.6	1103.6	1337.1
Mean	1307.5	773.8		1150.9	827.4	
S.E.D (D × C)	77.05					
S.E.D (D × V)	63.67					
S.E.D (C × V)	77.98					
S.E.D (D × C × V)	107.62					

‡D = Time of cowpea introduction, C = cropping system, V = variety.

grain yield in Sabon-Gari but not in Tilla (Table 3). At both times of introduction of cowpea into maize crop (6 and 8 WAP), IT89KD-288 produced a higher grain yield than IT97K-499-35 in both locations (Table 4). Grain yield of IT97K-499-35 was higher when sole-cropped than when relay-intercropped into early and late maize at all times of

Table 5. Effect of time of cowpea introduction and cropping system on number of branches plant^{-1} at Sabon-Gari and Tilla in Borno State, northeast Nigeria.

	Sabon-Gari			Tilla		
Cropping system	**6wap**	**8wap**	**Mean**	**6wap**	**8wap**	**Mean**
Early maturing maize	3.9	3.0	3.4	3.3	2.8	3.0
Late maturing maize	3.2	3.1	3.2	3.2	2.3	2.8
Sole cowpea	4.5	3.5	4.0	4.5	4.1	4.3
Mean	3.9	3.2		3.8	2.9	
S.E.D (D) ‡		0.12			0.11	
S.E.D (C)		0.14			0.13	
S.E.D (D × C)		0.20			0.18	

‡D = Time of cowpea introduction, C = cropping system.

planting in both locations. In Sabon-Gari, grain yield of sole-cropped cowpea did not significantly differ between the two varieties when cropped at 6 WAP. The variety IT89KD-288 produced a higher grain yield than IT97K-499-35 when sole-cropped at 8 WAPs.

Grain yield of IT89KD-288 was higher than IT97K-499-35 when introduced into maize at all dates of planting cowpea. When relay-intercropped into early maize at 6 WAP, IT89KD-288 produced a grain yield that was 29% higher than when sole-cropped; when introduced into late maize at 6 WAP, grain yield did not significantly differ from that of sole cropped cowpea. When introduced at 8 WAP, grain yield of IT89KD-288 was reduced by 13% when relayed cropped with early maize and by 26% when relayed into late maize. When introduced at 6 WAP, grain yield of IT97K-499-35 was reduced by 181% when relay-cropped into early maize and by 306% when relay-cropped into late maize. When introduced into maize at 8 WAP, grain yield reduction was 102% when introduced into early maize and 109% when introduced into late maize. In Tilla, sole cropping of both varieties produced the highest yield; IT89KD-288 out-performed IT97K-499-35 in all the cropping systems. Grain yield was more reduced for IT97K-499-35 than for IT89KD-288 when relay-intercropped into maize. Grain yield reductions were also higher when the varieties were relay-intercropped into late maize than into early maize. The introduction of cowpea into maize at 8 WAP also reduced grain yield more than when it was introduced at 6 WAP for IT89KD-288.

Number of branches per plant

Branching in the cowpea varieties was significantly influenced by D, C, and V (Table 3). D × C and Y × D × V interactions were also detected in both locations. Sole cowpea produced the highest number of branches in both locations (Table 5). The number of branches was higher when cowpea was relay-cropped into early maize than into late maize at 6 WAP in Sabon-Gari and at 8 WAP in Tilla (Table 5). In 2005, number of branches was significantly higher for IT89KD-288 than for IT97K-499-35 on all dates of introduction into maize in both locations (Table 6). In 2006, IT89KD-288 also produced a number of branches that was significantly higher than that of IT97K-499-35, except when introduced into maize at 8 WAP when the differences between the two cowpea varieties were not significant.

Number of pods per plant

In Sabo-Gari but not in Tilla (Table 3), D significantly influenced the number of pods per plant while C and V significantly influenced the number of pods per plant in both locations. Y × D × C was significant in Sabon-Gari but not in Tilla. Y × D × V interactions were significant in both locations. In both years, the number of pods per plant was significantly higher in sole-cropped cowpea than in relay-cropped cowpea in Sabon-Gari at all dates of introducing cowpea, except in 2006 when there were no differences between the cropping systems when cowpea was introduced at 8 WAP (Table 7). When introduced at 6 WAP, number of pods per plant was higher in cowpea relay-intercropped into early maize than in cowpea relay-intercropped into late maize. In Tilla, the number of pods per plant was higher in sole-cropped cowpea than in relay-intercropped cowpea in both years. Cowpea relayed into early maize produced a number of pods per plant that did not significantly differ from that of cowpea relay-intercropped into late maize, except in 2005 when cowpea relay-intercropped into late maize at 8 WAP produced a number of pods per plant that was significantly lower than that of cowpea relay-intercropped into early maize. In both years and locations, IT89KD-288 produced a higher number of pods per plant than IT97K-499-35 at all dates of introduction into maize (Table 8). In Sabon Gari, the magnitude of the differences between the varieties was higher in 2006 than in 2005 while in Tilla, the magnitude of differences between the varieties was higher in 2005 than in 2006 when cowpea was relay-intercropped at 6 WAP.

Table 6. Effect of year, time of cowpea introduction and variety on number of branches plant^{-1} at Sabon-Gari and Tilla in Borno State, northeast Nigeria.

	2005			2006		
Cropping system	**6wap**	**8wap**	**Mean**	**6wap**	**8wap**	**Mean**
Sabon-Gari						
IT89KD-288	3.6	4.0	3.8	4.9	3.1	4.0
IT97K-499-35	3.1	2.6	2.9	3.9	3.2	3.6
Mean	3.4	3.3		4.4	3.2	
S.E.D (Y × D)	0.17					
S.E.D (Y × V)	0.17					
S.E.D (D × V)	0.17					
S.E.D (Y × D ×V)	0.24					
Tilla						
IT89KD-288	4.0	3.3	3.6	4.4	3.6	4.0
IT97K-499-35	2.8	2.3	2.5	3.5	3.0	3.3
Mean	3.4	2.8		4.0	3.3	
S.E.D (Y × D)	0.15					
S.E.D (Y ×V)	0.15					
S.E.D (D× V)	0.15					
S.E.D (Y × D × V)	0.20					

Table 7. Effect of year, time of cowpea introduction and cropping system on number of pods plant-1 at Sabon-Gari and Tilla in Borno State, northeast Nigeria

Cropping system	2005			2006		
	6wap	**8wap**	**Mean**	**6wap**	**8wap**	**Mean**
Sabon-Gari						
Early maturing maize	13.2	13.1	13.2	15.1	12.5	13.8
Late maturing maize	12.9	12.8	12.8	11.3	10.1	10.7
Sole cowpea	18.9	24.4	21.6	23.1	12.9	18.0
Mean	15.0	16.8		16.5	11.8	
S.E.D (Y × D)	0.98					
S.E.D (Y ×C)	1.20					
S.E.D (D × C)	1.21					
S.E.D (Y × D × C)	1.72					
Tilla						
Early maturing maize	14.2	14.6	14.4	13.0	11.4	12.2
Late maturing maize	12.3	7.5	9.9	10.7	9.7	10.2
Sole cowpea	20.7	18.3	19.5	17.2	18.9	18.1
Mean	15.7	13.5		13.6	13.3	
S.E.D (Y × D)	1.21					
S.E.D (Y ×C)	1.47					
S.E.D (D ×C)	1.47					
S.E.D (Y × D × C)	2.11					

DISCUSSION

Our results revealed interactions for cowpea grain yield among C, D, and V, suggesting that the cowpea varieties responded differently to C and D. This may be expected, because the cowpea varieties evaluated had different growth habits and responds differently to shade from the companion maize crop. The variety IT89KD-288 produced a higher yield, and more branches and pods than IT97K-499-35 in all cropping systems. This may be due to the fact that IT89KD-288 is late maturing and indeterminate, which means a higher accumulation of

Table 8. Effect of year, time of cowpea introduction and variety on number of pods plant-1 at Sabon-Gari and Tilla in Borno State, northeast Nigeria.

	2005			2006		
Cropping system	**6wap**	**8wap**	**Mean**	**6wap**	**8wap**	**Mean**
Sabon-Gari						
IT89KD-288	17.2	20.4	18.8	24.5	15.1	19.8
IT97K-499-35	12.8	13.1	12.9	8.4	8.6	8.5
Mean	15.0	16.8		16.5	11.8	
S.E.D (Y × D)	0.98					
S.E.D (Y × V)	0.98					
S.E.D (D × V)	0.98					
S.E.D (Y × D ×V)	1.37					
Tilla						
IT89KD-288	20.8	15.6	18.2	15.6	16.1	15.9
IT97K-499-35	10.6	11.4	11.0	11.6	10.5	11.1
Mean	15.7	13.5		13.6	13.3	
S.E.D (Y × D)	1.21					
S.E.D (Y ×V)	1.22					
S.E.D (D × V)	1.22					
S.E.D (Y × D × V)	1.68					

biomass and higher grain yield than IT97K-499-35. The magnitude of differences between the two varieties was higher in the relay-intercrops, suggesting that IT89KD-288 was more tolerant of competition for resources from the companion maize crop. This is also confirmed by the lower grain yield recorded for IT97K-499-35 when intercropped compared to when planted sole. As a semi-determinate cultivar, IT97K-499-35 completes its life-cycle earlier and may not compensate for growth after the maize crop has been harvested. N'tare (1990) reported that intercropping early-maturing determinate cowpea cultivars with millet caused a reduction in cowpea yield in Niger Republic. Our findings are also consistent with those of Wakiti et al. (1993) who reported that cowpea grain yield greatly varied among 15 cultivars when intercropped.

The performance of IT89KD-288 in the relay-intercrops depended on D, Y, and V. When introduced at 6 WAP, it produced a higher grain yield than when introduced at 8 WAP. Late introduction may have reduced grain yield and number of pods because of late season drought. Introducing cowpea into maize at 8 WAP means that cowpea is planted in September. If the rain stops at the end of September like as it did in 2006 in Sabon-Gari, the crop will experience drought stress. Kamara et al. (2010) reported a reduction in yield when cowpea was planted after August in the SS ecology of northern Nigeria. Generally, introducing both cowpea varieties at 6 WAP produced higher yields than introducing them at 8 WAP. This may be due to the availability of sufficient moisture during the growing season for cowpea introduced earlier in the season. Also relay-intercropping cowpea into early maize produced a higher cowpea grain yield than intercropping into late maize. The late maize variety used in this study is taller, leafy and stays green longer in the field, thereby shading out the cowpea introduced. The early maize variety used is shorter, less leafy, and matured before the introduced cowpea started flowering, thereby leaving some time for the cowpea crop to compensate for growth. Similar findings were reported by Santalla et al. (2001) for bush bean in Spain. They reported that intercropping with a leafy type, taller field maize reduced bush bean grain yield by 55%; intercropping with sweet maize reduced grain yield of bush bean by 44%. This suggests careful selection of maize cultivars is required for intercropping with cowpea to optimize the yield of cowpea in the intercrop.

Conclusion

This study showed considerably differences between the cowpea varieties in their performance in the maize relay-intercrops. Although both varieties are currently popularwith farmers in the Nigerian dry savannas, IT89KD-288 is better suited for relay-intercrops because of its superior performance when introduced into maize at all times of introduction. IT89KD-288 is indeterminate, allowing it to produce branches and compensate for growth long after the maize crop has been harvested. Its indeterminate growth habit may make it more tolerant to shade from the companion maize crop. It may also have an extensive root system allowing it to compete better for moisture and nutrients. Further studies would be required to understand the root system of this variety. The following could be recommended from this study:

1. Where farmers want to practice relay-intercropping, IT89KD-288 should be chosen

2. It is preferable to introduce IT89KD-288 into the maize crop at the most 6 WAP. This will allow the cowpea crop to make use of the available moisture throughout the growing season. The cowpea crop will be affected by moisture stress if introduced late

3. When relay-intercropping IT97K-499-35, it should be introduced into maize at 8 WAP

4. Careful selection of the maize variety is necessary for a productive cowpea crop. Early maturing, less leafy maize varieties should be promoted for relay intercropping of cowpea.

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REFERENCES

Andrews DJ (1974). Responses of sorghum varieties to intercropping. Exp. Agric., 10: 57-63.

Blade SF, Shetty SVR, Terao T, Singh BB (1997). Recent developments in cowpea cropping systems research. In: Singh, B.B., Mohan Raj, D.R., Dashiell, K.E., Jackai, L.E.N. (Eds.), Advances in Cowpea Research. Co-publication of International Institute of Tropical Agriculture (IITA) and Japan International Centre for Agricultural Sciences (JIRCSA), IITA, Ibadan, pp. 114-128.

Chang JF, Shibles RM (1985). An analysis of competition between intercropped cowpea and maize: 11. The effect of fertilization and population density. Field Crops Res., 12: 145-152.

Fukai S, Trenbath BR (1993). Processes determining intercrop productivity and yields of component crops. Field Crops Res., 34: 247-271.

Isenmilla AE, Babalola O, Obigbesan GO (1981). Varietal influence of intercropped cowpea on the growth, yield, and water relations of maize. Plant and Soil, 62: 153-156.

Kamara AY, Ekeleme F, Chikoye D, Omoigui LO, Dugje IY (2010) Integrating planting date with insecticide spraying regimes to manage insect pests of cowpea. Int. J. Pest Manage., (In Press).

Littell RC, Milliken GA, Stroup WW, Wolfinger WW (1996). SAS system for mixed models. SAS Inst. Cary, NC, USA.

N'tare BR (1990). Intercropping morphologically different cowpea with pearl millet in a short season environment in the Sahel. Exp. Agric., 26: 41-47.

Nelson SC, Robichaux RH (1997). Identifying plant architectural traits associated with yield under intercropping: implication of genotype-cropping system interactions. Plant Breed., 16, 163-170.

Ofori F, Stern WR (1987). Cereal-legume intercropping systems. Adv. Agron., 41: 41-90.

Olufajo OO, Singh BB (2002). Advances in cowpea cropping systems research. In: Fatokun, C.A., Tarawali, S.A., Singh, B.B., Kormawa, P.M., M. Tamo (eds.), Challenges and opportunities for enhancing sustainable cowpea production. Proceedings of the World Cowpea Conference 111 held at the International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria, 4-8 September 2000. IITA, Ibadan, Nigeria.

Santalla M, Rodino AP, Casquero PA, de Ron AM (2001). Interactions of bush bean intercropped with field and sweet maize. Eur. J. Agron., 15: 185-196.

Steiner KG (1982). Intercropping in tropical smallholder agriculture with special reference to West Africa. Deutsche Gesellschaft fur Technische Zusammenarbit (GTZ) GmbH, No.137, Eschborn, Germany, p. 303.

SAS Institute (1995). SAS user's guide: Statistics. 6th ed. SAS Inst., Cary, NC, USA.

Singh BB, Cambliss OL, Sharma B (1997). Recent advances in cowpea breeding. In: Singh, B.B., Mohan Raj, D.R., Dashiell, K. E., Jackai, L.E.N. (Eds.), Advances in Cowpea Research. Co-publication of International Institute of Tropical Agriculture (IITA) and Japan International Centre for Agricultural Sciences (JIRCSA), IITA, Ibadan, pp. 30-49.

Singh BB, Ajeigbe HA, Tarawali SA, Fernandez-Rivera S, Musa A (2003). Improving the production and utilization of cowpea as food and fodder. Field Crops Res., 84: 169-177.

Terao T, Watanabe I, Matsunaga R, Hakoyama S, Singh BB (1997). Agro-physiological constraints in intercropped cowpea: an analysis. In: Singh, B.B., Mohan Raj, D.R., Dashiel, K.E., Jackai, L.E.N., (eds), Advances in cowpea research. Copublication of International Institute of Tropical Agriculture (IITA) and Japan International Research Center for Agricultural Sciences (JIRCAS). IITA, Ibadan, Nigeria, pp 129-140.

Wakiti JM, Fukai S, Banda JA, Keating BA (1993). Radiation interception and growth of maize/cowpea intercrop as affected by maize plant density and cowpea cultivar. Field Crops Res., 35: 123-133.