Short Communication

Cowpea response to planting date under different maize maturity types in West African Sudan savannah

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Abstract

Intercropping is the traditional cropping system of the West African Sudan savannah with low system productivity. Timely growing together of adapted and compatible cowpea and maize cultivars is a potential way to improve the low productivity of the system. A two-year field experiment was conducted at Minjibir in Sudan savannah of Nigeria to determine the performance of medium and late maturing cowpea cultivars intercropped with extra-early and early maize cultivars at four and six weeks after maize. Early intercropping of cowpea with extra-early maize improved grain yield of cowpea (early maize, 405 kg ha^{-1} vs extra - early maize, 621 kg ha^{-1}). Improved yield was also achieved with early intercropping of late maturing cowpea with maize (medium cowpea, 302 kg ha^{-1} vs late cowpea, 723 kg ha^{-1}). Grain yield and crop value were maximized (884 kg ha^{-1} , \$2411 ha^{-1} , respectively) with early intercropping of late maturing cowpea with extra-early maize. Therefore, late maturing cowpea can be recommended for intercropping with extra-early maize at four weeks after maize or less for maximum intercrop productivity.

Key words: Cowpea; Maize; Intercrop; Grain yield; Planting date; Sudan savannah

Cereals and cowpea (*Vigna unguiculata* (l.) walp.) are important crops traditionally grown as intercrops in the savannahs of West Africa (NAERLS and NPAFS, 2010). In recent years, with the availability of earlier maturing cultivars, maize (*Zea mays* L.) is fast expanding to the Sudan savannah where the short rainy season had adversely affected maize cultivation in the past (IITA, 2009).

Intercropping cowpea with maize has a major weakness of very low cowpea yield (Olufajo and Singh, 2002). Cowpea farmers in the dry savannah areas of sub-Saharan Africa obtain low yields, estimated at about 350 kg per hectare (Olufajo and Singh, 2002; IITA, 2009). A major reason for the low productivity of cowpea in intercropping systems is shading from the taller cereal plants (Olufajo and Singh, 2002). However, intercropping would become more productive if the effect of shading was reduced especially when combined with the use of fertilizers and pesticides.

Timely planting and adapted cultivars are potential ways to reduce the negative shading effect of cereal on cowpea (Olufajo and Singh, 2002). It affects the extent to which plants of component crops can reach their yield potential (Singh and Ajeigbe, 2002; Kamara et al., 2011). Availability of improved cowpea cultivars that are tolerant to shade and that can match improved maize cultivars that are suitable for intercropping has high prospects to increase the grain yield of cowpea and maize in the cropping

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system. With the availability of a number of improved maize and cowpea cultivars with varying growth habits (IITA, 2009), there is need to identify improved genotypes of both crops that are suitable, compatible and adapted to intercropping. Occurrence of a strong cowpea cultivar × maize cultivar interaction can lead to the identification of specific cowpea cultivar plant type that is compatible with certain maize cultivar of distinct maturity group that can be recommended for the mixed cropping system of the region. Therefore, a study was undertaken to assess the effect of planting date of cowpea and growing of new maize cultivars of different maturity on yield and yield components of improved cowpea cultivars in a maize-cowpea intercrop in a Sudan savannah environment.

The experiment was conducted during the rainy seasons (June–November) of 2008 and 2009 at the Research Farm of IITA, Minjibir (Lat 12° 08'N, Long 08° 32'E, elevation 500 m asl). Minjibir is in the Sudan savannah and has an average annual rainfall of 690 mm and a growing period of about 120 days; soils are classified as typic Utipsamments and are loamy sands. Prior to the establishment of the field trial in 2008, the soil had 82% sand, 8% silt, 10% clay, 0.23% organic carbon, 0.02% total nitrogen, 15.57 ug g^{-1} Mehlich phosphorus, 0.13 cmol kg^{-1} potassium, and a pH (H_2O)1:1 of 5.4. In 2009, the soil of the experimental site (not same plot as previous) was 83% sand, 8% silt and 10% clay with organic carbon of 0.32%, 0.025% total nitrogen, 21.13 ug g^{-1} Mehlich phosphorus, 0.39 cmol kg^{-1} potassium, and a pH (H_2O)1:1 of 5.9. Mean air temperatures (minimum and maximum) during the growing season for both years were 23 and 32°C respectively. Rainfall for the period was 697.8 in 2008 and 757.4 in 2009.

Two maize cultivars- 2000-SYN-EE (extra-early maturing, 80-90 days and *Striga* tolerant) and TZE-COMP.5-W (early maturing, 90-100 days and *Striga* tolerant) and cowpea cultivars IT89KD-391 (medium maturing, semi-determinate and semi-spreading) and IT99K-241-2 (late maturing, indeterminate and spreading), developed at IITA (IITA, 2009) were evaluated in this study (Table 1). The treatments were planting date of cowpea, maize maturity type as well as cowpea cultivar. Sole crop of each cowpea cultivar was added for comparison. Sole crop of maize was however, not included in the trial. This was due to the fact that the effect of maize maturity type on cowpea was more of interest than the effect of cowpea on maize. The experiment was set in a randomized complete block design having the treatments arranged as a split-split-plot factorial. Planting dates of cowpea constituted the main plot treatment while maize maturity type was the subplot and cowpea cultivars the sub-subplots. The experiment had four replications and a sub-subplot measured 3.0 m × 5.0 m.

Maize seeds were planted on 24 June and 01 July in 2008 and 2009 respectively (Table 1) at a spacing of 75 cm between ridges and 50 cm apart on a ridge. Cowpea seeds were planted as a sole crop or an intercrop four and six weeks relative to the time maize was planted. Two hills of cowpea spaced 25 cm apart were maintained between two hills of maize in a ridge with each hill containing two plants; this spacing was also maintained in the sole cowpea. Nitrogen, phosphorus and potassium were applied at a rate of 50 kg N, P and K ha^{-1}, respectively, at

Table 1. Planting and maturity dates of intercropped maize and cowpea.

	Planting date				Maturity date					
	Maize		Cowpea				IT89KD-391		IT99K-241-2	
Year	Extra-early maize	Early maize	4 WAPM	6 WAPM	Extra- early maize	Early maize	4 WAPM	6 WAPM	4 WAPM	6 WAPM
2008	24-Jun	24-Jun	22-Jul	05-Aug	6-Sep	28-Sep	15-Oct	29-Oct	26-Oct	09-Nov
2009	01-Jul	01-Jul	29-Jul	12-Aug	23-Sep	05-Oct	22-Oct	05-Nov	02-Nov	16-Nov

WAPM, weeks after planting maize

the time of planting maize. A second dose of nitrogen was applied at a rate of 50 kg N ha^{-1} three weeks after planting maize. For cowpea, 30 kg P ha^{-1} were applied at the time of planting cowpea. Data were collected from the net plot. At maturity, grain yield was determined. For cowpea, days from planting to the growth stage when 50% of the plants in a plot and when 95% of the pods reached maturity were measured. At pod maturity, number of peduncles m^{-2} and number of pods m^{-2} were assessed. Grain yield and fodder yield were determined. Value of production was calculated for both crops using the expression as described by Ewansiha et al. (2014a). Combined statistical analysis for two years was performed using SAS for Windows (SAS Institute, 2011). The SAS procedure used for the ANOVA was mixed model. Differences between two treatment means were compared using LSD at 5% level of probability as calculated by LSMEANS statement of PROC MIXED code of SAS with option pdiff.

Results of the main effects of cowpea planting date, maize maturity type and cowpea cultivar on cowpea performance are summarized in Table 2. Number of peduncles m^{-2}, number of pods m^{-2}, fodder yield and grain yield of cowpea were significantly influenced ($p \leq 0.01$) by these factors. Performance of cowpea was higher when cowpea was planted at four than at six weeks after planting maize in these traits. Cowpea intercropped with extra-early maize had significantly higher number of peduncles m^{-2}, number of pods m^{-2}, fodder yield and grain yield compared with when intercropped with early maize. The performance of sole cowpea in these traits was significantly higher than intercropped cowpea. The late-maturing cowpea cultivar IT99K-241-2 had higher number of peduncles m^{-2}, number of pods m^{-2}, fodder yield and grain yield compared with the medium maturing IT89KD-391

Table 2. Effect of year, cowpea planting date, maize maturity type and cowpea cultivar on grain yield of maize and yield and yield components of cowpea at Minjibir in Nigerian Sudan savannah.

Treatments	Maize grain yield (kg ha^{-1})	Peduncles (no. m^{-2})	Pods (no. m^{-2})	Cowpea fodder yield (kg ha^{-1})	Cowpea grain yield (kg ha^{-1})
Year (Y) 2008	3577.2b	19.5b	24.8a	1481.1b	627.3a
Year (Y) 2009	4683.5a	28.9a	25.4a	1866.2a	529.7b
Cowpea planting date (D)					
4 weeks after planting maize	4168.5a	31.4a	31.6a	2207.9a	768.7a
6 weeks after planting maize	4092.3a	16.9b	18.5b	1139.4b	388.3b
Maize maturity type (M)					
Extra-early maize	4086.8a	19.9b	21.9b	1255.9b	440.4b
Early maize	4173.9a	12.9c	15.1c	799.8c	294.6c
Sole cowpea	-	39.8a	38.3a	2965.3a	1000.4a
Cowpea cultivar (V)					
IT89KD-391	3950.2b	20.3b	23.5b	1053.4b	508.8b
IT99K-241-2	4310.5a	28.0a	26.7a	2293.9a	648.2a
Interaction					
Y × D	0.7823	0.6831	0.8592	0.0079	0.369
Y × M	0.3148	<.0001	0.0004	<.0001	<.0001
D × M	0.3212	<.0001	0.0254	<.0001	<.0001
Y × D × M	0.0544	0.3563	0.0452	0.0017	0.0012
Y × V	0.1453	0.2245	0.0037	0.0053	0.0072
D × V	0.0135	0.9808	0.428	<.0001	0.5463
Y × D × V	0.243	0.2018	0.4858	0.0007	0.0705
M × V	0.5976	0.3296	<.0001	<.0001	<.0001
Y × M × V	0.6937	0.3185	0.4278	0.5103	0.002
D × M × V	0.0343	0.937	<.0001	0.4585	<.0001

Means in the same column with different letters indicate significant difference ($LSD_{0.05}$)

There were various significant interactions among the factors for the attributes studied (Table 2). A notable three-way interaction among cowpea planting date, maize maturity type and cowpea cultivar for grain yield showed that at both planting dates, grain yield was significantly reduced by intercropping. Intercropped with extra-early maize at four weeks after planting maize, IT99K-241-2 had superior performance than IT89KD-391. At this time, however, grain yield was higher for IT89KD-391 than IT99K-241-2 in sole crop. In intercrop with extra-early maize and in sole crop at six weeks after planting maize, grain yield was higher for IT99K-241-2 than IT89KD-391; both cultivars had similar performance when intercropped with early maize. Grain yield reduced more with early maize than extra-early maize. Similar trend was observed for the other interactions.

Crop values of intercropped maize plus cowpea and those of sole cowpea are summarized in Table 3. When cowpea was intercropped with maize at four weeks after planting maize, mean crop value of maize plus cowpea for extra-early maize and early maize was 128% and 110% higher than that obtained in sole cowpea, respectively. When cowpea was intercropped with maize at six weeks after planting maize, mean crop value of maize plus cowpea for extra-early maize and early maize was 242% and 255% higher than that obtained in sole cowpea, respectively. Generally, mean crop values were higher when cowpea was intercropped with maize at four than at six weeks after planting maize. The significant interactions between planting date and maize maturity type and between planting date and cowpea cultivar for various traits indicate that planting date of cowpea affected the competitive ability of cultivars of both crops in the intercrop. The superior performance of cowpea under extra-early maize at both planting dates of cowpea may be due to less competition for growth resources from the maize cultivar compared with early maize. Similarly, the superior performance of IT99K-241-2 when planted at both dates may be due to higher competitive ability of the late maturing cowpea cultivar over IT89KD-391. The reduction in performance in both cowpea cultivars when intercropped at six weeks after planting maize coupled with the larger variation between the two cowpea cultivars when intercropped with maize at four weeks after planting maize may indicate that the cowpea cultivars are more tolerant of competition for resources when intercropped with maize at four weeks after planting maize. This may be due to the more available moisture and higher reception of light at critical growth stages when the foliage of the maize plants has not yet closed. Alternatively, the lower performance of cowpea may be attributed to more severe shading and competition for growth resources when cowpea was intercropped with maize at six weeks after planting maize. At this time, the companion maize already had closer canopy and well-developed stem and root systems for stronger competition for resources (Singh and Ajeigbe, 2002; Ewansiha et al, 2014a).

Table 3. Mean crop values of maize-cowpea intercrops and sole cowpea over two years at Minjibir in Nigerian Sudan savannah.

Cowpea planting date	Maize maturity type	Maize + cowpea		
		IT89KD-391	IT99K-241-2	Mean
		US Dollar ($) equivalent ha^{-1}		
4 weeks after planting maize	Extra-early maize	2145.3	2411.1	2278.2
	Early maize	1906.7	2274.8	2090.7
	Sole cowpea	1178.4	816.6	997.5
6 weeks after planting maize	Extra-early maize	1669.6	2134.6	1902.1
	Early maize	1851.4	2091	1971.2
	Sole cowpea	505	606.4	555.7

Mean price kg^{-1} for maize = $0.43, for IT89KD-391 = $0.80 and for IT99K-241-2 = $0.75. Exchange rate of one US dollar ($) to one hundred and fifty Nigerian naira (₦) was used.

Delayed planting may also have reduced performance of cowpea because of reduction in the length of the crop growth cycle and available water in the soil.

The significant interactions that occurred between maize maturity type and cowpea cultivar for number of pods, fodder yield and grain production, suggest that cowpea cultivars respond differently to maize cultivars for these traits. In relation to sole cropping, reduction in number of peduncles, number of pods, fodder production and grain yield was more when cowpea was intercropped with early maize compared with extra-early maize and was less for IT99K-241-2 compared with IT89KD-391. This may be an indication that IT99K-241-2 was more tolerant of intercropping conditions than IT89KD-391 and that extra-early maize and IT99K-241-2 were more compatible in intercrop. Earlier maturity of extra-early maize plus the greater growth and later maturity of IT99K-241-2 may have given the advantage of reduced competition, exposure to more light and higher yielding. Kamara et al. (2011) and Ewansiha et al. (2014b) reported that intercropping cowpea with extra early or early maize cultivar produced a higher grain yield of cowpea than intercropping with late maize cultivar. Santalla et al. (2001) found that grain yield of bush bean was reduced more when intercropped with a leafy type, taller field maize compared with when intercropped with shorter sweet maize. Thus, these findings suggest that for maximum yield in intercrop, late maturing and indeterminate cowpea cultivars should be intercropped with extra early maize cultivars.

Crop values indicate that it would be more profitable to intercrop late maturing cowpea with extra early maize. It would also be more profitable growing either intercropped cowpea or sole cowpea at four weeks after planting maize than at six weeks after planting maize in a growing season. Cowpea cultivar IT89KD-391 may be preferred as a sole crop and IT99K-241-2 as an intercrop when planted at four weeks after planting maize. Nonetheless, planting IT99K-241-2 at six weeks after planting maize may be more profitable than IT89KD-391 when grown sole.

It can be concluded that intercropping late-maturing cowpea with extra-early maize would improve the overall productivity of the cropping system. Intercropping cowpea with maize, however, reduced the number of peduncles, number of pods, fodder yield and grain yield of cowpea due to competition from the maize plants. The degree of reduction depended on planting date of cowpea, maize maturity type and cowpea cultivar. Extra-early maize was more compatible with IT99K-241-2 for more peduncles and pods as well as higher fodder and grain yields. Grain yield and crop value were highest when IT99K-241-2 was intercropped with extra-early maize at four weeks after planting maize. Therefore, IT99K-241-2, a late and indeterminate cowpea can be recommended for intercropping with extra-early maize at four weeks after planting maize or less for maximum intercrop yields.

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