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GROWTH AND DEVELOPMENT OF COMPONENTS OF SORGHUM/COWPEA INTERCROP IN NORTHERN NIGERIA

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ABSTRACT

The objective of the study was to evaluate the growth and dry matter production of components of sorghum/cowpea intercrop at Kano, Nigeria. The treatments consisted of thirty cowpea genotypes differing in maturity periods and growth habits which were intercropped with local sorghum in 1:1 or single alternate row arrangement. The results revealed that plant height, number of days to maturity and dry matter of sorghum was not affected by cowpea genotype. The percent plant count after emergence and at harvest of the genotypes was not affected by sorghum intercropping; the mean values were 91% and 86%, respectively. The early maturing genotypes flowered (36-39 days) and matured (70-75 days) earlier than the medium genotypes which took (36-39 days) and (70-75 days) to flower and mature, respectively. The late maturing genotypes took longer time to flower (42-81 days) and some matured in 79-80 days while Kanannado and IT95K-1133-2 which flowered, did not attain maturity due possibly to insect damage. Generally the early maturing genotypes had narrower canopy spread (65-97 cm) than the medium and late maturing genotypes most of which were at par with IT96D-738 having the widest width (165 cm). Plant height of cowpea was not affected by cowpea genotype. Medium maturing genotypes IT96D-740 recorded the highest dry matter but which was at par with few other medium and late maturing genotypes while lower values were recorded by the early maturing group.

Keywords: sorghum, cowpea, intercropping, genotypes, dry matter, production, Nigeria.

INTRODUCTION

Cowpea is important as a food crop throughout West Africa and especially in the Sudan savanna (Singh and Ntare, 1985). Nigeria is the world's largest producer of cowpea, and substantial amounts come from Niger, Burkina Faso and Ghana (Craufurd *et al.*, 1996). In Nigeria, cowpea grains form an important source of cheap vegetable, containing approximately 25% protein (Oyenuga, 1959). It is cultivated for both food and fodder (Singh *et al.*, 1997). According to Henriet *et al.*, (1997) and van EK *et al.*, (1997) the bulk of cowpea production in the Sudan savanna is produced under intercropping with millet and sorghum. Previous studies had shown that improving the productivity of millet/cowpea intercrop lies in improving the performance of the cowpea component which include among others the choice of appropriate genotype (Willey, 1979; Ntare, 1989 and Reddy and Oumara, 1985).

Currently, improved varieties of cowpea have been developed by the International Institute of Tropical Agriculture (IITA). These varieties are superior to the local cultivars in many respects (high yielding, resistant to major pest and diseases, earlier maturity, etc) (Singh, 1997). However, with the predominance of intercropping, increasing attention is being given to developing cultivars that can fit well into the systems. Therefore, this study was undertaken to evaluate improve cowpea genotypes for intercropping with millet.

The objective of the present experiment was to evaluate the growth of some newly developed cowpea genotypes under intercropping with sorghum in the Sudan savanna of Nigeria. Such study would provide better understanding of the physiological basis for yield variation among genotypes.

MATERIALS AND METHODS

The investigation was conducted in 1998 at the Institute of Agricultural Research/International Institute of Tropical Agriculture Research Farm, Minjibir located in the Sudan savanna ecological zone of Nigeria (lat. 12^0 08'N, long. 8^0 32'E, 500m above sea level). The rainfall pattern is mono-modal with an average annual amount (1961-1990) of 690mm (Craufurd and Wheeler, 1999). Rainfall and weather data during the growing season are presented in Table-1. The treatments consisted of twenty-seven improved and three local genotypes of cowpea. Using Randomized Complete Block Design (RCBD), the thirty genotypes were planted in single alternate rows of sorghum and replicated three times.

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Table-1. Mean monthly weather data for Minjibir in 1998 cropping seasons.

Month	Rainfall (mm)	Temperature ^oC		Relative Humidity %		Solar radiation MJ M^{-2}	Wind speed km/hr
		Max	Min	Max	Min		
April	4.3	39.6	25.0	42	10	24.3	3.7
May	42.4	36.5	24.7	75	31	22.0	6.5
June	163.3	35.5	24.9	78	41	23.8	6.7
July	242.6	31.2	22.1	86	58	20.9	5.9
Aug	256.3	30.0	21.9	91	62	18.7	4.2
Sept	189.4	33.0	22.5	82	45	21.4	3.2
Oct.	22.8	35.6	19.5	59	23	22.0	3.0
Nov.	0.0	34.2	14.2	41	10	22.0	3.2
Total/ Average	921.1	34.4	21.9	69.3	35.0	21.9	4.6

The land was ploughed, harrowed and ridged (0.75m apart) after the rains have established. The plot sizes consisted of 4 ridges, 75cm apart, 5m long ($15m^2$) for gross area and two 2 ridges 5 m long for the net area. Sorghum was sown on 20^{th} June 1998 at the spacing of 75cm x 50cm while the cowpea was planted on 27 June 1998 at the spacing of 75 cm x 20 cm. At first weeding both sorghum and cowpea were each thinned to 2 plants/stand to obtain the sole plots plant populations of 53,333 and 133,333, respectively. Sole plots of both crops were established for the determination of Land Equivalent Ratio (LER). The intercrop plant population was a replacement series made up of 50:50 proportions of the sole cereal and cowpea populations in each intercrop combination. Each plot received a basal application of 30 kg N, 13 kg P and 24.3 kg K/ha as urea, single superphosphate and muriate of potash, respectively at land preparation. The sorghum plants were top-dressed at 5 weeks after planting with 30 kg N/ha in form of urea.

Cowpea plants were not sprayed against insect pests. Weeding was accomplished using hand hoes at 3 and 6 weeks after cereal planting. For sorghum data on number of days to maturity; plant height and dry matter per plant at 18 weeks after sowing (WAS). The data for cowpea included plant count at establishment and harvest; number of days to flower, attain 50 % flowering and maturity; plant height at 12 WAS; canopy spread or width, number of branches and dry matter per plant at 12 WAS. For each variable, mean of three plants was recorded. The data was analyzed using SAS (SAS, 1988) following the procedure described by Snedecor and Cochran (1967) and means of treatments were separated using DMRT (Duncan, 1955).

RESULTS

The results of the physical and chemical analysis of the soil of the experimental site (Table-1) indicated that the soil is sandy loam, slightly acidic pH 5.3, with low organic carbon (0.18%), available phosphorus (9.63 ppm), total nitrogen (0.04) and CEC of 4.2 meq/100g. Records of weather data recorded during the season (Table-2) showed that a total of 921.1 mm of rainfall was received. Mean maximum and minimum temperatures were 34.4 and 21.9^0C, respectively; mean values for maximum and minimum relative humidity were 69.3% and 35.0%; solar radiation interception was 21.9 MJ M^{-2} and wind speed of 4.6km/hr.

Table-2. Physico-chemical properties of the soil of the experimental site.

Texture	Sandy loam
pH (1:2.5)	
H_2O	6.10
Cacl	5.30
Organic carbon (%)	0.18
Total nitrogen	0.04
Available phosphorus	9.63
Cation exchange capacity (CEC)	4.2

The plant height, plant dry matter and number of days to maturity were not significantly affected by cowpea intercropping (Table-3). Cowpea genotype did not have significant effect on plant count after emergence and at harvest (Table-4). Cowpea genotype had significant effect on number of days to first flowering, 50% flowering and maturity of cowpea intercropped with sorghum (Table-4). The early maturing genotypes IT95K-719-3, IT93K-437-1, IT95K-410-1, IT96D-612, IT93K-596-9-12, IT94K-440-3, IT94K-410-2 and IT93K-513-2 as well as the medium maturing genotypes IT90K-277-2, IT96D-651 and IT89KD-349 required significantly shorter time (35-40 days) to flower than the medium maturing (IT96D-759, IT96D-740 and IT96D-757) and late maturing (IT95K-1133-2 and Kanannado) genotypes.

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Table-3. Growth of sorghum intercropped with cowpea genotypes at Minjibir, 1998.

Cowpea genotype	Number of days to maturity	Plant height (cm)	Plant dry weight (g)
Early maturing			
IT95K-719-3	123.0	320.6	289.6
IT93K-437-1	123.3	255.6	289.0
IT94K-410-1	123.3	329.3	293.4
IT96D-612	123.0	322.6	290.0
IT93K-596-9-12	123.0	330.6	289.0
IT94K-440-3	124.3	327.6	291.3
IT94K-410-2	124.3	313.6	289.0
IT93K-513-2	124.3	319.0	289.1
Medium maturing			
IT95K-1091-3	123.6	303.3	288.1
IT96D-666	123.0	329.0	289.0
IT90K-277-2	123.3	331.3	288.1
IT96D-772	123.3	339.0	289.5
IT93K-734	123.0	336.3	291.3
IT96D-759	123.3	342.0	290.2
IT95K-222-14	123.3	312.3	289.9
IT96D-738	123.3	351.6	289.3
IT96D-757	123.6	316.6	289.3
IT96D-740	123.3	294.3	290.3
DANILA	123.0	330.6	288.9
IT96D-684	123.0	297.3	289.3
IT95K-52-34	124.0	310.0	289.6
IT96D-602	124.0	300.6	287.9
IT94K-2058-14	124.0	281.3	292.1
IT96D-651	123.6	301.3	288.5
IT89KD-349	124.00	272.3	289.4
Late maturing			
ALOKA	124.0	304.3	290.0
KANANNADO	123.3	334.0	289.2
IT95K-1133-2	123.3	341.0	290.2
IT89KD-288	123.6	325.5	289.3
IT94K-2052-3	123.3	340.0	290.0
SE ±	0.36	21.8	7.5

Means followed by the same letter (s) within treatment are not significantly different at 5% using Duncan Multiple Range Test.

Table-4. Effect of cowpea genotype on percent plant count number of days to first flower, 50% flowering and maturity of cowpea intercropped with sorghum at Minjibir, 1998.

Cowpea genotype	Percent plant count		Number of days to		
	after sowing	at harvest	first flower	50% flower*	maturity*
Early maturing					
IT95K-719-3	93.3	83.0	36.7^{lm}	43.7^{jk}	73.0^{e-h}
IT93K-437-1	92.3	88.6	37.0^{klm}	44.0^{ijk}	69.7^{h}
IT94K-410-1	81.6	79.0	36.3^{lm}	43.3^{k}	72.7^{fgh}
IT96D-612	91.6	84.3	38.7^{i-m}	45.0^{g-k}	74.7^{d-h}
IT93K-596-9-12	87.3	76.0	36.7^{lm}	43.3^{k}	72.0^{gh}
IT94K-440-3	99.3	97.3	35.7^{m}	42.7^{k}	72.0^{gh}
IT94K-410-2	86.0	81.6	36.3^{lm}	43.0^{k}	72.3^{fgh}
IT93K-513-2	89.6	80.0	36.7^{lm}	43.3^{k}	69.7^{h}
Medium maturing					
IT95K-1091-3	83.0	87.0	44.0^{e-h}	51.0^{def}	76.7^{b-g}
IT96D-666	92.0	79.0	44.3^{e-h}	52.3^{de}	74.7^{d-h}
IT90K-277-2	87.3	75.3	39.7^{g-m}	46.3^{f-j}	75.7^{c-g}
IT96D-772	100.0	91.6	42.7^{e-j}	50.0^{d-g}	77.7^{b-f}
IT93K-734	91.0	91.0	41.3^{f-l}	48.7^{e-i}	72.7^{fgh}
IT96D-759	92.6	81.6	50.3bc	57.7^{abc}	81.7^{ab}
IT95K-222-14	95.0	87.6	42.7^{e-j}	50.0^{d-g}	74.7^{d-h}
IT96D-738	92.0	89.0	45.7^{c-f}	52.7^{de}	76.7^{b-g}
IT96D-757	91.6	81.0	53.3^{b}	60.7^{a}	83.3^{a}
IT96D-740	87.0	81.3	49.7^{bcd}	58.0^{ab}	83.3^{a}
DANILA	92.6	83.3	43.3^{e-i}	50.7^{def}	78.7^{a-d}
IT96D-684	81.6	76.6	47.3^{cde}	56.3^{bcd}	78.3^{a-e}
IT95K-52-34	88.3	79.0	42.0^{f-k}	49.0^{d-i}	77.0^{b-g}
IT96D-602	89.0	80.6	44.7^{efg}	51.7^{de}	77.0^{b-g}
IT94K-2058-14	90.3	83.6	45.3^{def}	53.0^{cde}	79.0^{a-d}
IT96D-651	85.0	80.3	38.0^{j-m}	44.7^{h-k}	72.7^{fgh}
IT89KD-349	88.3	82.0	39.3^{h-m}	48.7^{e-i}	75.3^{c-g}
Late maturing					
ALOKA	92.0	82.6	42.3^{e-j}	49.3^{d-h}	78.7^{a-d}
KANANNADO	93.3	91.3	80.7^{a}	3.0^{l}	3.0^{i}
IT95K-1133-2	90.6	81.6	82.0^{a}	3.0^{l}	3.0^{i}
IT89KD-288	82.0	79.3	42.0^{f-k}	50.7^{def}	80.3^{abc}
IT94K-2052-3	95.0	90.3	42.0^{f-k}	50.7^{def}	80.3^{abc}
SE $\pm$	4.30	4.20	1.30	1.23	1.77

Means followed by the same letter (s) within treatment are not significantly different at 5% using Duncan Multiple Range Test.
* Data was transformed by adding +3 to all values.

The early maturing non photosensitive genotypes IT95K-719-3, IT93K-437-1, IT95K-410-1, IT96D-612, IT93K-596-9-12, IT94K-440-3, IT94K-410-2 and medium maturing IT96D-651 reached 50% flowering significantly earlier (40-42days) than the other genotypes which required 43-58 days to attain 50% flowering.

The early maturing photosensitive genotypes (IT93K-437-1, IT95K-410-1, IT94K-440-3, IT94K-410-2, IT93K-513-2, IT95K-719-3, IT93K-734, IT96D-612, and IT93K-596-9-12 and medium maturing genotype (IT96D-651, IT96D-666 and IT95K-222-14) matured earlier (66-71 days) than the other genotypes which were similar except IT96D-740 and IT96D-757 which took significantly longer (80 days) time to mature.

Across the maturity groups, the percent plant count after emergence and at harvest ranges between 81.6 to 100% and 75.3 to 97.3%, respectively. Cowpea genotype had significant effect on canopy spread of cowpea intercropped with sorghum (Table-5). Medium maturing genotype IT96-738 had the highest (165cm) canopy spread but which was statistically similar with the other medium maturing genotypes except IT96D-757,

IT96D-684, IT96D-602 and IT96D-651 which recorded between 66 and 85 cm. Within the late maturing group, only IT94K-2052-3 produced narrower canopy spread while the others recorded values statistically comparable to the highest value recorded. By and large, the early maturing genotypes produced narrow canopy width (65-97cm).

Table-5. Effect of cowpea genotype on canopy spread, number of branches/plant, plant height and plant dry weight of cowpea intercropped with sorghum at Minjibir, 1998.

	Canopy spread (cm)	**Number of branches/plant**	**Plant height @12 WAS** (cm)	**Plant dry weight** (g) **@ 12 WAS**
Early maturing				
IT95K-719-3	74.0[fgh]	9.50[a-e]	63.7	43.2[f]
IT93K-437-1	75.0[fgh]	6.67[cde]	44.0	44.3[f]
IT94K-410-1	76.6[e-h]	8.33[a-e]	64.7	54.4[cde]
IT96D-612	65.3[h]	6.50[cde]	62.0	44.4[f]
IT93K-596-9-12	69.7[gh]	8.00[a-e]	60.0	50.4[e]
IT94K-440-3	93.7[c-h]	6.33[cde]	69.3	44.3[f]
IT94K-410-2	96.5[b-h]	8.50[a-e]	56.0	51.2[e]
IT93K-513-2	77.2[e-h]	7.00[cde]	56.0	43.0[f]
Medium maturing				
IT95K-1091-3	146.7[abc]	6.5[cde]	53.3	55.4[cd]
IT96D-666	132.7[a-g]	10.5[b]	73.3	60.6[b]
IT90K-277-2	101.0[a-h]	10.7[a-d]	66.0	55.5[cd]
IT96D-772	102.0[a-h]	9.0[a-e]	54.3	57.5[bc]
IT93K-734	130.3[a-h]	9.5[a-e]	62.6	54.4[cde]
IT96D-759	102.7[a-h]	7.7[b-e]	69.0	45.4[f]
IT95K-222-14	108.7[a-h]	5.3[e]	60.0	60.4[ab]
IT96D-738	165.0[a]	8.7[a-e]	65.0	54.1[cde]
IT96D-757	84.7[d-h]	9.7[a-e]	57.3	54.5[cde]
IT96D-740	151.7[ab]	9.0[a-e]	46.3	65.2[a]
DANILA	160.7[ab]	9.6[a-e]	45.3	55.4[cd]
IT96D-684	86.3[c-h]	8.8[a-e]	44.6	55.0[cd]
IT95K-52-34	106.7[a-h]	8.3[a-e]	66.6	55.4[cd]
IT96D-602	66.6[h]	8.0[a-e]	71.6	58.5[bc]
IT94K-2058-14	144.7[a-d]	7.3[b-e]	65.3	55.2[cd]
IT96D-651	65.8[h]	6.0[de]	66.6	52.7[cde]
IT89KD-349	136.1[a-f]	11.5[a]	59.0	65.9[a]
Late maturing				
ALOKA	122.7[a-h]	9.7[a-e]	50.0	62.1[ab]
KANANNADO	140.3[a-e]	10.7[a-d]	51.3	60.2[b]
IT95K-1133-2	144.3[a-d]	12.9[a]	52.6	55.9[cd]
IT89KD-288	145.0[a-d]	8.8[a-e]	62.6	60.3[b]
IT94K-2052-3	87.6[c-h]	10.7[a-d]	63.6	62.2[ab]
SE $\pm$	19.08	1.27	6.56	1.38

Means followed by the same letter (s) within treatment are not significantly different at 5% using Duncan Multiple Range Test.

Number of branches of cowpea intercropped with sorghum was significantly influenced by cowpea genotype (Table-5). Late maturing genotypes IT94K-2052-3 had the highest number of branches which was at par with the other late maturing genotypes except 288, and with all the medium maturing genotypes except IT95K-1091-3, IT96D-759, IT95K-222-14, IT94K-2058-14 and IT96D-651. Plant height of intercropped cowpea was not significantly affected by cowpea genotype (Table-6). The results revealed that the effect of cowpea genotype was significant on cowpea dry weight (Table-6). Medium maturing genotypes IT96D-740 recorded the highest dry matter which was statistically at par with Aloka and IT94K-2052-3 both of which are late maturing genotypes. Generally, the late maturing genotypes recorded superior mean values followed by the medium and then the early maturing genotypes.

DISCUSSIONS

Plant height, dry matter and number of days maturity of sorghum were not affected cowpea intercropping. These results are in agreement with several others which indicated that the growth of intercropped tall canopy cereals such as sorghum, are little affected by intercropping with legumes (Andrews, 1972 Singh, 1997 and Francis *et al.*, 1975). This has been why rural farmers have resisted adoption of improved varieties of sorghum in spite of their high grain yielding potential (but low fodder). Furthermore, crop-livestock integration is a popular practice in the Sudan savanna and thus farmers will want varieties capable producing sufficient dry matter (fodder) for their animals. In the present trial local variety of sorghum was used which matures in 125 days while the intercropped cowpea genotypes matured between 67 and 80 days. Thus the wide temporal separation in maturity periods of the component crops largely due to the slow growth rate of the local sorghum would have minimize competition for growth resources between them (Francis, 1994). Furthermore, local varieties of sorghum have been reported to exhibit adaptation to intercropping with cowpea (Henriet *et al.*, 1997).

Cowpea genotypes had no significant effect on percent plant count of intercropped cowpea after emergence and at harvest. This could be associated with the fact that the genotypes were bred under the same soil and climatic conditions the trial was conducted, hence adapted to the environment. Singh (1997) had earlier reported that most of the genotypes developed by IITA have moderate tolerance to major pests and diseases of cowpea. The percent plant count after emergence (84.6 to 100%) and at harvest (75.3 to 97.3) recorded by the genotypes across the maturity groups, could be said to be good relative to what obtains in the farmers field. The import of this is that optimum plant density could be maintained and, hence higher crop yields.

As is expected the early maturing genotypes produced flowers significantly earlier than the medium and then the late maturing types. Almost a similar trend was exhibited in respect of number of days to 50% flowering and maturity. However, there were close similarities in maturity periods the genotypes across and within each maturity groups. Medium maturing genotypes IT96D-757 and IT96D-740 took the highest number of days (83) to mature which was statistically at par with late maturing genotypes Aloka, IT94K-1133-2 and IT89KD-288. Similar observations were recorded by Singh (1998) indicating that dual purpose medium maturing genotypes such as IT96D-757 and IT96D-740, take relatively similar time to mature with the improved late maturing types. The canopy spread, number of branches and dry matter of the genotypes differed markedly across the maturity groups. Most of the spreading late and semi-erect medium genotypes had statistically similar dry matter values, which were superior to the values recorded by the early maturing group which were erect in nature. The superiority of the former genotypes could have been supported by their wider canopy width and higher number of branches as shown in Table-5. Both characters are important determinants of dry matter in cowpea especially under intercropping situations where competition for light is common phenomenon. In a related study Terao *et al.*, (1997) reported that under intercropping situations, spreading cowpea genotypes produced higher dry matter because of their ability to intercept sufficient solar radiation. The results demonstrated that medium maturing genotypes IT96D-740 and IT89KD-349 had the statistically heavier dry matter compared with the other genotypes. The dry matter was determined at 12 WAS when the late maturing genotypes had not attained their maximum vegetative growth. So probably they could have out-yielded the others since dry matter production is positively correlated with radiation interception (Monteith, 1978) which is in turn dependent on the length of the crop vegetative/maturity period (Monteith, 1972).

CONCLUSIONS

From the above trial it was found that there are opportunities for improving the growth and dry matter production of cowpea intercropped with sorghum under the traditional 1:1 or single alternate row arrangement in the Sudan savanna of Nigeria. The local sorghum was not affected by cowpea intercropping. Medium maturing genotypes IT96D-740 and IT89KD-349 produced higher dry in sorghum. However, the late maturing genotypes need relatively longer vegetative/maturity period to express their full dry matter production potential.

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