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Response of Local Cowpea to Intra Row Spacing and Weeding Regimes in Yobe State, Nigeria

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Abstract**—**Weeds are known to interfere seriously with crop growth, thereby affecting the productivity and quality of crops. Crops are also known to compete for natural growth resources if they are not adequately spaced, also affecting the performance of the growing crop. Farmers grow cowpea in mixtures with cereals and this is known to affect its yield. For this reason, a field experiment was conducted at Yobe State College of Agriculture Gujba, Damaturu station in the 2014 and 2015 rainy seasons to determine the appropriate intra row spacing and weeding regime for optimum growth and yield of cowpea (*Vigna unguiculata* L.) in pure stand in Sudan Savanna ecology. The treatments consist of three levels of spacing within rows (20 cm, 30 cm and 40 cm) and four weeding regimes (none, once at 3 weeks after sowing (WAS), twice at 3 and 6WAS, thrice at 3WAS, 6WAS and 9WAS); arranged in a Randomized Complete Block Design (RCBD) and replicated three times. The variety used was the local cowpea variety (white, early and spreading) commonly grown by farmers. The growth and yield data were collected and subjected to analysis of variance using SAS software, and the significant means were ranked by Students Newman Keul's test (SNK). The findings of this study revealed better crop performance in 2015 than in 2014 despite poor soil condition. Intra row spacing significantly influenced vegetative growth especially the number of main branches, leaves and canopy spread at 6WAS and 9WAS with the highest values obtained at wider spacing (40 cm). The values obtained in 2015 doubled those obtained in 2014 in most cases. Spacing also significantly affected the number of pods in 2015, seed weight in both years and grain yield in 2014 with the highest values obtained when the crop was spaced at 30-40 cm. Similarly, weeding regime significantly influenced almost all the growth attributes of cowpea with higher values obtained from where cowpea was weeded three times at 3-week intervals, though statistically similar results were obtained even from where cowpea was weeded twice. Weeding also affected the entire yield and yield components in 2015 with the highest values obtained with increase weeding. Based on these findings, it is recommended that spreading cowpea varieties should be grown at 40 cm (or wider spacing) within rows and be weeded twice at three-week intervals for better crop performance in related ecologies.

Keywords**—**Intra row spacing, local cowpea, Nigeria, weeding.

I. Introduction

COWPEA (*Vigna unguiculata* L.) is among the most important grain legumes used in tropic and subtropical environments especially in sub-Saharan Africa, possibly due to its nutritional value [1]. Singh and Sharma [2] show that the cowpea variety that grow erect or semi erect has high yield potential as cereal crops, especially when grown with required input and in pure stand. A farmer can use appropriate agronomic practices such as planting density and row spacing to vary the yield levels of cowpea especially where/when other growth conditions are favorable [3]. Studies with several annual crop species have shown that yield potential can be increased by growing appropriate cultivar at extremely high plant densities [4]. Weeds (are known to) play an important role in the proper stand establishment of the growing crop, which ultimately affect the productivity and quality at the end of the growing season [5]. The objective of this study was, therefore, to investigate the effects of weeding regime on the growth and yield of local cowpea grown under different plant densities (intra row spacing).

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II. Materials and Methods

This research was conducted during 2014 and 2015 rainy seasons (July-November) at Yobe State College of Agriculture Gujba, Damaturu station. The site is located between latitude 11^0 45' N and longitude 11^0 58' E. The variety used was the early variety commonly used by farmers in the study area. It is small in size, white with brown hilum and kidney shaped, spreading indeterminate cultivar procured from Damaturu grain market. The treatments comprised of three intra row spacing (20 cm, 30 cm and 40 cm) representing plant densities of 66,666.66, 44,444.44 and 33,333.33 plants ha^{-1}, respectively, at one plant $hill^{-1}$; and four weeding regimes (once at 3WAS, twice at 3WAS and 6WAS, thrice at 3WAS, 6WAS and 9WAS and weedy check (control)), factorially combined and laid out in a RCBD and replicated three times. Each gross plot was made up of four rows measuring 4.8 m long and spaced at 0.75 m (14.4 m^2) with alley of 0.5 m and 1m between plots and blocks, respectively. Thinning was done two weeks after emergence where one plant was left per hill. A compound fertilizer N P K 20-10-10 was applied as basal at the rate of 200 kg ha^{-1} (288g per plot) using side placement. Some insect pest noticed during flowering (grass hoppers, been beetles and pod borers) were controlled using Cypermethrin at 1 liter ha^{-1} Meteorological data gathered in 2014 were inadequate due to insurgency that bedeviled the state capital. As such, combined data from Yobe State Agricultural Development Program (ADP) [6] and Desert Research Centre [7] of State University, Damaturu were sourced and used. Data were collected on plant height, number of leaves, branches, canopy spread, pods per plant, pod weight, seed per pod, seed weight, grain and haulm yield. The

collected data were analyzed using analysis of variance and significant means were separated using SNK test.

III. Results and Discussion

The soil from the experimental site (Table I) was sandy, slightly acidic, low in total nitrogen and phosphorus content while potassium (K^+,) sodium (Na^{2+}) and organic carbon were observed to be very low. The calcium (Ca^{2+}) and magnesium (Mg^{2+}) contents of the soil were medium and high, respectively. Considering the sandy nature of the soil, there is no doubt that most essential nutrients are lacking and basic cations are easily leached down by percolating water and the soil is prone to erosion. Generally, the results of this study have shown better crop performance in 2015 than in 2014. The reason could be attributed to higher rainfall (701.2 mm) and higher temperature (26.3 °C – 35.8 °C in 2015 relative to 27.1 °C – 28.6 °C in 2014 (Table II). Most of the meteorological data in 2014 could not be obtained due to Boko Haram insurgency but, from what was observed practically, 2015 was wetter than 2014.

TABLE I
Physicochemical Properties of Soil (0-15 Cm Depth) From The Experimental Site

Properties	Status
Physical properties	
Sand g kg^{-1}	908
Silt g kg^{-1}	32.8
Clay g kg^{-1}	59.2
Textural class	Sandy soil
Chemical properties	
pH (H_20 1:2.5)	5.85
Total N g kg^{-1}	0.7
Organic carbon g kg^{-1}	2.6
Available P mg kg^{-1}	6.72
Exchangeable Bases cmol kg^{-1}	
Ca	2.83
Mg	1.1
K	0.17
Na	0.06
CEC	4.50

TABLE II
Meteorological Data Showing Mean Rainfall and Temperature for 2014 and 2015 Rainy Seasons

	Rainfall (mm)		Temperature (°C)			
			Minimum		Maximum	
Month	2014	2015	2014	2015	2014	2015
May	NA	10.6	NA	26.3	NA	40.8
June	NA	51.0	NA	24.9	NA	37.3
July	NA	60.9	NA	23.9	NA	34.1
August	NA	338	27.1	22.6	27.2	31.3
September	NA	223.4	27.0	22.5	27.7	31.3
October	NA	17.3	28.1	22.8	28.6	35.8

Source: Yobe State ADP [6] and Desert Research Centre, Damaturu, [7]

A. Effects of Intra-Row Spacing and Weeding Regime on the Number of Branches and Number of Leaves of Cowpea

The effects of intra-row spacing on the number of main branches and number of leaves of cowpea are presented in Tables III. Intra-row spacing did not affect number of main branches produced at 3WAS in both years and at 9WAS in 2015. However, at 6WAS in both years and at 9WAS in 2014, intra row spacing significantly ($p< 0.05$) influenced the number of main branches of cowpea with highest values obtained from where the plants were widely spaced (40 cm). Similarly, the number of branches produced in these periods in 2015 was more than double the one of the previous year, probably due to the high rain fall received (i.e. increase was more than 100%). Intra row spacing only affected the number of leaves produced at 6WAS and 9WAS in 2015 and at 9WAS in 2014 with highest number of leaves from where the plants were spaced far apart (40 cm) within rows and those with least number of leaves from where the plants were closely spaced (20 cm). The highest mean number of leaves (473) produced at 9WAS in 2015 exceeded that reported by [8] at 12 WAS of 127, and [9] reported a mean value of 141 for Kanannado cowpea variety at Kano in the same semi-arid environment. This could be due to less interplant competition with plants that were widely spaced in addition to high rain fall received. For instance, the increase in leaf numbers were 110%, 159% and 143% for plants spaced at 20 cm, 30 cm and 40 cm, respectively, at 9WAS in 2015. Weeding regime also significantly ($p< 0.05$) affected number of branches and number of leaves at 9WAS in 2014 with high values from where cowpea was weeded thrice or twice at a three-week interval. Madukwe [10] reported that number of branches per plant was influenced by the presence of weeds.

B. Effects of Intra-Row Spacing and Weeding Regime on Plant Height and Canopy Spread of Cowpea

Intra row spacing did not affect plant height throughout the period of data collection in both years probably because the cultivar was a spreading type. The results also agree with the findings of [11] who reported that intra-row spacing had no significant influence on plant height throughout the period of data collection. However, intra-row spacing significantly ($p< 0.05$) affected canopy spread at 3WAS in 2014, 6WAS in 2015 and in both years at 9WAS, always with highest canopy cover from plants that were widely spaced. Similar results were reported by [8]. This is not surprising because as the plants grow older they compete for available growth resources such as space, nutrients, moisture and sunlight; therefore, those that were relatively spaced widely (40 cm) tend to grow better as interplant competition is less. Also at this age, cowpea has provided complete soil cover by spreading its vines on all plots (capable of suppressing weeds) thereby making it crowded where the plant was densely populated (i.e. at 20 cm within rows). Weeding regime significantly ($p< 0.05$) influenced plant height only at 6WAS in 2014 with the tallest plants obtained from where the crop was weeded three times at a three-week interval. However, this result was statistically on par with those that were weeded once or twice at a three-week interval, indicating the significance of weeding in crop production. Similarly, weeding significantly ($p< 0.05$) influenced canopy spread at 3WAS, 6WAS and 9WAS in

2014, with THE least values obtained from where cowpea received no weeding at all.

TABLE III
EFFECTS OF ROW SPACING AND WEEDING REGIMES ON NUMBER OF BRANCHES AND LEAVES OF COWPEA

Treatment	Number of Branches						Number of Leaves					
	3WAS		6WAS		9WAS		3WAS		6WAS		9WAS	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Spacing												
20	4.1	5.0	9.1b	20.3b	11.2b	25.2	13.7	19.9	119	138b	144b	303c
30	4.5	5.1	9.6b	20.9b	12.0b	27.5	15.3	20.1	118	150b	153b	396b
40	4.7	5.1	10.7a	23.8a	13.3a	29.0	15.3	20.6	132	183a	195a	473a
SE	0.16	0.10	0.33	0.52	0.31	1.10	0.58	0.86	11.7	8.1	10.2	25.9
Weeding												
0	4.4	5.1	9.3	20.7	11.3b	26.3	14.4	20.9	105	154	139b	363
Once	4.3	4.9	9.5	21.5	11.6b	26.4	14.6	19.6	109	156	153ab	389
Twice	4.6	5.1	9.8	21.8	12.7a	27.8	14.9	20.2	135	158	176ab	390
Thrice	4.3	5.2	10.7	22.5	13.0a	28.5	15.0	20.1	143	159	189a	420
SE	0.19	0.12	0.38	0.60	0.36	1.27	0.67	0.99	13.5	9.3	11.8	29.9
S x W	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) in the same column are statistically similar at 5% level of significance using Student Newman Keul's test. S=spacing, W=Weeding; NS= not significant

C. Effects of Intra-Row Spacing and Weeding Regime on Yield and Yield Components of Cowpea

Intra row spacing significantly ($p< 0.05$) affected the number of pods in 2015, seed weight per pod in both years and the grain yield of cowpea in 2014 with the highest values obtained at widest spacing of 40 cm within rows though, statistically similar values were obtained with 30 cm spacing in some cases. This result is in line with the findings of [12], who found that grain yield, seed weight per pod and haulm yield (kg ha^{-1}) substantially decreased with decreased plant spacing from 40 cm to 10 cm. They attributed this reduction to interplant competition at closer spacing. In 2015, intra row spacing did not influence grain yield significantly, although the yield differences with those of 2014 were more than double. Similarly, weeding regime has significantly ($p< 0.05$) affected the entire yield and yield components of cowpea in 2015, with the highest values obtained with increased weeding regime in most cases. Grain yields ranged from 0.54 t ha^{-1} – 0.68 t ha^{-1} in 2014, as against 1.0 t ha^{-1} – 1.5 t ha^{-1} in 2015 between unweeded-plots and plots that were weeded three times at a three-week interval (resulting in a 50% increase in grain yield between 2014 and 2015 in clean plots). This result can be compared with the work of [13] who found that grain yield ranged from 0.66 t ha^{-1} in unweeded plots to 2.33 t ha^{-1} in clean-weeded- plots. Even in terms of haulm yield, cowpea yielded 2.7 t ha^{-1} – 2.8 t ha^{-1} in unweeded plots compared to 3.7 t ha^{-1} – 3.8 t ha^{-1} between 2014 and 2015 from where cowpea was weeded three times at three-week intervals (i.e. 1.0 t ha^{-1} higher than where it was left as weedy check).

TABLE IV
EFFECTS OF ROW SPACING AND WEEDING REGIMES ON PLANT HEIGHT AND NUMBER OF LEAVES OF COWPEA

Treatment	Plant Height (cm)						Canopy Spread (cm)					
	3WAS		6WAS		9WAS		3WAS		6WAS		9WAS	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Spacing												
20	10.20	9.89	25.00	24.12	28.43	52.4	11.66b	23.76	32.27	62.6b	61.19b	151.1b
30	10.32	9.65	25.29	24.71	29.84	52.8	11.80b	24.31	31.55	67.7ab	64.67b	167.0b
40	10.37	9.45	26.80	26.02	32.88	53.9	13.22a	24.25	33.29	77.0a	71.86a	200.0a
SE	0.062	0.222	1.624	1.386	1.668	2.32	0.234	1.176	1.288	3.73	1.375	9.60
Weeding												
0	10.34	9.81	21.11b	24.69	26.70	52.7	11.02b	24.00	25.91c	66.3	57.22c	153.9
Once	10.23	9.63	24.61ab	24.81	30.06	53.0	12.06a	23.76	30.89b	68.3	63.24b	175.9
Twice	10.28	9.79	27.71ab	24.91	31.16	53.2	13.00a	24.28	35.14ab	68.6	70.72a	179.9
Thrice	10.32	9.42	29.36a	25.39	33.62	53.2	12.83a	24.39	37.53a	73.3	72.43a	181.1
SE	0.071	0.256	1.875	1.601	1.926	2.68	0.271	1.358	1.488	4.30	1.587	11.08
S x W	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) in the same column are statistically similar at 5% level of significance using Student Newman Keul's test. S=spacing, W=Weeding; NS= not significant

TABLE V
EFFECTS OF ROW SPACING AND WEEDING REGIMES ON YIELD AND YIELD COMPONENTS OF COWPEA

Treatment	No of pod plant per plant		Number of seed per pod		Seed weight per pod (g)		Grain Yield (kg ha^{-1})		Haulm Yield (kg ha^{-1})	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Spacing										
20	16.38	29.62b	12.36	13.69	3.950b	6.692b	472.2b	1241	3333	3167
30	18.73	31.24b	13.30	13.81	3.992b	7.400a	666.7ab	1352	3250	3463
40	18.73	35.95a	13.50	14.40	4.375a	7.317a	722.2a	1389	3556	3352
SE	1.008	0.835	0.359	0.212	0.1058	0.1646	69.29	108.1	232.7	156.3
Weeding										
0	16.62	29.74b	12.31	13.43b	3.911b	6.544b	543.2	1025b	2654b	2802b
Once	15.81	31.99ab	13.29	13.88ab	3.933b	6.978ab	580.2	1309ab	3469a	3333a
Twice	17.99	33.11ab	13.09	14.03ab	4.178ab	7.600a	679.0	1432ab	3593a	3444a
Thrice	20.29	34.23a	13.52	14.52a	4.400a	7.422a	679.0	1543a	3802a	3728a
SE	1.164	0.964	0.414	0.245	0.1222	0.1901	80.01	124.8	268.6	180.5
S x W	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter(s) in the same column are statistically similar at 5% level of significance using Student Newman Keul's test. S=spacing, W=Weeding; NS= not significant

IV. CONCLUSION

Generally, the influences of intra row spacing and weeding regimes on the growth and yield of cowpea were observed between the ages of six and nine WAS, both in the 2014 and 2015 wet seasons. The values were double or more in 2015 than in 2014 in most cases. At 40 cm, intra row spacing at 9WAS, the crop was capable of spreading up to 0.7 m and 2.0 m in 2014 and 2015, respectively, suggesting that spreading cowpea varieties in the drier savanna should be grown at wider spacing for better crop performance. The influence of weeding regimes on the yield of the crop was apparent, especially in 2015, with the highest values obtained when the crop was kept weed free (three times at three-week intervals); however, the recommend weeding regime is twice for economic reasons and for the fact that the results were statistically similar.

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