PERFORMANCE OF COWPEA INTERCROPPED WITH AMARANTH IN AN INLAND VALLEY OF A DERIVED SAVANNA

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Abstract

The study was conducted to investigate the performance of cowpea (Vigna unguiculata L.) (Walp.) Intercropped with amaranth (Amaranthus cruentus L.) in an inland valley (IVs) during the dry season. The 4 by 2 factorial experiment was carried out in 2003/2004 and 2004/2005 dry season at the University of Agriculture Abeokuta. The design was randomized complete block design (RCBD). The varieties used were IT90K-76, IT90K-277-2, Oloyin and Drum while the cropping system was sole and intercrop. Amaranth, a vegetable usually planted in the IVs in the dry season was intercropped with each cowpea variety. The intercrop proportion mixture and population adopted in this study was additive series. Cowpea grain in intercropping was similar with sole in both years. The four varieties of cowpea had similar yield in 2003/2004 whereas the grain yield of IT90K-76, IT90K-277-2 and Oloyin were similar but significantly higher than that of Drum in 2004/2005 dry seasons. The moisture content of the soil in each plot monitored weekly during the growth period of cowpea/amaranth was similar. It ranged between 13–26 and 12–26% in 2003/2004 and 2004/2005, respectively. The depth of ground water table during the growth period varied between 59–75 and 61–110 cm in 2003/2004 and 2004/2005, respectively. Land equivalent ratio (LER) also varied between 1.31–1.62 and 1.33–1.90 in 2003/2004 and 2004/2005 dry season, respectively. Thus, the yield produced in the total intercrop would have required 31–62% and 33–90% more land in 2003/2004 and 2004/2005, respectively if planted in pure stands yield advantage of intercrop over the sole. Intercropping amaranth with cowpea was compatible in terms of insecticidal spray.

Key words: Amaranth, cowpea, intercrop, inland valley

INTRODUCTION

Inland valleys (IVs) occur all over West Africa, where valley bottoms and hydromorphic fringes are estimated to occupy between 22–52 million ha of land (Windmeijer and Andriesse, 1993). They show considerable potential for intensification and sustainable land use (Izac et al., 1991; Windmeijer and Andriesse, 1993). However, they are only marginally utilized. In most areas, the valley bottom offers the only possibility for dry season cropping (Carsky and Ajayi, 1992). Increased sustainable cultivation of IVs, which generally have more fertile soils and more available water than the adjacent uplands, promises to relieve the pressure on over exploited upland soils while adding significantly to food production in the developing nations, particularly in Africa (IITA, 1990). The potential impact of this valley is related to the presence of water and total areas covered for the production of many food crops. Therefore, to increase the production of rice, vegetable and other upland crops, intensified use of the IVs is inevitable.

The leaf protein of amaranth (*Amaranthus cruentus* L) whish belong to the family of Amaranthaceae contains more lysine than the best high-lysine corn and more methionine than soybean meal (Fletcher, 1999). Amaranths are usually grown in the inland valley (locally referred to as *fadama* or *akuro* in south western Nigeria) during the dry season by farmers. Being an ephemeral crop, it matures in 4–6 weeks after planting. This period of time is likely to occur between vegetative and the early part of reproductive stage of cowpea when insecticidal spray would be inevitable. The presence of many insect pest species from seedling to harvest is a feature of cowpea, although flower and pod attacking pests are the most important (Raheja, 1976; Kyamanywa, 1996; Karungi et al., 2000). Two insecticide sprays of Cypermethrin + dimethoate (Sherpa plus 30 + 250g/a.i/ha at flower bud initiation and 50% flowering stages increased grain yields considerably from 225 to 900 kg/ha for cowpea planted in July and August (Aasnte et al., 2001). The use of insecticide could result in contamination of companion food crops. There is therefore the need to ascertain the possibility of intercropping amaranth with cowpea without the risk of insecticide contamination.

The potential benefits of mixed cropping that includes greater resistance to pest infestation and more reliable yields in the adverse weather conditions (Steiner, 1982) have not been exploited in the IVs. Practices such as sole cropping of vegetables like amaranth during the dry season can be made more sustainable in the IVs by intercropping. Furthermore, the weather conditions during the dry season in the IVs of the southwest Nigeria appeared to be similar to those required for the cultivation of cowpea in the north. Most cowpeas such as *Oloyin*, *Drum* and other land races, which command high premium in the market in southern States of Nigeria, were grown and transported from the north.

Cowpea, *Vigna unguiculata* (L.) Walp, belong to the family of Fabaceae. The total world production of dry cowpea seeds in 2002 was about 5 million tonnes from 14 million ha of which 64% was produced in West and Central Africa. The dry region of Nigeria (Northern Nigeria) alone produces 2.1 million tonnes from 5 million ha (Grubben and Denton, 2004). Added attractions of growing cowpeas in the dry season include little or no need for fungicide applications, little or no leaching of fertilizers, few seed dry problems, less seed spoilage and therefore better storability (Rhodes, 1982 and Adigbo, 2005). Furthermore, Singh et al. (1997) reported that cowpea fits very well as a rotation/alternate crop during the dry season, as it requires a moderate amount of water and matures within 60–80 days.

Therefore, the objectives of this study were to (1) evaluate the performance of cowpea intercropped with amaranth in an inland valley and (2) investigate the compatibility of growing amaranth with cowpea without the risk of insecticide contamination.

MATERIALS AND METHODS

The experiment was conducted in two years (2003 December/2004 March and 2004 December/2005 March dry seasons) at the bottom of the inland valley of the University of Agriculture, Alabata, Abeokuta (7^{o}20'N, 3^o 23'E), Nigeria. The average annual rain fall 1 148 mm and average daily temperature is 28^{o}C. The textural class of the soil is loamy sand (78% sand, 16.4% silt and 5.2%). The top 1–20 cm soil layer had pH (1 : 2 Soil : water) 6.66, K 10.3 mg/kg (Flame photometry method), 38.5 g/kg organic matter (Walkley-Black method), 1.90 g/kg total N (Macro-Kjedahl method) and 10.1 mg/kg Bray extractable P.

The 4 × 2 factorial experiment was carried out in 2003 December/2004 March and 2004 December)/2005 March dry seasons. The design was Randomized Complete Block Design (RCBD). Four crop varieties and 2 cropping systems were the factors. The varieties used were IT90K-76, IT90K-277-2 (improved varieties), *Oloyin* and *Drum* (commercial land races) while the cropping systems were (1) sole and (2) intercropping systems. *Amaranthus cruentus* was planted as intercrop. The treatment combinations included IT90K-76, IT90K-277-2, Oloyin, Drum, IT90K-76 + amaranth, IT90K-277-2 + amaranth, Oloyin + amaranth and Drum + amaranth.

The plot size was 4 m × 3 m. The land was prepared using slash and burn method. Planting was done at a spacing of 20 cm × 80 cm for cowpea while amaranth was drilled into the soil spacing between rows. The intercrop proportion mixture and population adopted in this experiment was additive series (i.e. each plot of sole cowpea and mixture consisted of six rows, while sole amaranth was 11 rows and intercrop consisted of 5 rows planted alternatively). Three seeds of cowpea were planted per hole and thinned to two plants per hole two weeks after planting (WAP) giving a total of plant 150 000 plants/ha. The mixture of amaranth seed and fine soil (1 kg of seed/10 kg of soil) was placed into the shallow opening of the soil and a wooden mallet was used to compress the drilled seed to enhance good contact between the soil and seed. Ninety N kg/ha, 45 P kg/ha and 45 K kg/ha was applied to amaranth 20 days after planting. Weeding was done 3 and 8 WAP. Spraying of cowpea was done twice at 6 and 8 WAP against flower and pod attacking insect pests. Sherpa plus®, a broad-spectrum insecticide, 280 g/l active ingredient (30g/l dimethoate and 250 g/l cypermethrin) was used at the rate of 30 ml per 15 liters of water. Amaranth was harvested fresh at 5 and 6 WAP before the application of insecticide to cowpea. The first harvest was done by uprooting the big and vigorous plants from the net plot while small and feeble plants were left unharvested until 6 WAP while cowpea was harvested at 12 WAP.

DATA COLLECTION

Number of pods/peduncle: The total number of pods divided by the total number of peduncles on each plant. This was done for five plants randomly selected and the average was recorded

Number of peduncles/plant: The total number of peduncles of five plants randomly selected was counted. The average was obtained by dividing the total by five.

Canopy height: With the aid a meter rule, the canopy height was determined at maturity by measuring from ground level to the top of the highest canopy. This was repeated for five times in a plot. The average of the five values was recorded as the canopy height

Biomass: Two plants were uprooted from the sample rows at 4 WAP and fortnightly thereafter. The samples were dried to constant weight at 70^{o}C.

Grain yield: The pods harvested from the net plot (2.4 m × 3 m) were dried, threshed and weighed. The grain yield was converted to t/ha.

Amaranth

Plant height of amaranth: The heights of five plants were measured from the ground to the top of the highest leaf prior to harvest at 5 WAP.

Fresh plant weight: The five rows of amaranth in the intercrop were harvested whereas seven center rows of the sole amaranth were harvested. The yields were converted to t/ha.

The moisture content was monitored weekly at 20 cm depth throughout the growth period of amaranth/cowpea (i.e. from December to March of each cropping cycle) using gravimetric water content method. The groundwater table was also measured by piezometer.

All the data collected were subjected to analysis of variance by using MSTAT-C program version 2.00 (Freed, 1988) and the means of variables that recorded significant effects were further separated using Fishers' least significant difference (LSD).

RESULTS

The biomass of the IT90K-277-2 variety was significantly higher than that of IT90K-76 whereas those of *Drum* and *Oloyin* were similar at 6 WAP in 2003/2004 (Table 1).

The biomass of IT90K-277-2 variety at 8 WAP was higher than that of *Oloyin.* However, Oloyin, *Drum* and IT90K-76 varieties had similar biomass. Similarly, the biomass of all the varieties tested were not significantly different from each other in 2004/2005 dry seasons. The sole plots of cowpea had higher biomass than those of intercropped plots at 6 and 8 WAP in 2003/2004 whereas the biomass of the cropping pattern in 2004/2005 dry seasons were similar. The interaction of variety and cropping system on biomass was significant at 6 and 8 WAP in 2003/2004. This suggests that the biomass of varieties responded differently in the cropping systems at 6 and 8 WAP. The biomass of the varieties was higher in sole cropping than those of intercrop.

Oloyin had the highest number of pods per peduncle in 2003/2004 dry seasons while Drum had the least (Table 2). However, in 2004/2005 dry seasons, the pods per peduncle of all the varieties were similar. The number of peduncles per plant of IT90K-277-2 was significantly higher than that of IT90K-76 while the two commercial varieties were similar in 2003/2004 dry seasons. However, the peduncles per plant of the two commercial varieties were significantly lower than that of IT90K-76. In 2004/2005 dry season, the two improved varieties and Oloyin had similar peduncles per plant but significantly higher than that of Drum. The interaction of variety and cropping pattern on peduncle per plant was significant in 2003/2004.

Tab. 1: Effects of cropping pattern on the biomass (gm/plant) of cowpea in 2003/2004 and 2004/2005 dry seasons

Treatments	4 WAP			6 WAP			8 WAP			10 WAP		
Variety	2003/04	2004/05	Mean	2003/04	2004/05	Mean	2003/04	2004/05	Mean	2003/04	2004/05	Mean
IT90K-76	2.78	3.79	3.29	4.95	14.23	9.59	36.44	50.63	43.54	58.98	87.29	73.14
IT90K-277-2	3.08	4.10	3.59	14.24	15.37	14.81	47.34	44.46	45.90	86.08	60.55	73.32
Oloyin	3.32	4.53	3.93	8.86	20.36	14.61	28.75	52.75	40.75	42.70	60.55	51.73
Drum	3.67	4.33	4.00	10.35	14.32	12.34	37.11	34.03	35.57	61.44	86.43	73.94
Mean	3.22	4.29	3.76	9.60	16.07	12.84	37.41	45.47	41.44	62.30	53.74	58.02
LSD (A)	1.78	1.7		6.29*	9.53		16.62*	16.36		21.47*	34.79	
Cropping systems												
Sole	3.58	4.51	4.05	12.74	18.59	15.67	44.25	50.68	47.47	68.27	76.77	72.52
Intercrop	2.85	3.87	3.36	6.46	13.56	10.01	30.57	40.25	35.41	56.24	67.25	61.75
Mean	3.22	4.19	3.71	9.60	16.08	12.84	37.41	45.47	41.44	62.30	72.01	67.16
LSD (B)	1.26	1.20		4.45*	6.74		11.76*	11.57		15.18	24.60	
LSD (AB)	2.58	1.40		8.10*	13.22		23.54*	23.14		30.26	49.20	

* = Significant (Prob. < 0.0 5)

Tab. 2: Effects of cropping pattern on the grain yield, pod damage, pods/peduncle and peduncle/plant of cowpea in 2003/2004 and 204/2005 dry seasons

Treatment	Grain yield (t/ha) 1.2			Pods/peduncle			Peduncles/plant			Canopy height (cm)			No. of days to 50% flowering	
Variety	2003/04	2004/05	Mean	2003/04	2004/05	Mean	2003/04	2004/05	Mean	2003/04	2004/005	Mean	2003/04	2004/05
IT90K-76	1.33	0.91	1.12	14.6	23.8	19.2	2.6	1.4	2.0	58.0	52.4	55.2	49.00	48.00
IT90K-277-2	1.24	0.79	1.02	20.9	21.8	21.4	3.1	1.4	2.3	61.6	54.0	57.8	49.83	47.83
Oloyin	1.34	0.65	1.00	9.8	24.8	17.3	7.3	1.6	4.5	59.2	53.9	56.55	48.17	47.17
Drum	1.52	0.29	0.91	8.5	10.7	9.6	2.2	1.4	1.8	34.5	32.0	33.3	50.5	48.5
Mean	1.36	0.66	1.01	13.5	20.3	16.9	2.5	1.5	2.0	53.3	48.1	50.7	49.3	47.9
LSD (A)	0.231	0.274		4.3*	9.4*		0.4*	0.3		6.89*	3.09*		10.16	9.41
Cropping systems														
Sole	1.30	0.69	1.00	13.4	22.4	17.9	2.4	1.3	1.9	53.1	45.5	49.3	49.2	48.2
Intercrop	1.41	0.63	1.02	13.5	18.2	15.9	2.7	1.5	2.1	53.6	50.8	52.2	48.9	47.9
Mean	1.36	0.66	1.01	13.5	20.3	16.9	2.55	1.4	1.98	53.3	48.2	50.75	49.1	48.1
LSD (B)	0.163	0.193		3.03	6.64		1.27	0.21		4.87	1.82*		4.1	5.1
LSD (AB)	0.281	0.387		6.08	13.29		0.36	0.53		8.64	3.64		5.2	6.2

* = Significant (Prob. < 0.05)

In 2003/2004 dry seasons, cowpea grain yields of all the varieties were similar whereas in 2004/2005 dry seasons, *Drum* had a significantly lower grain yield than the other cowpea varieties (Table 2). The grain yield in sole and intercrop plots were similar in the two years. The canopy height of the two improved varieties and *Oloyin* were similar in both years. *Drum* also had significantly lower canopy height than the others varieties. The canopy height of cowpea in 2004/2005 intercropping was significantly increased. The number of days to 50% flowering of sole and intercrop cowpea were similar.
The fresh leaf weight of amaranth in crop mixture of IT90K-76 + amaranth, IT90K-277-2 + amaranth, and *Drum* + amaranth were similar in 2003/2004 dry season (Table 3). However, fresh leaf weight of amaranth from IT90K-76 + amaranth mixture was significantly higher than that of *Oloyin* + amaranth. In 2004/2005 dry seasons, the fresh leaf weights of amaranth in all crop mixture were similar. The difference in time of harvesting of amaranth (5 and 6 WAP) and the commencement of insecticidal spray of cowpea at flowering stage (6 WAP) made the crop mixture compatible. The Land Equivalent Ratio (LER) of the crop mixtures was similar in both years. The soil moisture content measured during the growth period of cowpea/amaranth was similar in both years (Table 4). It ranged between 13–26% and 12–26% in 2003/2004 and 2004/2005 dry seasons, respectively. The ground water table as at 6 to 10 WAP ranged between 59–75 cm and 61–110 cm in 2003/2004 and 2004/2005 dry seasons, respectively.

DISCUSSION

The similarity of biomass of cowpea in sole and intercropped could be attributed to the beneficial effects of fertilizer application to amaranth (particularly phosphorus). The grain yields of the two improved varieties (IT90K-76 and IT90K-277-2) were not superior to *Oloyin* a local variety contrary to the report of Singh et al. (1997) who experimented in an upland ecology. The comparable grain yield obtained from local variety could be due to the fact that flower- and pod-attacking pest are not major constrains during the dry season but viruses,

Tab. 3: Fresh leaf weight of amaranth and LER of the intercrop as influenced by cowpea intercropping

Treatments	Fresh leaf weight (t/ha)			LER		
Variety	2003/2004	2004/2005	Mean	2003/2004	2004/2005	Mean
IT90K-76 + A	6.20	5.53	5.87	1.62	1.44	1.53
IT90K-277-2 + A	5.89	6.52	6.21	1.43	1.39	1.41
Oloyin + A	2.05	4.83	3.44	1.31	1.90	1.61
Drum + A	4.08	5.19	4.64	1.51	1.33	1.42
Sole amaranth	16.37	12.28	14.33			
Mean	6.92	5.44	6.18	1.47	1.52	1.50
LSD	3.89*	2.29*		0.45	0.60	

A = amaranth and * = significant (Prob. < 0.05)

Tab. 4: Effects of intercropping on the moisture content and groundwater table measured during the growth of cowpea

Treatments	6 WAP (%)			8 WAP (%)			10 WAP (%)		
	2003/04	2004/05	mean	2003/04	2004/2005	mean	2003/2004	2004/2005	mean
Variety	+58.87	+61.01	+59.94	+76.17	+81.10	+78.64	+74.50	+109.60	+92.55
IT90K-76	25.86	19.62	22.74	18.89	18.73	18.81	17.91	17.89	17.9
IT90K-277-2	20.87	19.34	20.11	16.27	13.38	16.10	14.19	15.01	14.6
Oloyin	21.24	18.43	20.17	16.70	11.99	14.35	15.70	14.78	15.24
Drum	25.50	19.10	22.30	13.26	16.43	14.84	15.69	19.93	17.81
Mean	22.57	19.12	20.85	16.60	15.13	15.87	15.87	16.75	46.31
LSD (A)	5.70	4.13		6.12	7.04		5.37	5.25	
Cropping systems									
Sole	21.87	19.21	20.54	17.98	15.88	16.93	16.03	16.86	16.45
Intercrop	23.86	19.03	21.45	14.63	14.39	14.51	15.71	16.44	16.08
Mean	22.87	19.12	21.00	16.30	15.14	15.73	15.87	16.75	16.31
LSD (B)	4.03	2.92		4.33	4.98		3.80	2.15	
LSD (AB)	8.07	3.84		8.66	9.97		7.60	4.30	

+ = Groundwater table (cm)

leaf thrip and aphids do most damage according to Singh et al. (1997).
The similar grain yields of cowpea obtained in the sole and intercrop plot in both years could due to the short life span of amaranth that reduced the competition for plant resources to the barest minimum. Furthermore, cowpea in the intercrop may have benefited from the fertilizer applied to amaranth. Thus cowpea could be grown with amaranth to enhance efficient use of limited resources.
Cowpea grain yield obtained from inland valley in this trial was comparably to yield from uplands in the works of Okeleye and Ariyo (2000); Aasnte et al. (2001) and Oyekanmi et al. (2006). The higher grain yield obtained from IV could be attributed to the prevailing dry season weather that might adversely affect the flowers and pod insect pests which damage it. However, the quality of grain obtained from IV was better than that of uplands (Adigbo, 2005). The high grain yield coupled with higher quality grains in IV was attributed to the favourable weather conditions (high temperature, low humidity and no rain at pod formation and harvesting that are similar to the dry region of northern Nigeria. Prices of cowpea grain yield harvested between March and April are usually higher because it coincides with hungry period (i.e. a time when farmers are preparing for planting) (Singh et al., 1997). Hence, grain cowpea harvested from IV command higher price than the upland cowpea. Much money would be saved from storing and transporting cowpea from the northern Nigeria or any part of the world that have similar climate and IV.
The maturity period of amaranth did not coincide with the flowering and pod formation stages of cowpea when the control of insect pests is crucial to sustain production**.** This makes the mixture of cowpea and amaranth to be compatible in terms of insecticidal spray. This suggest that cowpea particularly the local variety that taste better and command higher premium in the market could be intercropped with amaranth during the dry season when all major food stuffs are expensive.
The soil moisture 13–26% and 12–26% in 2003/2004 and 2004/2005, respectively were higher than 12–13% (Schmide, 1977). Schmide (1977) reported that amaranth grows well in soil moisture content of 11–13%. The high moisture content of the 20 cm topsoil in the IV was not unconnected with the shallow ground water table (59–110 cm). This is an indication that the amaranth and cowpea plant evaporative demand could be met by capillarity.
Based on this study, the performance of cowpea in IV during the dry season were not only comparable to upland yield but had a better grain quality than the uplands. It also shows that Oloyin variety which, command the highest premium in the market had similar grain yield with the two improved varieties tested in the IV. The land equivalent ratio (1.33–1.90) suggests that intercrop is more efficient than sole. Amaranth could be intercropped with cowpea without the fear of chemical contamination.

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