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Effect of planting pattern, crop variety and insecticide on the productivity of cowpea-cereal systems in Northern Guinea Savanna of Nigeria

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Abstract

A cropping system trial involving two spray regimes, two cowpea varieties and ten cowpea–cereals planting patterns involving two cereals was conducted in the wet season in the northern Guinea Savanna of Nigeria in 1999 and 2000 to identify suitable row to row planting arrangement for cowpea-cereal systems. The systems involved different row-to-row combinations of cowpea with maize or sorghum and with or without insecticide spray. Spraying of cowpea increased cowpea grain yield, returns on grain and total produce significantly under all planting patterns and varieties. Sole cowpea produced significantly higher monetary returns compared to other treatments. The improved cowpea variety produced higher grain yields than the local variety and required less insecticide spray. The maize-cowpea systems were more productive than the sorghum-cowpea systems. Systems with higher cowpea proportions produced relatively higher monetary returns on total grains. Returns on total produce from sole crop cowpea with insecticide spray almost doubled returns compared to the total produce from sole cereals due to high price of cowpea grain and fodder. The systems, 2maize:4cowpea and 1maize:4cowpea with spraying were most productive and gave high monetary returns and therefore were recommended for the area.

Key words: Guinea savanna, intercrop, planting pattern, *Vigna unguiculata*.

Introduction

In the mixed farming systems widely prevalent in West Africa, cowpea [*Vigna unguiculata* (L.) walp] is the main legume and a major source of human food and livestock fodder [15]. It is a very important crop in the moist savanna and semiarid zones, where it is grown together with other food or fibre crops such as pearl millet (*Pennisetum typhoides*), sorghum (*Sorghum vulgare*), maize (*Zea mays*), cassava (*Manihot esculentum*) and cotton (*Gossypium* spp.). Production data by Food and Agriculture Organisation [7] indicate West Africa as the largest cultivator of cowpea (3.2 million mt, from 9.8 million ha), with Nigeria (2.2 million mt, from 5 million ha) as the largest producing country in the world. Cowpea is equally important as a nutritious fodder for livestock [19].

On a dry weight basis, the price of cowpea haulms ranges between 50 and 80% of the grain price [16]. Cowpea cultivation in Africa is mainly under traditional systems and it has the lowest average yield. Although, under sole cropping, the potential grain yield is high (1.5-3.0 t/ha), when insecticide is applied to the crop. The actual farm yields obtained in the West African sub-region are much lower (0.025-0.100 t/ha), due to severe attacks from extensive pest complexes [11] and lack of inputs and traditional intercropping systems. In most of the traditional cropping systems cowpea is intercropped with cereals whose tall canopy shades the cowpea thereby reducing yield. There are several advantages to intercropping: it reduces damage caused by pests and diseases, and also ensures greater yield stability by producing some yield, even when some of the component crops failed [4]; resources such as light, water and nutrients are maximized [6]. Insecticides are rarely used by farmers on cowpeas even though, insect pests can cause up to 100% loss of cowpea grain yields [13]. The rapid increasing population and consequent pressure for food have required greater intensification of agriculture in West Africa [12]. The intercropping systems must therefore be improved for greater intensification and productivity.

Cultivation of the cowpea crop has become more attractive with the adoptions of improved cowpea varieties developed by International Institute of Tropical Agriculture (IITA) and National Programs. Cowpea varieties with higher grain yields, early maturing and resistance to several diseases and insect pests are available [14, 18, 19] and are now grown over wider range of ecologies and seasons than before.

To ensure maximum yield of the new improved, high yielding and disease resistant varieties, the traditional 1:1 cereal: cowpea systems need to be changed and necessary input be applied. This paper reports the effect of varieties, insecticide and planting arrangement of maize-cowpea and sorghum-cowpea systems on productivity of food and fodder in the Northern Guinea Savanna of Nigeria.

Materials and Methods

Experimental sites: The experiment was conducted during 1999 and 2000 rainy seasons at the Abubakar Tafawa Balewa University Teaching and Research Farm situated on Yelwa Campus of the University in Bauchi, Bauchi State of Nigeria (10°16.888'N; 9°47.269'E) in the Northern Guinea Savanna of West Africa.

Land preparation and planting: The land was harrowed and a

basal dose of 100 kg NPK (15 kg N, 15 kg P_2O_5, 15 kg K_2O) per ha was broadcasted and incorporated into the soil and then ridged at 75 cm spacing. Planting was manually done at a spacing of 20 cm and 25 cm within ridge for cowpeas and the cereals respectively. Three seeds of cowpea were planted per hill and later thinned to two stands per hill, six to ten seeds of sorghum were planted while three seeds of maize were planted and both were thinned to two plants per hill three weeks after planting (WAP). In the first year (1999), maize and sorghum were planted on 17 June and cowpeas were planted on 1 July, while in the second year (2000) maize and sorghum were planted on 15 June and cowpeas were planted on 4 July.

Experimental design: The trials were laid out in a split-split plot design with four replications. Main plot was the spray treatment, which consisted of 2-3 insecticide sprays and a no-spray on cowpea. The improved cowpea IT90K-277-2 was sprayed twice with insecticide at flowering and podding while the local variety (Yaro) was sprayed three times at vegetative, flowering and podding stage because of the very late maturity. Subplots consisted of the cowpea varieties, which included an improved variety and a local. The sub-sub plot consisted of 10 planting patterns as follows: 1) Sole cowpea; 2) 1 row maize : 4 row cowpea (1Mz: 4C); 3) 2 row maize : 4 row cowpea (2Mz: 4C); 4) 2 row maize : 2 row cowpea (2Mz: 2C); 5) 1 row maize : 1 row cowpea (1Mz: 1C); 6) 1 row sorghum : 4 row cowpea (1S: 4C); 7) 2 row sorghum : 4 row cowpea (2S: 4C); 8) 2 row sorghum : 2 row cowpea (2S: 2C); 9) 1 row sorghum : 1row cowpea (1S:1C); 10) 1 row sorghum/maize : 1 row cowpea (1MzS: 1C). Maize being planted on alternate hill of same row as sorghum. A sole maize and sole sorghum plot was included in each replication as check. Plot sizes were 4.5 m x 5 m.

Crop husbandry and data collection: The plots were maintained by manual weeding three times (3, 5 and 8 WAP). A total of 50 kg ha^{-1} urea (46% N) giving 23 kg N was applied to the maize and sorghum rows only as top dressing at tasselling in the case of maize and at flag leaf stage in the case of sorghum.

Matured cowpea pods were harvested from the net plots, sun-dried to constant weight. The weights were recorded as pod weight. The sun-dried and weighed cowpea pods were threshed, weighed and recorded as cowpea grain weight. The fodder left after pod harvests were cut and sun-dried until constant weight and recorded as fodder weight.

The sorghum panicles/maize cobs harvested per plot were sun-dried until constant weight; the weights were recorded as cereal head weight. The harvested panicles/cob were threshed and the grain sun-dried and weighed. Their weights were recorded as cereal grain weight. The cereal stalk left after cutting of the panicles was sun-dried and weighed. Economic values of grain and stover produced were estimated based on the prevailing prices in three major markets in Northern Nigeria. Data were subjected to statistical analysis using computer programme Genstat 5 Release 3.2.

Results

Soil and rainfall: The soil samples taken at the commencement of the trial showed that the soil was slightly acidic (pH 5.5) and the available phosphorus (P) was 5.5 mg kg^{-1}. Particle size analysis showed that the soil type was loamy sand. Rain started in April, reached its peak in July/August and ended in October. There was a significant difference in total rainfall between the two years. The rainfall was over 1600 mm in 1999 and only 1157 mm in 2000 (Fig.1).

Cowpea productivity: There were significant differences ($P<0.05$) between means of cowpea grains yield in the spray treatments, with spray producing higher grain yields than the no-spray in both years and combined (Table 1). The variety IT90K-277-2 yielded significantly ($P<0.05$) higher grains than Yaro in 1999, but the differences were not significant in 2000 and the combined year analysis. Cowpea grain yields were higher under sole cropping than the intercropping systems in both years. The planting pattern (1 sorghum :1 cowpea) gave the lowest cowpea grain yield among the cropping systems investigated. The combined year analysis gave cowpea grain yields which ranged from 200 kg ha^{-1} in 1 sorghum : 1 cowpea to 819 kg ha^{-1} under sole cowpea. There was no significant difference in mean cowpea grain yield in 1999 and 2000.

The interaction effect of insecticide spray by cowpea varieties by planting patterns on cowpea grain yields are shown in Table 2. There was significant difference ($P<0.05$) between spray by system interactions in 1999 and combined but not in 2000. Planting pattern with higher proportions of cowpea (1:4 and 2:4) produced significantly higher cowpea grain yields than pattern with lower cowpea proportions (1:1 and 2:2) under sprayed conditions but they had similar yields under no-spray conditions.

The effect of spray regime and cowpea variety on mean cowpea grain yields of cowpea-cereal systems is shown in Table 2. There was no significant spray by variety interactions in 1999. However, in 2000 and combined year analysis, spray by variety interaction was significant. In 2000, the mean grain yield of no-spray Yaro was significantly higher than mean grain yield of no-spray IT90K-277-2. The combined year analysis showed that mean grain yield of sprayed Yaro was significantly ($P<0.05$) lower than mean grain yield of sprayed IT90K-277-2 but no significant difference was observed in their no-spray yields.

The mean cowpea fodder produced by sprayed treatments was not significantly different from the no-spray treatments in 1999, 2000 and combined year analysis (Table 1). The mean fodder yield produced by Yaro was significantly ($P<0.05$) higher than that of IT90K-277-2 in 1999, while IT90K-277-2 produced significantly ($P<0.05$) higher fodder than Yaro in 2000 but the two years combined analysis showed that Yaro produced significantly ($P<0.05$) higher fodder than IT90K-277-2. The mean cowpea fodder yield produced in the different systems followed the proportion of cowpea in the systems, the higher the cowpea proportion the higher the cowpea fodder yield. Cowpea fodder

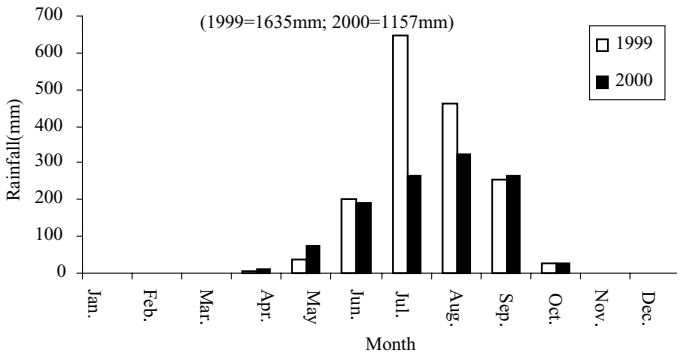

Figure 1. Monthly rainfall (mm) at Bauchi in 1999 and 2000.

Table 1. Mean cowpea grain and fodder yields from different insecticide spray treatments, cowpea varieties and planting patterns at Bauchi in 1999 and 2000.

	Grain (kg/ha)			Fodder (kg/ha)			
Treatments	1999	2000	Combined	1999	2000	Combined	Striga/m^2
Spray Treatments							
Spray	612	611	611	1432	964	1198	2.22
Nospray	289	329	309	1447	1102	1275	1.71
SED (5%)	48	27	28	124	85	75	0.25
Variety							
IT90K-277-2	520	472	496	959	1211	1085	2.95
Yaro	381	469	425	1920	855	1388	0.98
SED (5%)	17	46	24	124	98	79	0.38
Planting Pattern (row:row)							
1Mz:1C	413	271	342	1296	864	1080	1.12
1Mz:4C	507	634	570	2272	1361	1817	2.33
1MzS:1C	283	229	256	727	665	696	2.13
1S:1C	223	176	200	689	640	665	1.62
1S:4C	555	598	577	1488	1175	1332	2.17
2Mz:2C	408	477	443	1562	946	1254	2.45
2Mz:4C	559	567	563	1891	943	1417	1.58
2S:2C	282	360	321	733	711	722	2.48
2S:4C	473	555	514	1202	1057	1120	1.76
Sole Cowpea	803	835	819	2536	1969	2252	1.98
SED (5%)	75	44	43	195	109	111	0.53

Mz maize, S sorghum, C cowpea

Table 2. Effect of planting pattern, insecticide spray and cowpea varieties on cowpea grain yields (kg ha^{-1}) in Bauchi, Nigeria.

	Year	1999			2000			Combined		
Spray treatment	Planting pattern*	Yaro	IT90K-277-2	Mean	Yaro	IT90K-277-2	Mean	Yaro	IT90K-277-2	Mean
Spray	1Mz:1C	499	634	566	190	327	259	345	480	412
	1Mz:4C	651	730	690	855	858	856	753	794	773
	1MzS:1C	361	212	286	250	211	231	305	21	259
	1S:1C	249	300	275	177	151	164	213	226	219
	1S:4C	666	789	728	733	839	786	700	814	757
	2Mz:2C	592	634	613	550	580	565	571	607	589
	2Mz:4C	628	974	801	631	926	778	629	950	790
	2S:2C	397	285	341	511	699	455	454	342	398
	2S:4C	558	706	632	714	856	785	636	781	709
	Sole cowpea	814	1556	1185	1097	1362	1229	955	1459	1207
	SED (5%)		151	112		99	65		90	65
	Mean	541	682		571	651		576	666	
	SED (5%)		51			53			37	
No-spray	1Mz:1C	246	272	259	297	272	284	271	272	272
	1Mz:4C	233	413	323	469	354	411	351	383	367
	1MzS:1C	214	344	279	236	218	227	225	281	253
	1S:1C	97	247	172	156	220	188	126	234	180
	1S:4C	306	459	383	503	318	410	404	388	396
	2Mz:2C	206	200	203	425	353	389	316	276	296
	2Mz:4C	156	477	316	429	282	355	292	379	336
	2S:2C	138	309	223	285	243	264	211	276	244
	2S:4C	201	426	314	375	276	325	288	351	319
	Sole cowpea	405	439	422	496	385	441	451	412	431
	SED (5%)		151	112		99	65		90	65
	Mean	220	359		367	292		355	334	
	SED (5%)		51			53			37	

*Planting pattern row:row, Mz maize, S sorghum, C cowpea

yields were, however, higher in maize based systems than in sorghum-based systems of similar planting pattern. These differences were significant (P<0.05) at high cereal proportions (1 maize:1 cowpea vs 1 sorghum: 1 cowpea).

Spraying of cowpea did not significantly affect the Striga infestation of the cowpea (Table 1). However, significantly (P<0.05) more Striga emerged from IT90K-277-2 than from Yaro, while planting pattern did not significantly (P<0.05) affect Striga infestation.

Cereal productivity: There was no significant difference between mean cereal grain yields in the spray treatments in 1999 but cereal grain yields were significantly (P<0.05) higher under spray than no-spray regime in 2000 (Table 3). The combined year analysis showed that there were no significant differences between spray and no-spray. The mean cereal grain yield was much higher in 1999 than in 2000.

There was no significant (P<0.05) difference between mean cereal grain yield for treatments involving Yaro and IT90K-277-2 in 1999 and combine. However, treatments involving IT90K-277-2

produced significantly (P<0.05) higher cereal grain than treatments involving Yaro in 2000. There was a significant (P<0.05) effect of planting pattern on cereal grain yields. In 1999, the maize and sorghum grain yields from same planting pattern were similar. However, in 2000, the maize grain yields were higher than sorghum grain yields in systems with same planting pattern. The mean cereal stalk yields produced by no-spray treatments were not significantly (P<0.05) different from the spray treatments in 1999, 2000 and combined (Table 3). There were significant differences (P<0.05) among the means of the systems in the two years. Systems involving sorghum produced significantly higher stalk yields than similar systems involving maize.

Economic returns of produce

Returns on grain: The mean returns of the total grains were significantly (P<0.05) higher in the spray treatments than in the no-spray treatments in both years and the combined year analysis (Table 4) and this was as a result of the increase in cowpea yield. Similarly, mean returns of total grains from IT90K-277-2 was significantly (P<0.05) higher than Yaro in 1999, but in 2000 and combined year analysis there was no significant (P<0.05) difference between the two cowpea varieties in their returns of total grain.

Significant (P<0.05) differences were observed among the planting pattern in the mean returns of the total grains in 2000 and combined analysis, with sole cowpea providing the highest and 1MzS:1C and 1S:1C the lowest returns. Systems with higher proportion of cowpea to cereals (1Mz:4C, 1S:4C, 2Mz:4C and 2S:4C) had significantly higher returns of the total grains than systems with low cowpea proportions (1:1 and 2:2).

The effect of spraying cowpea, cowpea varieties and planting pattern on the monetary returns of the total produce (grain + fodder) is shown in Table 4. Spraying of cowpea significantly (P<0.05) increased total produce returns of cowpea-cereal systems in both years and the combined. Cowpea variety however, did not have significant effect on returns of the total produce in any of the three analyses, though IT90K-277-2 had higher values. There were significant (P<0.05) differences in the systems for the returns of total produce with sole cowpea having significantly higher values than other systems in 2000 and combined year analysis. Maize-based systems had higher returns of total produce than similar sorghum-based systems.

Table 3. Mean cereal grains and stalk yields (kg ha^{-1}) as affected by insecticide spray of companion cowpea, cowpea varieties and planting patterns in Bauchi, Nigeria.

	Grain			Fodder		
Year	1999	2000	Combined	1999	2000	Combined
Spray treatments						
Spray	1187	413	800	3800	1647	2724
No-spray	1146	339	743	3574	1510	2542
SED (5%)	209	11	99	366	142	231
Variety						
IT90K-277-2	1188	397	793	3450	1567	2509
Yaro	1145	355	750	3724	1590	2657
SED (5%)	32	13	14	308	56	187
Planting pattern (row:row)						
1Mz:1C	1359	714	1037	3266	1252	2259
1Mz:4C	689	252	471	1657	752	1205
1MzS:1C	1653	314	984	5640	2082	3861
1S:1C	1433	454	944	5386	2277	3832
1S:4C	957	202	580	2840	1300	2070
2Mz:2C	1283	515	899	3350	1531	2441
2Mz:4C	799	319	559	1981	947	1464
2S:2C	1346	354	850	5403	2404	3904
2S:4C	979	260	620	3729	1662	2696
SED (5%)	160	34	79	439	161	359
Sole maize	2585	1060	1823	5693	2015	1823
Sole sorghum	2772	960	1866	9769	4134	1866

Mz maize, S sorghum , C cowpea.

Discussion

Insecticide spray had significant and positive effect on the grain yields of cowpea in Bauchi. Both local and improved cowpea varieties responded to the insecticide spray but less spray was needed by the improved variety. This is similar to the results of Alghali [3] who reported response to insecticide spray by the local cowpea landrace (Danila) in Minjibir. The improved variety performed better than the local variety under spray condition but under no-spray treatment, there were no clear differences between the improved and local cowpea variety. This could be attributed to the multiple harvests done on the local variety (it was harvested four times compared to two for IT90K-277-2) and also the incidence of Striga, which was higher on the improved cowpea.

The effect of insects attack appeared less severe in intercrop plots and reduced with increased in cereal proportions. Alghali [2, 3] obtained results similar to this, and recommended intercropping of cowpea with cereal where applications of insecticide were not possible. Mensah [9] also observed a reduction in pests and damage to cowpea in mixtures compared with sole crops. He, however, recommended one to two insecticide applications to maximize cowpea yields. There were no significant differences between mean cowpea grain yields in 1999 and 2000 despite the poor rainfall distribution in 2000. The cereal grain yields were, however, affected by the lower rainfall. The relatively poor rainfall distribution in 2000 actually improved mean cowpea grain yields because of poor performance of the intercropped cereals proving that cowpeas are more tolerant of erratic rain than cereals.

A farmer interested in high fodder production could as well maximize the grain production by applying insecticide to his cowpea without affecting the fodder yield because spraying did not affect cowpea fodder production. The local cowpea variety (Yaro) produced higher fodder than IT90K-277-2 in 1999 but IT90K-277-2 produced higher fodder than Yaro in 2000. Yaro is a photosensitive, late maturing cowpea variety with spreading and climbing growth habit. This growth habit and late maturity might have subsequently led to the production of higher biomass [1] as compared to the early maturing erect IT90K-277-2. This habit also makes it more sensitive to late drought and this may account for its lower fodder yield in 2000 compared to IT90K-277-2. IT90K-277-2 therefore had a more stable fodder production than Yaro.

Striga was a major pest in the trial

Table 4. Mean monetry returns (Naira) on grains and total produce harvested from different spray treatments, cowpea varieties and planting pattern in Bauchi, Nigeria.

	Total Grain			Total Produce		
Year	1999	2000	Combined	1999	2000	Combined
Spray treatments						
Spray	35154	34314	34734	45717	42770	44243
No-spray	31503	20601	21243	32350	3008	31219
SED (5%)	2327	1304	1334	2983	1908	1771
Variety						
IT90K-277-2	31503	27898	29700	39577	38281	38929
Yaro	25538	27017	26277	38489	34576	36533
SED (5%)	714	2024	1073	877	2283	1223
Planting pattern (row:row)						
1Mz:1C	30095	26228	28161	39840	33728	36784
1Mz:4C	27156	32924	30040	40173	44188	42180
1MzS:1C	27841	16358	22100	37114	22722	29918
1S:1C	23260	16822	20041	32090	23084	27587
1S:4C	31773	30356	31065	42053	40403	41228
2Mz:2C	29155	31292	30223	40314	39623	39969
2Mz:4C	30335	31321	30828	41772	39340	40556
2S:2C	24751	22902	23827	33818	29790	31804
2S:4C	28698	29634	29166	38345	38924	38634
Sole Cowpea	32137	36735	34436	44814	52486	48650
SED (5%)	3521	2032	2033	4008	2377	2330
Sole maize	25850	21200	23525	31543	22208	26876
Sole sorghum	27720	19200	23460	37489	21267	29378

Mz maize, S sorghum, C cowpea ; Prices 1999: cowpea grain N40/kg, cowpea fodder N5/kg, Cereal grain N 10/kg, stalk N 1/kg; 2000: cowpea grain N44/kg, cowpea fodder N8/kg, cereal grain N20/kg, stalk N 0.5/kg

area and as cultivation intensifies, the problem is expected to increase. Presently, the improved cowpea variety was able to produce acceptable yield despite the attack, however, with increase in the severity of attack an improved Striga resistant variety would be required in this region.

In 2000 with poor rainfall distribution, both spray and variety seemed to have significant effect on the cereal grain yield. This assertion was supported by Terao *et al.* [21], who reported that competitions between cowpea and cereals for moisture were more severe under moisture stress conditions. Spraying of cowpea increased the cereal grain yield. This may be due to the reduced fodder yields of cowpea under spray treatments, which could result in reduced competition with cereals under low rainfall. It was also noted that Yaro under no-spray condition behaved like a climber and this may have reduced light interception of the maize and consequently grain yield. Similarly, Yaro reduced cereal grain yields compared to IT90K-277-2 because of its climbing growth habit and intense competition, which was more pronounced in 2000 with relatively lower rainfall. Yaro is a late maturing variety staying almost as long as the sorghum in the field; this may also affect the intercropping competition for moisture. This is in agreement with the findings of N'tare [10] who noted that early maturing cowpea cultivars planted in closely spaced hills had less effect on millet yields than the late maturing cultivars. Maize and sorghum had similar grain yields in 1999, a favourable year climatically, however, maize had significantly higher grain yield than sorghum in 2000 because of the end of season drought which affected the late maturing local sorghum used in this trial while the maize was harvested before the drought.

The cereal grain yields were affected by spraying of cowpea while, cereal stalk was not affected by the spray treatment. This confirmed that the effect of competition seen in cereal grain yield occurred at the reproductive phase. Cereal stalk yield was higher than expected in intercrop showing that intercropping was beneficial to the stalk yield confirming the observation of Bandyopadhyay and De [5] in a sorghum-cowpea and sorghum-mungbean intercrop trials who reported that intercropping was beneficial to cereal stalk production.

Spraying of cowpea in the cowpea-cereal systems significantly increased the total grain returns (cowpea+cereal grains) irrespective of the weather conditions. The average cost of insecticide spraying in 1999 and 2000 was ₦1000/ha (1lt insecticide at ₦ 700 and ₦ 300 labour cost). If spraying was carried out three times, the total cost of spraying would be ₦3000/ha. The mean difference in the combined analysis between the total grains return of the spray and no-spray treatments was ₦13491/ha. Deducting the cost of spraying, the balance would be ₦10491/ha signifying the advantage of insecticide spraying of cowpea. This advantage increased with increase in cowpea proportion of the system. Tarawali *et al.*[20], suggested that it would be more profitable for a farmer to grow sole sprayed cowpea if maximum profit is the aim. This suggestion was supported by this trial where intercropped systems, when sprayed produced total grain monetary returns that were as high as or in most cases higher than sole cereal, but sprayed sole cowpea produced grain value more than double that of the cereal grains. This was despite higher sole cereal grain yields. However, when cowpea is not sprayed, the returns on total grain were less than sole cereals underlying the importance of spray in cowpea production.

The maize-cowpea systems were better than the sorghum-cowpea systems when the cereals were 50 percent in the combination but when the cereals were less than 50 percent in the combination sorghum-cowpea systems produced higher total grain value. This was as a result of the greater competition in the sorghum-cowpea systems. Planting patterns with high cowpea proportion especially under the spray treatments produced higher total grain returns than systems with high cereal proportion. This was mainly because of the higher value of the cowpea grains. When the 2Mz:4C, 1Mz:4C and 2Mz:4C planting pattern were sprayed, they produced over 200 percent the value of the sole cereal grains. Higher monetary returns from systems involving intercropping of legumes and non-legumes compared to sole non-legumes were also reported by Krantz *et al.*[8], who attributed it to a better utilization of different resources like labour capital and natural resources.

Spraying of cowpea produced significantly higher mean total produce returns in a cowpea cereal system than no-spray as a result of the effect of spraying on cowpea grain. Comparing the cowpea varieties, the IT90K-277-2-cereal based system would be preferred because of its higher grain yield and early maturity, coupled with the less insecticide needs and labour for harvesting the cowpea.

In both years, the total produce returns from the sole cowpea were higher than the intercropping systems. This confirmed the observation of Singh and Ajeigbe [15], who reported sole crop cowpea to be more profitable than the intercropping systems. The cowpea-maize systems produced higher total produce returns than the cowpea-sorghum systems especially where the proportions of the cereals were high. The reason for this was the better performance of the cowpea in maize-based systems, due to the early matury of the maize used in this trial compared to the local sorghum. The maize was harvested and the stalk was cut early leaving the cowpea (especially Yaro) to continue growth. Sole cropped cowpea with insecticide spray produced total produce returns that almost double that of the sole cereals especially when the improved cowpea was used. The planting patterns, 2M:4C and 1M:4C with spraying appeared to be alternative in situations where the farmers insists on planting maize. This supports the recommendations of Singh and Ajeigbe[15] for strip cropping of cowpea and cereals in a 2 cereal : 4 cowpea row : row combination for higher economic returns when farmers are hesitant to plant sole cowpea. It is therefore concluded that for the small to medium scale farmers who practice intercropping of cowpea with cereals, the 2 row cereal : 4 row cowpea is recommended and improved cowpea varities IT90K-277-2 or Striga resistant one should be encourage. Spraying with insecticide should be encouraged for maximum productivity. Opportunity exits for a second crop of cowpea in the IT90K-277-2-cowpea systems because of the early maturity of IT90K-277-2.

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