Effect of Intercropping and Crop Arrangement on Yield and Yield Component of Late Season Maize and Cowpea in the upland of Njala Soil Series Southern Sierra Leone.

Abstract

A lot of farmers are desirous of cultivating cowpea in intercrop but for fear of crop failure due to the variability in the environment where the two crops thrive best. A sound knowledge of the productivity of cowpea and maize in intercrop in any agro ecological zone is pertinent to food security policies for farming families. This will ensure that innovations to be developed are suitable to meet the economic needs of the various farmer groups and have a high probability of being accepted by the farm families.Hence the need to develop new technology they will practically adapt to late season production of maize and cowpea. It is against this background that this study was conducted to determine the effect of intercropping and crop arrangement on the yield and yield component of late season maize and cowpea in the upland.

A field study was conducted during the 2014 late cropping season (October) in the upland, at the School of Agriculture (SOA). SOA is located on an elevation of 5m above sea level on latitude806N and longitude 1206W of the equator. The aim of the study is to determine the effect of intercropping and crop arrangement on yield and yield component of late season maize and cowpea production in the upland of njala soil series, Kori chiefdom, Moyamba district, southern Sierra Leone.The experiment had five treatments, sole maize crop, sole cowpea crop, intercrop 1 (spacing of 40 cm between rows of maize and cowpeas), intercrop 2 (spacing of 20cm between rows of maize and cowpeas) and intercrop 3 (Both crops were randomly planted). The experimental design used was a randomized complete block design and the experimental plots were replicated three times. There were significant differences in mean Fresh biomass weight, Leaf number and Days to 50%

Key words: Cowpea, Maize, Intercropping, Randomized

INTRODUCTION

Maize (Zea mays L.) is an important cereal crop in the family Poaceae. It is an important source of carbohydrate in human diet and as animal feed in Sierra Leone. Early season maize is planted as cash crop in mixture with other crops and is harvested first from the mixture and sold as fresh maize to consumers.

Farmers practice different cropping systems to increase productivity and sustainability (H. Hauggaard-Nieson, et al 2001). Intercropping is the simultaneous growing of two or more crops in the same field (F. O. Takim, 2012) and is a cropping system that has long been used for a long-time in tropical areas where Sierra Leone is no exception. It increases total productivity per unit area through maximum utilization of land, labor and growth resources (P.Q. Craufard, 2000). Yields of intercropping are often higher than in sole cropping systems (A.S. Lithourgidis, et al 2006) mainly due to resources such as water, light and nutrients that can be utilized more effectively than in sole cropping systems (L. Li, 2006,). Cereal-legume intercropping plays an important role in subsistence food production in both developed and developing countries, especially in situations of limited water resources (M. Dahmardeh, et al 2010,). Intercropping of cereal and legume crops helps maintain and improve soil fertility (M. Tsubo and S. Walker, H.O. Ogindo, 2005,) and plays an important role in subsistence food production in developing countries (M. Dahmardeh, et al 2010) because farmers cannot afford inorganic fertilizers. Legumes fix atmospheric nitrogen, which may be utilized by the host plant or may be excreted from the nodules into the soil and be used by other plants growing nearby (R.W. Andrews, 1979). Legumes can also transfer fixed N to intercropped cereals during their joint growing period and this N is an important resource for the cereals (Q.R. Shen and G.X. Chu, 2004). The use of intercropping by smallholder farmers is a common practice (J. Ofuso-Amin and N.V. Limbani, 2007) that dates back to ancient time in the tropics and rain-fed areas worldwide. Declining crop yields in the smallholder farms in dry land cropping systems in Sierra Leone present the need to develop a more sustainable cropping system, to maintain productivity in smallholder cropping systems in Sierra Leone. Intercropping legumes with non-legume in Sierra Leone can be a principal means of intensifying crop production both spatially and temporally to improve crop yields for smallholder farmers. Legume intercrops are a potential source of plant nutrients that compliment/supplement inorganic fertilizers (P. Jeranyama,et al 2000). Legume intercrops have several socioeconomic (F. Ofori and W.R. Stern, 1987), and biological and ecological (F. Chemeda, 1996) advantages compared to sole cropping for small-holder farmers (F. Chemeda, 1997). In addition, certain legumes crops provide food to humans and livestock (P. Jeranyama, 2000). There are several intercrop arrangements which may include row intercropping worldwide.

The objective of the present study was therefore to determine the effect of Intercropping and Crop Arrangement on Yield and Yield Component of Late Season Maize and Cowpea in the upland of Njala Soil Series Southern Sierra Leone.

MATERIALS AND METHODS.

Predominantly, the land scape of njala is covered with secondary bush and consists of well-balanced mixture of sand, clay, and humus. The site to be specific was densely covered with elephant grass, spear grass and sedges. The land have a gently slope. The soil of the experimental site belongs to the njala soil series (orthxic-palehumult). The soils are generally low in moisture, have a low nutrient status and are highly acidic with pH ranging from 5.5-6.0

The experiment had five treatments, sole maize crop, sole cowpea crop, intercrop 1 (spacing of 40 cm between rows of maize and cowpeas), intercrop 2 (spacing of 20cm between rows of maize and cowpeas) and intercrop 3 (Both crops were randomly planted).

Table 1: Showing the different treatment assigned to different plot

NUMBER	EXPERIMENTAL TREATMENT
1	Sole maize
2	Sole cowpea
3	Intercrop one: (1 row maize : 1 row cowpea)
4	Inter crop two: (1 row maize : 3 rows cowpea)
5	Intercrop three: (both crops randomly planted)

The experimental design used was a randomized complete block design and the experimental plots were replicated three times. An area of 17m × 14m was laid out in the plough land. The area was then marked out into three replications of 17m × 3m and fifteen plots of 4m × 3m ($12m^2$) each for both the sole and intercropped plots. A discard of 1m was allowed in between replications and each replication contains five plots with 0.5m between plots.

The experimental field was prepared by ploughing the soil to a depth of 30 cm and harrowing manually. Planting was carried out on the 15th October 2014. The cowpea variety IT99K-573-2-1 was the improved type, high yielding and semi upright, while maize variety DMR-ESR was used. The cowpea and maize were all sown simultaneously. In the sole maize crop treatment, three maize seeds were sown per hole at a depth of 5cm and later thinned to one seedling/hole at a spacing of 80 × 50 cm. In the sole cowpea crop treatment, two seeds were sown per hill at depth of 5 cm and later thinned to one at 50×30 cm spacing. In the intercrop 1 treatment, there were six rows of maize planted at spacing of 80×50 cm and between every two rows; a row of cowpea was placed at 40 cm from maize rows and 30 cm between plants. In the intercrop 2 treatment, after a row of maize, three rows of cowpeas were planted at a spacing of 20×20 cm and a row of maize placed at a spacing of 20 cm from cowpeas and 50 cm between plants. In the intercrop 3 treatment, both maize and cowpea were planted randomly. Watering was also done when crops showed water stress and weeding was done manually when necessary. No insecticide application was made.

Two hand weeding was done; the first was done three weeks after planting (3WAP) and the weeding 6WAP.

In each plot, five Specific maize and cowpea plants were tagged for measurements and harvested at end of the experiment to determine dry matter (DM) weight. The following parameters were assessed: Number of pods, number of cobs per plant, plant height, number of lateral branches, number of leaves for both crops, stems girth, leaf area, ear height, weight of 100 seeds and DM weight at the end the experiment.

The data collected were subjected to analysis of variance and means were separated using least significant difference.

RESULTS.

TABLE 2: Mean Plant height, Leaf area, Leaf number and Stem girth as affected by intercropping andCropping arrangement

TREAMENT	Plant height(cm)		Leaf area(cm^2)		Stem girth(cm)		Leaf number	
	3wap	6wap	3wap	6wap	3wap	6wap	3wap	6wap

SM	20.0	116.1	95.5	254.6	0.483	1.581	5.733	12.267
INTM 1	17.9	113.8	82.8	220.7	0.444	1.317	5.667	12.133
INTM 2	17.8	113.0	79.8	213.8	0.437	1.312	5.333	11.533
INTM 3	16.6	111.5	74.0	202.9	0.435	1.177	3.967	9.767
MEAN	18.1	113.6	83.0	223.0	0.450	1.347	5.175	11.425
LSD (5%) $_T$	7.68ns		56.76ns		0.3328ns		0.5401***	
LSD (5%)$_{WAP}$	5.43***		40.13***		0.2353***		0.3819***	
LSD (5%)$_{T*WAP}$	10.86ns		80.27ns		0.4706ns		0.7638ns	
CV (%)	9.4		30.0		29.9		2.9	

SM=sole maize, INTM=intercrop maize, ns=non-significant, *=significant at p<0.05, **=significant at p<0.01, ***=p<0.00

PLANT HEIGHT

The mean Plant height of maize significantly increases as the plant grew from 3WAP – 6WAP and it was observed that the sole maize produced the longest plant height (20.0) and (116.1) respectively, and the shortest (16.6) and (111.5) plant height respectively was recorded for intercrop 3. Statistically, plant height were not significantly affected by the three intercropping system,

LEAF AREA

The leaf area in both the sole and the intercropped maize produced significantly larger area as the plant grew from 3WAP-6WAP. It was observed that the sole maize have produced the largest (195.5) and (254.6) leaf area respectively and the smallest (74.0) and (223.0) leaf area was respectively recorded for intercrop 3. There were no significantly difference amongst maize in the intercropping system; maize in the intercrop 1 however produced the largest (82.8) and (220.7) leaf area when compared to intercrop2 &3 systems.

STEM GIRTH

From the above in table 2, it could be seen from statistical analysis that there was significant difference in stem girth as the plant grew from 3WAP–6WAP, where the sole maize was observed to have produces the largest (0.483) and (1.581) stem girth respectively when compared to intercrop. There was no significant difference in stem girth with respect to the three intercropping arrangement. However it was observed that intercrop 1 respectively produced the largest (0.444) and (1.317) stem girth when compared to intercrop 2&3. And the least (0.435) and (1.177) stem girth was recorded for intercrop 3.

LEAF NUMBER

Statistical analysis shows that significant differences exist in mean number of leaves as the plant grows from 3WAP – 6WAP, where the sole maize produced more leaves (5.733) and (12.267) respectively than the intercrop. Significant differences were also observed in the mean number of leaves with respect to intercropping and the highest mean number of leaves (5.667) and (12.133) respectively was recorded for intercrop 1 and the least (3.967) and (9.767) for intercrop 3.

TABLE 3: Mean days to 50% tasselling, ear height, fresh ear weight, and fresh biomass weight as affected by intercropping and cropping arrangement at Njala

TREATMENT	Days to 50% tasselling	Ear height	Fresh ear weight	Fresh biomass weight
SM	54.00	54.4	0.593	1150
INTM 1	53.67	53. 5	0.550	1367
INTM 2	45.67	53. 4	0.517	1282
INTM 3	45.67	51.8	0.450	1033.
MEAN	49.75	53.3	0.527	1208
LSD (5%) T	5.562***	0.03211ns	0.4493ns	137.9*
CV(%)	5.6	8.1	10.1	5.7

SM=sole maize, INTM=intercrop maize, ns=non-significant, *=significant at p<0.05, **=significant at p<0.01, ***=p<0.001

DAYS TO 50% TASSELLING.

The table above shows that there was significant difference in the mean days to 50% tasselling. The sole maize tassels earlier (54.00) than maize in the intercrop arrangement, among the intercrop arrangement, intercrop 1 tassels earlier (53.67) when compared to intercrop 2 and 3 who were at par (45.67) recording the least mean number of days to 50% tasselling.

EAR HEIGHT

Statistically, there was no significant difference in the mean ear height among the sole maize and intercrop maize. However, sole maize crop produced the highest mean ear height (54.4). And intercropped 3among the intercrop arrangement recorded the least (51.8) ear height.

FRESH EAR WEIGHT

Sole maize crop produced no significant difference in fresh ear weight when compared to the intercrop treatments. However the highest (0.593) ear weight was recorded for sole maize and the least (0.450) ear weight recorded for intercropped 3 among the intercrop arrangement.

FRESH BIOMASS WEIGHT

There were significant differences in the mean fresh biomass weight of maize between the sole and intercrop maize. Among the intercrop arrangement, the mean fresh biomass of Intercrop 1 maize produces the highest (1367) fresh biomass weight. This was followed by intercrop 2. The sole maize produces the least (1033) value for fresh biomass weight which was significant reduced when compared to the three intercropping treatments.

TABLE 4: Shelled grain weight (kg) and yield attributes of maize as affected by intercropping and cropping arrangement at Njala

TREATMENT	Shelled grain weight (Kg)	Dry cob weight (kg)	Cob length (cm)	Cob diameter (cm)	1000 grain weight (kg)
SM	0. 463	0.523	22.92	4.423	0.2067
INTM 1	0.357	0.403	21.01	4.191	0.2067
INTM 2	0.343	0.390	20.59	4.078	0.2000
INTM 3	0. 270	0.307	20.06	3.925	0.1767
MEAN	0.358	0.406	21.14	4.154	0.1975
LSD (5%) $_T$	0.2791ns	0.3160ns	3.448ns	0.4586ns	0.03211ns
CV (%)	39.0	39.0	8.2	5.5	8.1

SM=sole maize, INTM=intercrop maize, ns=non-significant, *=significant at p<0.05, **=significant at p<0.01, ***=p<0.001

SHELLED GRAIN WEIGHT

Intercropping and crop arrangement had no significant effect on shelled grain weight of maize. The sole maize crop produced reasonably the highest (0. 463) grain weight than any of the intercrop arrangements. Grain weight produced by the sole maize was higher than that obtained at intercropped 1, 2 and 3 arrangements, respectively. Among the intercrop arrangements, the intercropped 1 produced the highest (0.357) grain weight and intercropped 3 the lowest (0. 270) grain weight which was not statistically significantly than any of the weight obtained in intercropped 1 & 2 arrangements.

DRY COB WEIGHT IN MAIZE

Intercropping and crop arrangement had no significant effect on cob weight, the sole maize crop produced reasonably higher (0.523) cob weight compared to intercrop 1, 2 &3. Among the intercropped arrangements, intercrop 1 crop arrangement produced reasonably higher (0.403) cob weight whilst intercropped 3 the lowest (0.307) weight.

COB LENGTH

The sole maize produced the longest (22.92) cobs length than any of the intercrop arrangements, while among the intercrop arrangements; the intercrop 3 produced the shortest (20.06) cobs. However, the cob length difference between the sole crop and intercropped 1, 2 and 3 arrangements were not significantly different.

COB DIAMETER IN MAIZE

The sole crop gave the highest (4.423) cob diameter which was reasonably higher than those obtained either in intercropped 1, 2 or 3 arrangements. Crop arrangement had no significant effect on cob diameter. However intercropped 1 gave the highest (4.191) cob diameter when compared to intercropped 2 &3 respectively. Whilst intercrop 3 gave the least (3.925) cod diameter.

1000-GRAIN WEIGHT IN MAIZE

Thesole maize crop produced higher (0.2067) mean 1000-grain weight which was at par with intercrop 1but higher than the intercrop 2 and 3cropping arrangements. Among the intercrop arrangementsthe intercropped 3 produced the least (1767) weight. However, the 1000-grain weight difference between the sole crop and intercropped 1, 2 and 3 arrangements were not significantly different.

COWPEA

TABLE 5: Mean Plant height, Leaf area, Leaf number and Stem girth of cowpea as affected by intercropping and cropping arrangement.

	Plant height (cm)		Leaf area (cm^2)		Leaf number		No. of branches	
TREATMENT	3 WAP	6 WAP	3 WAP	6 WAP	3 WAP	6 WAP	3 WAP	6 WAP
SC	17.13	35.43	20.48	37.28	14.8	60.3	4.2	22.9
INTC 1	16.43	33.01	19.58	30.52	14.0	54.4	3.9	20.2
INTC 2	14.07	31.31	16.20	28.70	12.5	46.5	3.8	15.6
INTC 3	13.50	31.10	16.01	27.93	11.5	45.4	3.4	14.1
MEAN	15.29	32.71	18.07	31.11	13.2	51.7	3.8	18.2
$LSD_{(5\%)T}$	1.24***		4.94*		5.71ns		2.0***	
$LSD_{(5\%)WAP}$	0.88***		3.49***		4.04***		1.4***	
$LSD_{(5\%)T\times WAP}$	1.75ns		6.99ns		8.08*		2.8**	
CV (%)	4.2		16.2		14.2		14.4	

SC=sole maize, INTC=intercrop maize, ns=non-significant, *=significant at p<0.05, **=significant at p<0.01, ***=p<0.001

PLANT HEIGHT (cm)

The mean plant height increases significantly as the plant grew from 3WAP – 6WAP. And it was observed that the sole cowpea significantly out grew the intercrops and produced the tallest (117.13) and (35.43) mean plant height respectively. Results presented in Table 5 indicated that there were significant differences in mean plant heights among intercrop cowpea. However, among the intercrop treatment, Intercrop 1 produced significantly more plant height (16.43) and (33.01) respectively than cowpea in intercrop 2 & 3. And intercrop 3 was found to have produced the shortest (13.50) and (31.10) plant height. Overall, the sole and intercrop cowpeas were taller compared to intercrop 2 & 3.

LEAF AREA (cm2)

Result from the table above indicates that the mean leaf area significantly increases at 6WAP when compared to mean leaf area at 3WAP; this was portrayed by a 5% level of significant. Results of the study indicate that, there were significantly differences in the mean leaf area. The highest (20.48) and (37.28) mean leaf area was produced by cowpea in the monocrop than all the other cowpea intercropped with maize. However, among the intercrop treatment, Intercrop 1 significantly produced the highest (19.58) and (30.52) leaf area than cowpea in intercrop 2 & 3. And intercrop 3 was found to have produced the least (16.01) and (27.93) mean leaf area. Overall, the sole and intercrop 1 cowpeas produced the leaf area compared to intercrop 2 & 3 arrangement respectively.

NUMBER OF LEAVES

There were significant differences in the mean number of leaves at 6WAP when compared to those produced at 3WAP, as portrayed by a 5% level of significant. Results presented in Table 5 indicate that, there were no significantly differences in the mean number of leaves. It was however observed that the sole cowpea produced high number (14.8) and (60.3) of leaves at both 3WAP and 6WAP respectively than all the other cowpeas in the intercrops. However, among the intercrop treatment, Intercrop 1 produced reasonably more leaves (14.0) and (54.4) than cowpea in intercrop 2 & 3. And intercrop 3 was found to have produced the least(11.5) and (45.4) number of leaves respectively. Overall, the sole and intercrop 1 cowpeas produced the highest number of leaves compared to intercrop 2 & 3 arrangement.

NUMBER OF LATERAL BRANCHES

Generally, both sole and intercrop cowpea had significantly more branches at 6WAP when compared to 3WAP, as portrayed by a 5% level of significant. Results presented in Table indicate that, there were significantly more branches (4.2) and (22.9) produced by sole cowpea both at 3WAP and 6WAP respectively than cowpea in the intercrop in the intercrop arrangement. However, among the intercrop treatment, Intercrop 1 produced significantly more branches (3.9) and (20.2) than cowpea in intercrop 2 & 3. And intercrop 3 was found to have produced the least number (3.4) and (14.1) of lateral branches. Overall, the sole and intercrop 1 cowpeas produced more lateral branches compared to intercrop 2 & 3.

Table 6: The effect of intercropping and cropping arrangement on shelled grain weight (g), and yield attribute of cowpea

TREATMENT	Days to 50% flowering	Fresh biomass weight(g)	No. of pods per plant	Dry pod weight(g)	Shelled grain weight(g)	1000 grain weight (g)
SC	45.0	1150.0	18.1	850.0	583.0	166.7
INTC 1	43.0	1367.0	16.7	817.0	533.0	150.0
INTC 2	43.0	1282.0	16.1	733.0	533.0	150.0
INTC 3	42.3	1033.0	14.3	650.0	533.0	150.0
MEAN	43.3	1208.0	16.3	762.0	546.0	154.2
LSD (5%) $_T$	2.5ns	137.9**	2.1*	274.6ns	138.3ns	28.8ns
CV(%)	2.9	5.7	6.4	18.0	12.7	9.4

SC=sole cowpea, INTC=intercrop cowpea, ns=non-significant, *=significant at p<0.05, **=significant at p<0.01, ***=p<0.001

DAYS TO 50 % FLOWERING.

Sole cowpea flowered earlier (45.0), even though not significant when compared to intercrop cowpea. Intercrop Cowpea differed reasonably in days taken to 50% flowering. Among intercrop, cowpea in intercrop 1 flowered earlier (43.0) than the rest of the cowpeas in the other intercrop. And intercropped 3 were observed to have flowered late (42.3) in this study. However, cowpea in monocrop and intercropped 1cowpeas flowered earlier when compared to cowpeas in intercropped 2 & 3 arrangements respectively

FRESH BIOMASS WEIGHT

The result showed that there was a significance difference in mean fresh biomass weight between mono crop and intercrop cowpea, where the sole cowpea recorded (1150.0) mean fresh biomass weight which was significantly reduced when compared to intercropped cowpea. In addition, the mean fresh biomass in both the sole and among the intercrops the highest (1367.0) mean fresh biomass weight was recorded for intercrop 1 cowpea and low value (1033.0) for intercrop 3 cowpea intercrop arrangement

NUMBER OF PODS PER PLANT

Overall, sole cowpea produced significantly a higher number (18.1) of pods per plant when compared to the cowpeas in the intercrop. However, Intercrop Cowpea differed significantly in the number of pods per plant. Among intercrops, cowpea in intercrop 1 produced the highest number (16.7) of pods per plant than cowpeas in the other intercrops (2 and 3). And intercropped 3 were observed to have the least number (14.3) of pods per plant in this study. However, cowpea in monocrop and intercropped 1respectively produces the highest number of pods per plant when compared to cowpeas in intercropped 2 & 3 arrangements.

DRY POD WEIGHT

Intercropping had no significant effect on dry pod weight; the sole cowpea crop produced reasonably higher (850.0) dry pod weight compared to intercrop 1, 2 &3. Among the intercropped arrangements, intercropped 1 crop arrangement produced reasonably higher (817.0) cob weight whilst intercropped 3 the lowest weight (650.0)

SHELLED GRAIN WEIGHT

Overall, cowpea grain weight was higher (583.0) in sole cowpea when compared to grain weight of cowpeas in the intercrop system. Intercropping and crop arrangement had no significant effect on grain weight of cowpea. However, the mean shelled grain weight (533.0) was at par in both intercrop 1, 2, and 3

1000 SEED WEIGHT

The mean1000 seed weight was not significant between the sole cowpea compared to cowpeas in the intercrop. Significant differences were not also observed among the intercropped; cowpea in intercrop 1 produced the highest seed weight (150.0) which was at par with intercrop 2 and 3. However, cowpea in monocrop register the highest (166.7) seed weight

TABLE 7: LAND EQUIVALENT RAIO

TREATMENT	LER
INTM 1	1.69
INTM 2	1.66
INTM 3	1.50

The higher LER for maize cowpea intercrops (1.69) was recorded in these findings (table 7) which show that intercropping of maize-cowpea was advantageous in many instances rather than sole cropping. Yield advantage from intercropping, as compare to sole cropping are often attributed to mutual complementary effect of component crops.

DISCUSSION OF RESULTS

The practice of intercropping helps farmers increase profit margins and often slows down the growth of weeds. In addition, monitor pest and disease events and guide to prevent crop disappointment. Some research papers on intercropping have been introduced in detail. However, the agronomic recommendations for intercropping corn with cowpea and other food crops are not enough, especially in terms of row arrangement, water shortage conditions, and ideal and optimal populations that make up the crop. This may endanger the productivity and quality of future crops.

Focusing on this, agronomic growth and yield parameters in the maize-cowpea intercropping system are very important in determining the effects of late maturing seasons and crop arrangements. Therefore, current research focuses on the behavior of corn and cowpea in terms of growth and yield characteristics.

The results from this experiment show that with the growth of plants from 3WAP to 6WAP, the average plant height, leaf area, and stem circumference of maize increased significantly, and the performance of single plant maize on all these parameters was better than that of intercropping, but nonetheless there is no significant difference in staggered arrangement. In the intercropping arrangement, intercropping 1 is superior in all these parameters. Interaction 3 records the minimum value of all these parameters. These findings are consistent with the results of Silwana and Lucas (2002), who found that in the absence and presence of weeds, corn monoculture is higher than intercropping with beans. Thwala and Ossom (2004) found no significant difference between maize monoculture and intercropping with beans and peanuts.

It can also be seen from the results that intercropping and crop arrangement significantly affect the number of leaves of 3WAP-6WAP. During these two weeks, the number of leaves produced by a single corn was significantly higher than the number of leaves obtained from any intercropping and crop arrangement. In the intercropping arrangement, the average number of leaves in intercropping 1 is the highest. Intercropping 3 continuously and significantly produces the least number of leaves. The high average leaf number of a single corn may be due to the lack of competition for resources such as light, nutrients and water. The current research has not determined any factors that determine the competition of intercropping systems. On the other hand, differences in root depth, lateral root extension, and root density are some of the factors that affect nutrient competition between component crops in the intercropping system (H Eskandari and A. Ghanbari, +2009).

From a statistical point of view, intercropping and crop arrangement have a significant impact on average ear height, days of 50% tasselling, but the height of the ears of corn and the weight of the fresh ears are not significant. However, a single corn crop has the highest yield for these traits. And in the intercropping arrangement, the mean values of these intercrop-3 traits are always lower than intercrop-1 and 2. This is because the intraspecific competition of the corn-bean intercrop precedes the intraspecific competition of a single corn. Wahua (1983) mentioned that when component crops compete for nutrients, resource development and productivity can be delayed. Therefore, low nitrogen levels in the soil will reduce growth and ultimately males (Ugen and Wien, 1996). These results are consistent with the report by Ugen and Wien (1996), who reported that plain maize was harvested and matured earlier than maize intercropped with beans.

Intercropping and crop arrangement have a significant impact on the average weight of fresh biomass produced. The fresh biomass produced by a single corn is significantly higher than that obtained through any intercropping arrangement. Among the intercropping arrangements, Intercrop-1 corn produced the highest fresh biomass weight. This may be due to the high density of plants and the lack of competition for resources such as light, nutrients and water. This study has not determined the factors affecting the competition of intercropping systems. However,

differences in root depth, lateral root expansion, and root density are some of the factors that affect nutrient competition between component crops in the intercropping system [H. Eskandari and A. Ghanbari, 2009,].
Intercropping and crop arrangement did not have a significant effect on ear weight, grain weight, and 1000 grain weight. Compared with any intercropping arrangement, the single corn crop reasonably produced the highest weight of dry cob, weight of shelled grain, and weight of 1000 grain. However, the weight of 1,000 grain produced by a single corn crop is statistically equivalent to that of intercropping 1. Basically, there is no obvious contrast in the intercropping arrangement: intercropping 1 produces the dry cob weight and the weight heaviest grains, and intercrop 3 has the lightest weight of cod and grain. Compared with the cultivation of grains alone, the competition between mixtures is considered to be the main factor affecting these parameters (P.A. Ndakidemi, 2006). This finding is also consistent with the results obtained in a study conducted by the Ministry of Agricultural Research (1983/84), which reported that sorghum-cowpea intercropping did not reduce or increase sorghum production. The results are also consistent with Haizel (KA Haizel, 1974) who studied cowpea and corn, Andrews (DJ Andrews, 1972) and Rees (DJ Rees, 1986) who studied cowpea sorghum and Karikari (SK Karikari), 2003) Who used corn-class Bala peanut and sorghum-Bambara peanut intercropping system. My results are consistent with Fisher (1980). He did not find a significant difference in grain yield between single corn and intercropped corn. This situation is similar to the results I obtained in this study. On the other hand, he disagrees with the views of Gunasena et al. (1979) and Dalal (1977), they increased the yield of mixed corn kernels several times over that of a single crop.
Single corn produced the longest and largest ears of any intercropping arrangement, and in the intercropping arrangement, intercropping 3 produced the shortest and smallest ears of corn. However, there were no significant differences in cob length and diameter between monoculture and intercropping arrangements. This may be consistent with the fact that plant growth is restricted to very high and very low water levels. Water stress leads to a reduction in cell division and elongation, which affects growth and is directly related to the absorption of nutrients by plants. When the water supply is sufficient, the increased absorption of nutrients will increase the water use efficiency of the plants. Low water content reduces the activity of microorganisms and leads to decreased nitrogen supply (Metcalfe and Elkins, 1980). In the intercropping process, when water is the limiting factor, crops will compete for water, resulting in insufficient nutrient supply, resulting in slow growth and low yields.

COWPEA

The results showed that intercropping and crop arrangement significantly affected the average plant height and leaf area of 3WAP-6WAP. Compared with any different intercropping arrangement, a sole cowpea produces a significant average plant height and highest leaf area. However, in the intercropping treatment, the plant height and leaf area of intercropping 1 were significantly higher than that of cowpea intercropping 2 and 3. And it was found that Intercropping 3 produced the lowest average leaf area. This result is inconsistent with the findings of Singh (1981), who reported that although not significant, the intercropping produced higher cowpea plants. Similarly, when intercropped with corn, the leaf area of cowpea varieties increases considerably. This is consistent with the findings of Ofori and Stern (1987), who reported similar increases in dry matter yield, leaf area and leaf area index under an intercropping system.
As plants age from 3WAP-6WAP, the average number of leaves has a significant impact. During these two weeks, the single cowpea had more leaves than all the other cowpeas in the intercrop. Although not significant, intercropping 1 produced reasonably more leaves than cowpea in intercropping 2 and 3. There is no significant difference in mean number of leaves, clearly showing the importance of seasonal changes. Leaves are the main source of evapotranspiration, so plants tend to reduce leaf growth in limited water conditions to minimize water loss (Afuakwa and Crookston, 1984). The insignificance of the average number of cowpea leaves is contrary to the observations made by Eagles (1990), who reported that shading had a significant effect on cowpea during the intercropping period. Although the shading effect delayed the shedding of leaves from the 1 cowpea plants that were intercropped, the cowpea showed a strong decrease in leaves due to senescence, especially the 3 cowpea that was intercropped. This is similar to the observation of Wahua (1993), who reported that “the severe shade of cowpeas during the flowering period of corn can accelerate foliar senescence, accompanied by the loss of the lower leaves of legumes.
These results also had shown show that under 3WAP and 6WAP, cowpea only produces significantly more lateral branches than cowpea in the intercropping arrangement. In the intercropping treatment, intercropping 1 produced significantly more branches than cowpeas in intercropping 2 and 3. Maize plants in the intercropping of this study can shade cowpea, thus reducing the amount of light required to stimulate the production of the following growth parameters. These results also showed that the number of lateral branches per plant in intercrop 1 was significantly higher than that of intercrop 2, which may be due to the difference in plant density between the two planting modes.

Days to 50% flowering is not significantly affected by intercropping and crop arrangement. However, compared with intercropping cowpea, single cowpea flourished earlier. The intermediate corn plant in this study can shade cowpea by reducing the amount of light required to stimulate flowering. Maize is usually taller, growing faster or has a wider root system; especially a large number of fine roots, which are competitive to soil nitrogen (K. Carruthers et al., 2000 and I. H. Alhaji, 2008).

The results showed that the average fresh biomass of a single cowpea was significantly the lowest compared with any intercropping arrangement. In the intercropping arrangement, the average weight of the fresh biomass of intercropping 1 was significantly recorded. Due to the lack of competition for resources such as light, water and nutrients, a single cowpea crop grows and matures faster. This causes the cowpea plants to lose some leaves before harvest to analyze the biomass weight. The shedding of some leaves in the field may reduce the biomass weight in cowpea crops. It was observed that the intercropped cowpea still had leaves when they matured, this may be because the shade of the corn prevents them from drying out. Intercropping 1 produces more biomass weight than single crop and intercropping 2. At the end of the study, the cowpea from intercropping 1 still had leaves. Cowpea in intercropping 3 produced the least biomass, which may be due to resource competition due to high plant density. In this experiment, one possible explanation is the ability of the component crops to develop different layers of soil without competing with each other (Willey, 1979). May make better use of resources, such as (i) light (Gustavo et al., 2008), (ii) nutrients (willey, 1990) and water (willey, 1990). Other researchers (Ghanbari and Lee, 2003) reported similar results for intercropping pulses and grains, reporting that the yield of intercropping forage was higher than the yield of either species alone.

Intercropping and crop arrangement have a significant impact on the number of pods per plant. However, compared to any intercropping arrangement, a single cowpea produced significantly the highest number of pods per plant. In the intercropping arrangement, cowpeas from intercropping 1 produced significantly more pods than cowpeas from intercropping 2 and 3. The close spacing of intercropping 2 and 3 leads to high densities of cowpea plants, which leads to competition for growth resources. This is consistent with the results of a study conducted by the Ministry of Agricultural Research (1983/84), which also reported that intercropping reduced cowpea yield

The intercropping arrangement had no significant effect on the dry pod weight; compared to intercropping 1, 2 and 3, the single cowpea crop produced a reasonably higher dry pod weight. In the intercropping arrangement, the intercropping arrangement produced a reasonably higher pod weight, and the pod weight of the three sandwich crops was the lowest. The results of this study show that cowpea outperforms mixed planting when planted as a single crop. When intercropping with corn, the weight of pods and pods was not significantly reduced, but they were reduced. Although intercropping resulted in an overall decline in cowpea production, intercropping 1 had the highest grain yield. This is consistent with the results of Ofori and Stern (1987), who reported that intercropping led to a decrease in cowpea production, but did not comply at all with the increase in yield reported by Singh and Ahuja (1990).

Intercropping and crop arrangement had no significant effect on cowpea shell weight. Generally speaking, compared with the weight of cowpea beans in an intercropping system, cowpea has a higher shell weight in a sole crop. However, in periods 1, 2, and 3, the average grain weights were statistically equivalent. Chemeda (1997) reported that grain yields in intercropping were higher compared to intercropping. Under the number of intercropping 1, corn plants competition for water, nutrients and shade may be two factors that reduce cowpea yield (Lesoing and C. A. Francis, 1999,). It has been found that the yield obtained by intercropping can be affected by many variables, such as competition between plants and second season crops, and changes in plant population density. The structure of the vegetal vegetation, its cultivation structure and the total leaf area determine the distribution of light in the canopy (Fortin and Piercel., 1996). Light transmittance decreases during canopy development and is further complicated by population density and intercropping. Foroutan-pour et al. Also noted similar results. (1999) Show that soybean canopy development is affected by population density and intercropping.

The average weight of 1,000 seeds is not significantly affected by intercropping and crop arrangement. The results showed that the average weight of a sole crop of cowpea was the highest, with 1000 seeds. There was no significant difference in the weight of 1000 cowpea seeds between the treatments. This is consistent with (R. Chakma et al., 2011), no significant difference in weight of 1,000 seeds was observed in the popcorn-mung bean/cowpea intercropping system.

The intercropping land use efficiency measured by the intercropping LER value is greater than 1.0. Therefore, this indicates that the land use efficiency of corn and cowpea intercropping is more advantageous than monoculture. In general, monoculture yields higher yields compared with intercropping systems. However, in most cases, land productivity as measured by LER shows the advantages of mixed planting of cereals and beans (Mandal et al., 1990; Yunusal) , 1989). It has been reported that the LER of intercropping corn beans (Saban et al., 2007) and wheat-lentil (Carr et al., 1995) is greater than 1.0.

CONCLUSIONS

Sole maize yielded the highest maize grain weight, yield components and other growth parameters (Plant height, Leaf area, Leaf number and Stem girth).

Sole cowpea yielded the highest cowpea grain weight, yield components and other growth parameters (Plant height, lateral branches,Leaf area, and Leaf number)

Among the intercrops, intercrop 1 yielded the highest grain weight, yield components and other growth parameters for intercrops.

The LER of intercrop1 &2 were above 1.0 indicating that the land utilization efficiency for maize- cowpea intercropping was more advantageous than for sole cropping

REFERENCES

1. A.S. Lithourgidis, I.B. Vasilakoglou, K.V. Dhima, C.A. Dordas and M.D. Yiakoulaki, 2006, Forage yield and quality of common vetch mixtures with oat and triticale in two seeding ratios. Field Crop Res. 99: 106−113.
2. Agriculture Research Division (1983/84). Annual report for the Division of Arable Crop Research 1979 – 84. Agriculture Research Division, Ministry of Agriculture. Gaborone, Botswana.
3. Ahmadu Bello University, Zaria. In: *Proceedings of the First National Meeting of the Nigerian Soybean Scientists,* International Institute for Tropical Agriculture,Ibadan, Nigeria. November 1980.
4. ALLEN, J. R., & OBURA, R. K, R. K., 1983. Yield of corn, cowpea, and soybean under different intercropping systems. Agron J. 75, 1005- 1009.
5. Carr, P.M., J.J. Gardner, B.G. Schatz, S.W. Zwinger and S.J. Guldan, 1995. Grain yield and weed biomass of a wheat-lentil intercrop. Agron. J., 87: 574-579.
6. CHEMEDA, F., 1997. Effects of planting pattern, relative planting date and intra-rowspacing on a haricot bean/maize intercrop. African crop Sci. J. 5(1) 15- 22.
7. D.J. Andrews, 1972, Intercropping with sorghum in Nigeria. Exp. Agric. 8(2):139−150.
8. D.J. Rees, 1986, Crop growth, development and yield in intercropping sorghum with cowpea in semi-arid conditions in Botswana. II. Exp. Agric. 22(2):169−177.
9. Dalal, R. C. (1977). Effect of intercropping maize with soybean on grain yield. *Tropical Agriculture,* 54, 189-191.
10. Desir, S. and Pinchinat, A. M. (1976). In Francis, C. A., Flor, C. A. and Prager, M. (1978c)). Effects of Bean Association on Yields and Yield Component of Maize. Crop Science18(1): 760 – 764.
11. Eagles, C.C. (1990):Crop Science production in warm climates. Macmillan Publisher, London. Pp 207 - 209
12. Elings, A., 2000. Estimation of leaf area in tropical maize. Agron. J., 92: 436-444.
13. ENYI, B. A.C., 1973. Growth rate of three cassava varieties under varying population densities. *J. Agric*. 81, 15- 28.
14. F. Chemeda, 1996, Effect of bean and maize intercropping on bean common bacteria blight and rust diseases. Int. J. Pest Manag. 42(1):51−54.
15. F. Chemeda, 1997, Effects of planting pattern, relative planting date and intra-row spacing on a haricot bean/maize intercrop. Afr. Crop Sci. J. 5(1):15−22
16. F. O. Takim, 2012, Advantages of Maize-Cowpea intercropping over sole cropping through competition indices. J. Agric. Biod. Res., 1(4): 53−59.
17. F. Ofori and W.R. Stern, 1987, Cereal and legume intercropping systems. Advances in Agron. 41:41−90.
18. Fisher, N. N. (1980). A note on agronomic research with soybean at the Institute for Agricultural Research,
19. Foroutan-pour, K., Dutilleul, P., Smith, D. L. (1999): Soybean canopy development as affected by population density and intercropping with corn: fractal analysis in comparison with other quantitative approaches. Crop Sci.,39, 1784‑1791
20. FORTIN, M.C. & PIERCE, F.J., 1996. Leaf azimuth in strip-intercropped corn. Agron. J.88, 6-9.
21. Ghanbari Bonjar, A. and H.C. Lee, 2003. Intercropped wheat (*Triticum aestivum*.) and bean (*Vicia faba*.) as a whole-crop forage: Effect of harvest time on forage yield and quality. Grass Forage Sci., 58: 28-36.
22. Gunasena, H., R. Sangakkara & P. Wickrema-Singh. (1979). Studies on cereal-legume intercropping systems. Journal of National Science Council of Sri Lanka, 7, 85-93.
23. Gustavo NM, Jean F, Ois L, Xavier D (2008). Shoot and root competition in potato/maize intercropping: Effects on growth and yield. Environ. Exp. Bot. 64: 180-188

24. H. Eskandari and A. Ghanbari, 2009, Intercropping of Maize (Zea mays) and Cowpea (Vignasinensis) as whole-crop forage: effect of different planting pattern on total dry matter production and maize forage quality. Not. Bot. Hort. Agrobot. Cluj 37(2):152−155.
25. H. Hauggaard-Nieson, P. Ambus and E. S. Jensen, 2001. Temporal and spatial distribution of roots and competition for nitrogen in pea-barley intercrops. A field studies employing 23P techniques. Plant Soil 236:63−74
26. I. H. Alhaji, 2008, Yield performance of some varieties under sole and intercropping with maize at Bauchi, Nigeria. Afric. Res. Rev. 2 (3):278−291.
27. J. Ofuso-Amin and N.V. Limbani, 2007. Effect of intercropping on the growth and yield of cucumber and okra. Int. J. Agric. Biol. 9(4):594−597.
28. K. Carruthers, B. Prithiviraj, O. Fe, D. Cloutler, R. C. Martin and D. L. Smith, 2000, Intercropping corn with soybean, lupin and forages: yield component responses. Eur. J.Agron. 12:103–115.
29. K. Carruthers, B. Prithiviraj, O. Fe, D. Cloutler, R. C. Martin and D. L. Smith, 2000, Intercropping corn with soybean, lupin and forages: yield component responses. Eur. J.Agron. 12:103–115
30. K.A. Haizel, 1974, Maize-cowpea intercropping study in Kumasi. Ghana J. Agric. Sci. 7:169−178.
31. L. Li, J.H. Sun, F.S. Zhang, X.L. Li, S.C. Yang and Z. Rengel, 2006, Wheat/maize or wheat/soybean strip intercropping I. Yield advantage and interspecific interactions on nutrients. Field Crop Res. 71:123−137.
32. M. Dahmardeh, A. Ghanbari, B.A. Syahsar and M. Ramrodi, 2010, The role of intercropping maize (Zea mays L.) and Cowpea (VignaunguiculataL.) on yield and soil chemical properties. African J. Agric. Res. 5(8):631−636.
33. M. Tsubo and S. Walker, H.O. Ogindo, 2005, A simulation model of cereal-legume intercropping systems for semi-arid regions: l. Model development. Field Crops Res. 93(1):10−22.
34. Mandal, B.J, Dhara, M.C, Mandal, B.B., Das, S.K. &Nandy, R., 1990.Rice, mugbean, soybean, peanut, ricebean and black gram yields under different cropping systems.Agron. J. 82, 1063- 1066.
35. Nguimgo, K. A. B., V. Balasubramanian, F. Kaho & P. Zonskeng. (2003. Maize-legume rotation and association for intensive maize production in the humid forest zone of Cameroun. In: Badu-Akraku, B.; Fakorede, M.; Ouedraogo, M.; Carsky, R. J. &Menkir, A. (editors). Maize Revolution in West and Central Africa. Proceedings of a Regional Maize Workshop. International Institute for Tropical Agriculture,Cotonou, Benin Republic.14-18 May, 2001.
36. Ofori, F. & Stern, W.R., 1987.Cereal-legume intercropping systems.Adv. Agron. 41, 41- 90.
37. P. Jeranyama, O.B. Hesterman, S.R. Waddington and R.R. Harwood, 2000, Relay-Intercropping of Sunnhemp and Cowpeas into a smallholder maize system in Zimbabwe. Agron. J. 92:239−244.
38. P.A. Ndakidemi, 2006, Manipulating legume/cereal mixtures to optimize the above and below ground interactions in the traditional African cropping systems. Afri. J. Biotechnol. 5(25): 2526−2533.
39. P.M. Carr, G. B. Martins, J. S. Caton and W. W. Poland, 1998. Forage and N yield of barley-pea and oat-pea intercrops. Agron. J. 90(1):79−84.
40. P.Q. Craufard, 2000, Effect of plant density on the yield of sorghum-cowpea and pearl millet-cowpea intercrops in northern Nigeria. Exp. Agric. 36(3):379−395.
41. Q.R. Shen and G.X. Chu, 2004, Bi-directional nitrogen transfer in an intercropping system of peanut with rice cultivated in aerobic soil. Biol. Fertil. Soils. 40(2):81−87.
42. R. Chakma, M.A. Aziz, A.K.M.M. Rahman, M.F. Khatun and M. Sultana, 2011, Intercropping popcorn with bushbean and pea at different planting systems in hill valley areas.J. Expt. Biosci. 2(2):35−38.
43. R.W. Andrews, 1979, Intercropping, Its importance and research need I. Competition and yield advantages. Field Crops Abstr. 32: 1−10.
44. S.K. Karikari, 2003, A decade of Bambara groundnut agronomic research at the Botswana College of Agriculture. UNISWA J. of Agric. 12:24–28
45. Saban Y, Mehmt A, Mustafa E (2007). Identification of Advantages of Maize – Legume Intercropping over Solitary Cropping through Competition Indices in the East Mediterranean Region. Turk. J. Agric. 32: 111-119.
46. Singh, R. S. P. (1981). Studies on Spatial Arrangement in Sorghum- Legume Intercropping System. Journal of Agricultural Science, Cambridge, 97: 655 – 661.
47. Singh, S. P. and Ahuja, K. N. (1990). Intercropping Grain Sorghum with Fodder Legume under Dry land Condition of North – West India. Indian Journal of Agronomy, 35(3): 287 – 296.
48. W. G. Lesoing and C. A. Francis, 1999, Strip intercropping effects on yield and yield components of corn, grain sorghum, and soybean. Agron. J. 91(5):807

49. WAHUA, T. A. T., 1983. Nutrient uptake by intercropped maize and cowpeas and a concept ofNutrient Supplementation Index (NSI). Exp Agric. 19, 263- 275.
50. Willey, R.W., 1979. Intercropping- its importance and research needs. Part 1: Competition and yield advantages. Field crop abstract.32, 1- 10.
51. Willey, R.W., 1990. Resource use in intercropping systems. Agric. Water Manage. 17: 215-231.
52. YUNUSA, I.A.M., 1989. Effects of planting density and plant arrangement pattern on growth and yields of maize (*Zea mays* L.) and soybean (*Glycine max* L. Merr) grown in mixtures. *J. Agric. Sci*. (Camb.) 112, 1- 8.