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Effect of cowpea (*Vigna unguiculata L. walp*) in mixture with pearl millet [*Pennisetum glaucum* (L.) R. Br.] as affected by variety and time of cowpea introduction in Maiduguri North Eastern, Nigeria

JA Bassi[1*], IY Dugje[2]
[1-2] Department of Crop Production, Faculty of Agriculture, University of Maiduguri, P.M.B, Maiduguri, Nigeria

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Abstract
Field experiments were conducted in 2015 and 2016 rainy seasons at the Teaching and Research Farm of the Department of Crop Production, University of Maiduguri, Maiduguri ($11^0$47N; $12^0$16E) to study the Effect of Cowpea (Vigna unguiculate L. walp) in mixture with Pearl millet [*Pennisetum glaucum* (L.) R. Br.] as affected by variety and time of cowpea introduction. The treatments consisted of three pearl millet varieties: ZATIP, SOSAT-C-88 and LACRI-9702-IC, two cowpea varieties: Borno Brown and SAMPEA 11 and four cowpea sowing dates: 0 weeks after sowing millet (WASM), 1 WASM, 2 WASM and 3 WASM. The experimental design was Split-Split plot with the pearl millet varieties allocated to the main plots, cowpea varieties assigned to the sub-plots and cowpea sowing date assigned to the sub- sub plots in 1:1 alternate row arrangement, and replicated three times. The results showed that in 2015, 2016 and the combined mean, Plant height, number of branches/ plants, grain yield/hectare and were significantly greater for Borno Brown than SAMPEA 11 variety. Delaying cowpea sowing date by three weeks after sowing the millet component decreased number of branches, grain yield and fodder yield in cowpea. The SOSAT-C-88 and Borno Brown intercrop produced the highest grain yield of pearl millet in both the years and the combined mean. The cowpea variety Borno Brown was more competitive with pearl millet at simultaneous (0 WASM) or 1 week after sowing millet that had greater grain yield than SAMPEA 11. Fodder yield and pod yield were greater for Borno Brown intercropped with LACRI-9702-IC or SOSAT-C-88 than SAMPEA 11 intercropped with ZATIP. Linear relationships among agronomic parameters of cowpea revealed that, pod yield, grain and fodder yield increased significantly with increase in plant height and number of branches

Keywords: sowing, cowpea, dates, variety. introduction

Introduction
Cowpea is a major component of the traditional cropping system in Africa, Asia Central and South America where it is widely grown in mixture with other crops in various combinations. The performance of cowpea in this mixture is low, mainly due to low plant population, competition under intercropping and lack of crop protection measures. Studies have shown that the performance of cowpea in these systems could be enhanced through the use of improved varieties, appropriate date of planting with respect to the pearl millet, higher plant populations, improved soil fertility and suitable spatial arrangements. The fact that growing crops in mixtures ensure better land use efficiency is no longer disputable. But the dynamics of the intercrop over-yielding, especially the main source of gains in the mixtures is an aspect that many scientists report contrasting findings. But generally planting early maturing varieties and slow growing crops together seems to be an agreeable arrangement leading to intercrop over-yielding. Also important are the relative statures and size of different crops, growth cycles and seasonal period available for growth (Parish, 2005) [8]. According to Andrews and Kassam (1976) [2], the general criteria for intercropping are: Arrangement and relative numbers of the contributing crop plants will affect the expression of differences in competition. The effect of competition between crops is greatly alleviated when their maximum demands on the environment occur at different times. Intercropping is more effective where the seasonal period for growth is long enough. Legumes may be a necessary component under conditions of low soil fertility. Since intercropping has both space and time dimensions, it is possible, by judicious selection of crops variety to adjust the timing and spatial arrangement of the mixed crops to attain maximum leaf area production over longer periods of time than it is possible with sole cropping (Parish, 2005) [8]. Agoola and Eniola (2000) [1] screened legumes for performance under intercropping with pearl millet and suggested that early maturing legumes would be appropriate in intercropping with pearl millet. By this, soil fertility and crop yield can be increased.

In regions with long growing seasons properly spaced growing habit offer positive yield advantage as it is possible in wetter savanna, but for semi-arid savanna, the latitude in sowing date is minimal and choice of planting dates can contribute greatly to the yield outcome of the intercrop. To delay or hasten the relative planting date of one component versus other crop in a mixture provide farmers more flexibility in an unpredictable environment. Earlier sown crops has an earlier comparative advantage, due to quicker access to resources pool, particularly light and minimizes competition for growth limiting factors (Zarafi and Emechebe, 2005) [11]. Blade *et al.* (2007) [3] found that delaying cowpea sowing date by two or three weeks resulted in a cowpea grain yield reduction of over 50 % in comparison to simultaneous millet and cowpea planting. The objective of the study is to determine the suitable sowing date for relaying cowpea into the pearl millet + cowpea mixture

Materials and Methods

The experiment was conducted during 2015 and 2016 rain-fed cropping seasons at the Teaching and Research Farm, Department of Crop Production Faculty of Agriculture, University of Maiduguri. The experimental site was located between latitude $11^0 47^1$N and 56 00^1N, and longitude $03^0 12^1$ and 16^0E and altitude of 345 m above sea level, in the northern fringes of the Sudan savanna belt of Nigeria. The treatments consisted of three improved pearl millet varieties: (ZATIP, SOSAT-C-88 and LACRI-9702-IC) intercropped with two cowpea varieties: (Borno Brown and SAMPEA 11) and each sown at four cowpea sowing dates: (simultaneous, one week, two weeks and three weeks after sowing the millet WASM) in 2015 and 2016. The pearl millet was grown at (3) three plants/stand, while the cowpea were grown at 2 plants/stand (Dugje *et al*., 2009) [4]. experimental design was split-split plot with pearl millet varieties assigned to the main-plot, cowpea varieties assigned to the sub-plot and cowpea sowing date assigned to the sub-sub plots, which were replicated three times. The sub-plot size was 3.0 x 5.0 m (15.0 m^2). An alley of 2.0 m was allowed between the replicates, while 1.0 m and 0.50 m alley was allowed between the main plots and sub-plot, respectively. Data collected from the experiment were subjected to two-way Analysis of variance (ANOVA). Both the year wise and combined years' analysis was run using a Computer Software, Statistix Version 8.0 (Statistix, 2005) [9]. Differences between treatments means were compared using Duncan's multiple Range Text (DMRT) at 5% level of probability.

Growth and Development Parameters

Effect of pearl millet varieties on cowpea plant height showed that, relatively taller cowpea plants were produced in association with SOSAT-C-88 or LACRI-9702-IC compared to ZATIP at 3 and 6 WAS in 2015 (Table 1). Significantly ($P<0.05$) greater plant height was produced in association with ZATIP or SOSAT-C-88 compared to LACRI-9702-IC at 9 WAS and at harvest in 2015. There was no significant difference in cowpea variety plant height at 3 WAS, however SAMPEA 11 had slightly taller plants than Borno Brown. Plant height was significantly ($P<0.05$) shorter for Borno Brown compared to SAMPEA 11 at 6, 9 WAS and at harvest. Cowpea sowing date significantly influenced cowpea plant height at 3, 6, 9 WAS and harvest in 2015 cropping seasons. The 3 and 2 WASM significantly ($P<0.001$) produced taller plants compared to 0 or 1 WASM. Millet variety x cowpea variety, cowpea variety x cowpea sowing date and millet variety x cowpea sowing date interactions were not statistically significant in 2015 cropping seasons (Table 1).

In 2016, cowpea produced significantly ($P< 0.05$) taller plants in association with SOSAT-C-88 and LACRI-9702-IC compared to ZATIP at 3 and 6 WAS (Table 22). Relatively taller plants were observed for cowpea intercropped with SOSAT-C-88 or ZATIP compared to LACRI-9702-IC at 9 WAS and at harvest. The cowpea grown in mixture with pearl millet variety ZATIP slightly promoted plant height compared to SOSAT-C-88 or LACRI-9702-IC (Table 1). The cowpea variety SAMPEA 11 produced significantly taller plants compared to Borno Brown at 9 WAS and at harvest. In 2016, cowpea sown at 3 or 2 WASM produced significantly taller plants compared to 0 or 1 WASM at 3, 6, 9 WAS and at harvest. Cowpea produced shorter plants when sown at 0 WASM compared to 1, 2 or 3 WASM respectively (Table 1). Interaction of millet variety x cowpea variety and millet variety x cowpea sowing date were significant at 6, 9 WAS

Table 1: Effects of millet variety, cowpea variety, cowpea sowing date and their interactions on cowpea varieties plant height at 3, 6, 9 WAS and harvest at Maiduguri 2015, 2016 and combined mean

Treatment	3 WAS			6 WAS			9 WAS			Harvest		
	2015	2016	Combined	2015	2016	Combined	2015	2016	Combined	2015	2016	Combined
Millet Variety (M)												
ZATIP	13.49a	13.50c	14.27a	31.23a	29.12c	30.19a	49.18a	44.31a	46.75a	60.16a	56.54a	58.24a
SOSAT-C-88	14.43a	16.78a	15.60a	33.38a	35.36a	34.37a	47.23b	42.55a	44.89b	58.19b	54.01a	56.01a
LACRI-9702-IC	14.81a	15.79b	15.30a	31.48a	30.71b	31.10a	46.90c	39.40a	43.15c	52.16c	51.11a	51.64a
SE (±)	0.17	0.16	0.12	0.35	0.44	0.35	0.43	0.40	0.47	0.46	0.33	15.74
Cowpea Variety (C)												
Borno Brown	14.09a	12.12a	10.56b	25.41b	28.99b	27.19b	42.35b	37.32b	39.84b	54.39b	49.19b	51.79b
SAMPEA 11	15.09a	15.20a	14.44a	33.38a	36.51a	41.09a	51.92a	45.68a	48.00a	65.14a	58.59a	61.87a
SE (±)	0.14	0.11	0.10	0.27	0.36	0.28	0.35	0.30	0.41	0.38	0.26	12.85
Cowpea Sowing Date (S)												
0WASM	10.53d	9.60d	10.07d	21.82d	19.25d	20.54d	41.25d	37.86d	39.55d	55.12d	49.20d	52.16d
1WASM	12.47c	15.63c	14.05c	25.21c	21.30c	23.26c	45.97c	43.26c	44.61c	58.35c	53.74c	56.05c
2WASM	14.71b	16.65b	15.68b	28.76b	24.80b	26.78b	47.22b	49.43b	48.33b	61.83b	54.49b	58.16b
3WASM	17.65a	19.77a	18.71a	31.80a	29.82a	30.81a	50.92a	55.95a	53.44a	67.80a	64.49a	66.17a
SE (±)	0.20	0.17	0.14	0.40	0.51	0.38	0.50	0.48	0.54	0.46	0.39	1.18
Interaction												
M x C	NS	NS	NS	NS	*	NS	NS	*	NS	NS	*	NS
C x S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
M x S	NS	NS	NS	NS	NS	NS	NS	*	NS	NS	*	NS
M x C x S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS= Not significant, * =Significant ($P<0.05$), Comb= combined, WASM=Weeks after sowing millet. Means followed by the same letter in a column are not significantly different according to Duncan's Multiple Range Test ($P<0.05$). Values for 2016 are pooled means of three replications, while values for combined means are pooled means of three replications for the two years

and at harvest and millet variety x cowpea sowing date at 9 WAS and at harvest in 2016 cropping season.

For the combined mean, there was no significant difference in plant height of cowpea variety at 3 and 6 WAS (Table 1). However, cowpea grown in association with ZATIP produced significantly (P<0.05) greater plant height compared to SOSAT-C-88 or LACRI-9702-IC at 9 WAS. Similar trend was observed at harvest when cowpea in association with ZATIP produced relatively taller plants compared to SOSAT-C-88 or LACRI-9702-IC. The cowpea variety SAMPEA 11 produced significantly (P<0.01) greater plant height than Borno Brown at 6, 9 WAS and at harvest. Sowing cowpea 2 or 3 WASM produced significantly (P<0.01) taller plants at 3, 6, 9 WAS and at harvest. Shorter plants were produced for simultaneous (0 WASM) cowpea sowing with millet or 1 WASM. There was no significant interaction for the combined mean.

The effects of millet variety showed that, cowpea produced significantly (P<0.05) greater number of branches when intercropped with LACRI-9702-IC or SOSAT-C-88 than ZATIP (Table 2). Among the pearl millet varieties, cowpea significantly (P<0.05) produced lower number of branches in association with ZATIP compared to the other varieties at 6, 9 WAS and at harvest in 2015. Number of branches was significantly (P<0.01) greater for Borno Brown compared to SAMPEA 11. Cowpea number of branches was significantly affected by sowing date (Table 2). Cowpea sown simultaneously (0 WASM) with millet produced greater number of branches compared to 1 or 2 WASM that produced lower number of branches. The lowest number of branches was produced when cowpea was sown 3 WASM compared to 0, 1 or 2 WASM at 6, 9 WAS and harvest in 2015 cropping season (Table 2). There were significant interactions of millet variety x cowpea variety at 6, 9 WAS and at harvest and millet variety x cowpea sowing date at 9 WAS.

Table 2: Effects of Millet variety, cowpea variety, cowpea sowing date and their interaction on cowpea varieties number of branches / plants at 6, 9 WAS and harvest at Maiduguri 2015, 2016 and combined mean

Treatment	6 WAS			9 WAS			Harvest		
	2015	2016	Comb	2015	2016	Comb	2015	2016	Comb
Millet Variety (M)									
ZATIP	18.75c	21.43c	20.09c	42.48c	39.65c	41.06c	47.61c	49.62c	48.62c
SOSAT-C-88	22.03b	23.43b	21.69b	45.60b	48.41b	47.00b	51.60b	52.14b	51.82b
LACRI-9702-IC	23.42a	25.34a	25.38a	52.30a	48.83a	50.57a	59.38a	54.43a	56.91a
SE (±)	0.39	0.48	0.45	0.64	0.58	1.74	0.80	0.64	0.76
Cowpea Variety (C)									
Borno Brown	25.31a	23.96a	24.64a	31.98a	39.73a	35.88a	44.66a	48.71a	46.66a
SAMPEA 11	17.50b	19.67b	18.58b	26.60b	33.54b	30.07b	39.41b	43.09b	41.25b
SE (±)	0.31	0.43	0.39	0.57	0.47	0.34	0.65	0.52	0.62
Cowpea Sowing Date (S)									
0 WASM	22.03a	22.52b	22.43c	47.41a	45.34a	46.38a	49.63a	51.35a	50.49a
1 WASM	21.59b	22.81a	25.20a	47.08b	44.67b	45.88b	48.66b	50.88b	49.77b
2 WASM	21.45b	22.52b	22.49b	45.08c	42.28c	43.68c	47.21c	49.55c	48.38c
3 WASM	20.58c	22.21c	21.39d	44.41d	42.03d	43.22c	46.33d	48.31d	47.32d
SE (±)	0.45	0.55	0.64	0.72	0.67	1.03	0.92	0.74	0.88
Interaction									
M x C	*	*	NS	*	*	NS	*	NS	NS
C x S	NS	*	NS	NS	NS	NS	NS	NS	NS
M x S	NS	NS	NS	*	*	NS	NS	NS	NS
M x C x S	NS	NS	NS	NS	NS	NS	NS	NS	NS

NS= Not significant, * =Significant (P<0.05), Comb= combined, WASM= Weeks after sowing millet.

There was significant effect of pearl millet variety on cowpea number of branches in 2016 with LACRI-9702-IC or SOSAT-C-88 allowing greater number of branches compared to ZATIP (Table 2). It was observed that the cowpea variety Borno Brown produced significantly (P<0.05) greater number of branches than SAMPEA 11 at 6, 9 WAS and at harvest. The effect of cowpea sowing date on cowpea number of branches showed that, 0 WASM produced significantly (P<0.001) greater number of branches compared to the 1 or 2 WASM. Significantly (P<0.05) lowest number of branches was produced at 3 WASM compared to 0, 1 or 2 WASM sowing date at 6, 9 WAS and at harvest in 2016 (Table 2). Millet variety x cowpea variety interaction was significant at 6 and 9 WAS, also cowpea variety x cowpea sowing date interaction was significant at 6 and millet variety x cowpea sowing date interaction was significant at 9 WAS.

For the combined mean similar trend was observed for cowpea grown in association with SOSAT-C-88 or LACRI-9702-IC that produced greater number of branches compared to ZATIP at 6, 9 WAS and at harvest (Table 2). Cowpea variety Borno Brown produced significantly (P <0.05) greater number of branches compared to SAMPEA 11 variety at 6, 9 WAS and at harvest. The effect of cowpea sowing dates on cowpea number of branches was statistically significant at all the stages of growth. Simultaneous sowing of cowpea with millet (0 WASM) produced significantly (P<0.001) greater number of branches compared to 1 or 2 WASM. Among the sowing dates, cowpea produced lower number of branches at 3 WASM compared to 0,1 or 2 WASM at 6, 9 WAS and at harvest in the combined mean. There was no significant interaction of millet variety x cowpea variety x cowpea sowing in the combined mean.

Yield Parameters

Cowpea grain yield was significantly (P<0.05) greater when cowpea was intercropped with LACRI-9702-IC or SOSAT-C-88 (Table 3). Significantly (P<0.05) lower cowpea grain yield was produced when intercropped with ZATIP compared to the two millet varieties. Grain yield was significantly (P<0.05) greater for Borno Brown compared to SAMPEA 11 variety in 2015. Greater grain yield was observed for cowpea grown at 1 or 0 WASM compared to 2 or 3 WASM that produced lower grain yield. There was significant interaction of millet variety x cowpea variety, millet variety x cowpea sowing date and millet variety x cowpea variety x cowpea sowing date in 2015 cropping season.

Cowpea intercropped with LACRI-9702-IC or SOSAT-C-88 produced significantly (P<0.01) greater grain yield compared to ZATIP variety in 2016. Borno Brown variety in combination with pearl millet produced significantly (P<0.05) greater grain yield compared to SAMPEA 11 variety (Table 3). Cowpea grain yield at 1 WASM was significantly (P<0.01) greater compared to 0 or 2 WASM. The 3 WASM significantly (P< 0.05) produced lower grain yield than 0, 1 or 2 WASM in 2016. There was significant interaction of cowpea variety x cowpea sowing date, millet variety x cowpea sowing date, and millet variety x cowpea variety x cowpea sowing date in 2016 cropping season on the grain yield of cowpea.

For the combined mean, results showed that, cowpea grain yield was significantly (P<0.01) greater for cowpea in mixture with LACRI-9702-IC or SOSAT-C-88 compared to cowpea intercropped with ZATIP variety (Table 3). Similar trend was observed, when Borno Brown produced significantly (P<0.05) greater grain yield than SAMPEA 11 grown in association with pearl millet. Among the cowpea sowing date, the 1 WASM produced significantly (P<0.01) greater grain yield compared to 0, 2 or 3 WASM. The lowest grain yield was produced by 3 WASM compared to the three cowpea sowing dates. All the associated interactions were not significant.

Table 3: Effects of millet variety, cowpea variety, cowpea sowing date and their interaction on cowpea grain yield and fodder yield in 2015, 2016 and the combined mean at Maiduguri.

Treatment	Grain yield (kg/ha)			Fodder yield (kg/ ha)		
	2015	2016	Combined	2015	2016	Combined
Millet Variety (M)						
ZATIP	505.38c	575.70c	540.54c	230.00c	311.04c	270.52c
SOSAT-C-88	695.33b	599.70b	647.51b	267.68b	363.75b	315.71b
LACRI-9702-IC	810.42a	614.76a	712.29a	292.25a	391.12a	341.69a
SE (±)	13.18	3.59	154.90	5.72	5.08	6.32
Cowpea Variety (C)						
Borno Brown	742.72a	615.80a	679.26a	298.25a	389.25a	344.17a
SAMPEA 11	598.03b	587.65b	592.84b	227.86b	321.36b	274.61b
SE (±)	10.76	2.93	126.47	4.67	4.15	5.16
Cowpea Sowing Date (S)						
0WASM	604.33b	621.22b	613.00b	300.94a	394.27a	347.61a
1WASM	607.99a	708.61a	658.30a	286.00b	264.78b	275.39b
2WASM	591.38c	638.50c	615.01c	247.11c	241.77c	244.44c
3WASM	585.77d	612.94d	600.00d	219.16d	230.39c	224.78d
SE (±)	15.22	4.14	178.86	6.60	5.86	7.30
Interaction						
M x C	*	NS	NS	*	*	NS
C x S	NS	*	NS	**	NS	NS
M x S	*	**	NS	NS	NS	NS
M x C x S	*	*	NS	NS	NS	NS

NS= Not significant, * =Significant (P<0.05), ** =Significant (P<0.01), WASM= Weeks after sowing millet. Means followed by the same letter in a column are not significantly different according to Duncan's Multiple Range Test (P<0.05). Values for 2016 are pooled means of three replications, while values for combined means are pooled means of three replications for the two years.

The effect of pearl millet variety on cowpea fodder yield showed that, cowpea in association with LACRI-9702-IC produced significantly (P<.0.05) greater fodder yield compared to SOSAT-C-88 (Table 3). ZATIP association produced lower cowpea fodder yield compared to the two varieties. Cowpea fodder yield was significantly (P<0.05) greater for Borno Brown compared to SAMPEA 11. Fodder yield of cowpea plant was significantly affected (P<0.05) by cowpea sowing dates, as cowpea sown at 0 or 1 WASM sowing date produced significantly greater fodder yield. Cowpea fodder yield was consistently lower at 3 WASM compared to 2 WASM in 2015 (Table 3). There was a significant interaction of millet variety x cowpea variety and cowpea variety x cowpea sowing date on fodder yield.

Cowpea intercropped with LACRI-9702-IC or SOSAT-C-88 produced significantly (P<0.05) greater fodder yield compared to cowpea intercropped with ZATIP variety in 2016. The effect of cowpea variety on fodder yield showed that, Borno Brown variety produced significantly (P<0.01) greater fodder yield compared to SAMPEA 11. Cowpea produced significantly P (<0.05) lower fodder yield when sown at 3 WASM compared to 1 or 2 WASM respectively. However, the 0 WASM produced greater fodder yield compared to 1, 2 or 3 WASM in 2016 cropping season. There was significant interaction of millet variety x cowpea variety on cowpea fodder yield.

Results for the combined mean revealed that, cowpea fodder yield was higher in association with LACRI-9702-IC compared

to SOSAT-C-88, while the lowest fodder was statistically produced in association with pearl millet variety ZATIP (Table 3). Borno Brown significantly (P<0.05) produced greater fodder yield compared to SAMPEA 11. The effect of cowpea sowing date on cowpea fodder yield revealed that, 0 or 1 WASM produced higher fodder compared to 2 WASM. The 3 WASM produced the lowest fodder compared to the three sowing dates. No significant interactions on fodder yield was observed in the combined mean.

Performance of cowpea showed that greater pod yield per plant was produced by LACRI-9702-IC x Borno Brown x 1 WASM or SOASAT-C- 88 x Borno Brown x 1 WASM interactions compared to LACRI-9702-IC x SAMPEA 11 x 2 WASM or 3 WASM. The ZATIP x SAMPEA 11 x 3 WASM interaction produced lower pod yield compared to SOSAT-C88 x SAMPEA 11 x 0 or 1 WASM in 2016 cropping seasons (Table 4). There was significant interaction of millet variety x cowpea variety x cowpea sowing date on the cowpea grain yield in 2015 and 2016 cropping seasons. LACRI-9702- IC x Borno Brown x 0 WASM or LACRI-9702-IC x Borno Brown x 1 WASM produced significantly (P<0.05) greater grain yield/ha compared to SOSAT-C-88 x SAMPEA 11 x 2 WASM or ZATIP x SAMPEA 11 x 2 WASM. in 2015. The lowest grain yield was produced by the interaction of ZATIP x SAMPEA 11 x 3 WASM, SOSAT-C-88 x SAMPEA 11x 3 WASM or LACRI-9702-IC x SAMPEA 11 x 3 WASM compared to the other treatments (Table 4). The interaction of LACRI-9702-IC x Borno Brown x 1 or 0 WASM produced significantly (P<0.05) greater grain yield compared to SOSAT-C-88 x Borno Brown x 1 WASM interaction. Cowpea produced significantly (P<0.05) lower grain yield under the interaction of ZATIP XSAMPEA 11 x 3 WASM or SOSAT-C-88 x SAMPEA 11 x 3 WASM compared to the other treatments in 2016 cropping season.

Table 4: Interaction of millet variety, cowpea variety and cowpea sowing date on cowpea pod yield/ plant and grain yield in 2015 and 2016 cropping seasons

	Pod yield/ plant (g)	Grain yield (kg/ha)	
Millet Var. x Cowpea Var. x C S D	**2016**	**2015**	**2016**
ZATIP x Borno Brown x 0 WASM	17.25ef	529.22gh	599.42c-f
ZATIP x Borno Brown x 1 WASM	19.13cd	560.33fg	605.66a-d
ZATIP x Borno Brown x 2 WASM	15.63g	515.00g	562.33g-j
ZATIP x Borno Brown x 3 WASM	15.13gh	496.33gh	589.66e-h
SOSAT-C-88 x Borno Brown x 0 WASM	19.16cd	797.02de	601.32b-e
SOSAT-C-88 x Borno Brown x 1 WASM	24.20a	937.71ab	631.66a-c
SOSAT-C-88 x Borno Brown x 2 WASM	18.80d	601.33ef	581.66f-i
SOSAT-C-88 x Borno Brown x 3 WASM	17.43ef	505.00g	592.66d-g
LACRI 9702-IC x Borno Brown x 0 WASM	22.93ab	872.01c	640.00ab
LACRI 9702 –IC x Borno Brown x 1 WASM	24.20a	974.33a	672.00a
LACRI 9702 –IC x Borno Brown x 2 WASM	19.90cd	800.00d	601.00b-e
LACRI 9702 –IC x Borno Brown x 3 WASM	17.60ef	618.76ef	537.00h-j
ZATIP x SAMPEA 11 x 0 WASM	15.33g	744.66de	587.00e-h
ZATIP x SAMPEA 11 x 1 WASM	18.43de	890.33bc	595.00c-f
ZATIP x SAMPEA 11 x 2 WASM	17.16ef	618.00ef	508.33h-j
ZATIP x SAMPEA 11 x 3 WASM	16.26fg	401.00hi	481.00f-k-l
SOSAT-C- 88 x SAMPEA 11 x 0 WASM	17.13ef	597.68fg	580.01f-i
SOSAT-C- 88 x SAMPEA 11 x 1 WASM	18.30de	702.00de	586.67e-h
SOSAT-C- 88 x SAMPEA 11 x 2 WASM	15.06h	494.66gh	597.66c-f
SOSAT-C- 88 x SAMPEA 11 x 3 WASM	16.26fg	490.66gh	501.03j
LACRI 9702-IC x SAMPEA 11 x 0 WASM	20.76cd	664.66ef	582.01f-i
LACRI9702-IC x SAMPEA 11 x 1 WASM	21.23bc	696.33ef	591.00d-f
LACRI9702-IC x SAMPEA 11 x 2 WASM	18.80d	476.68hi	505.66i-j
LACRI9702-IC x SAMPEA 11 x 3 WASM	16.30fg	431.68i	501.00j
SE (±)	0.72	37.82	40.15

WASM= Weeks after sowing the millet, Var= variety, C= Cowpea, S= Sowing, D= Date

Means followed by the same letter in a column are not significantly different according to Duncan's Multiple Range Test (P<0.05). Values for 2015 and 2016 are pooled means of three replications.

The effect of intercropping pearl millet + cowpea variety and cowpea sowing date on cowpea for the combined mean showed that, there was positive correlation between the plant height at harvest and fodder yield/ ha (r=0.86*) (Table 5). Number of leaf branches at harvest was positively correlated with number of pods per plant (r=0.92 *), pod per plant (r=0.83*), grain yield/ ha (r=0.94*) and fodder yield/ ha (r=0.77*).

Length of branches at harvest was positively associated with number of pods per plant (r=0.99**), pod per plant (0.77*), grain yield/ ha (r=0.98**) and also fodder yield/ ha (r=0.91*). Number of pods per plant was significantly associated with grain yield/ ha (r=0.90*) and fodder yield/ ha (r=0.89*). No significant correlation was observed among the other agronomic parameters of the cowpea for the combined mean.

Table 5: Linear correlation coefficient (r) of cowpea agronomic parameters as influenced by two cowpea varieties intercropped with three pearl millet varieties and four cowpea sowing dates for the Combined mean

Parameter	1	2	3	4	5	6	7
1. PPH	-						
2.NLBS.	0.27	-					
3. LBH	0.10	0.08	-				
4.NPYP	0.07	0.92*	0.99**	-			
5.PYP	0.47	0.83*	0.77*	0.45	-		
6.GYPH	0.06	0.94*	0.98**	0.90*	0.15	-	
7.HGW	0.13	0.19	0.06	0.04	0.10	0.24	-
8.FYPH	0.86*	0.77*	0.91*	0.89*	0.17	0.11	0.07

*Significant (P<0.05), **significant (P<0.01), values without asterisk (s) have no significant linear correlation. D.F. = 22

1. PPH= Plant height, 2. NLBS= Number of branches 3. LBH= Length of branches, 4.NPYP= Number of pods per plant, 5 PYP= Pod yield per plant, 6 GYPH= Grain yield (Kg/ha), 7 HGW= Hundred grain weight, 8 FYPH= Fodder yield (kg/ha)

Discussion

Sowing cowpea simultaneous (0) or 1 week after sowing millet produced shorter plants with more and longer branches compared to sowing cowpea 3 weeks after sowing millet in both years and the combined mean. This could be attributed to relatively reduced competition in time and reduced shading from the pearl millet component early in the season. Early sowing provides adequate time for the cowpea plants to grow and express their full growth potentials in terms of more and longer branches and other associated growth characters in the presence of necessary mineral nutrients and other important growth factors. Elemo *et al*. (2006) [5] reported that, better utilization of light enhances canopy structure of the intercrops making up the crop mixture.

Plant height for the cowpea sown at 2 and 3 weeks after sowing millet were taller than 0 and 1 weeks after sowing millet probably due to competition for light. The simultaneous cowpea sowing date probably availed better light (Solar radiation) distribution, made nutrients more available to the plants and reduced competition. Cowpea sown at 3 weeks after sowing millet produced less but longer branches than the other treatments probably due to above ground interplant competition since plants in the mixture were in close proximity.

The interaction of pearl millet variety x cowpea variety revealed that SOSAT-C-88 x Borno Brown produced the highest grain yield and this may be attributed to greater vegetative and reproductive parameters over the other varieties. These interactions indicate a better performance of intercropping on growth and yield components in both years. Cowpea variety SAMPEA 11 produced shorter branches as well as lower grain yield in interaction with ZATIP which could be as results of competition for light and growth resources. This results confirms earlier reports by Makoi and Ndakidemi, (2010) [6], that intercropping cowpea with taller millet variety reduced the performance of cowpea.

The significant lower yields in interactions of cowpea variety x cowpea sowing date at 3 weeks after sowing millet in both the years could be attributed to the ability of crop system to form early canopy, thereby allowing pearl millet to suppress the lower storey crop as well as capturing more sunlight for photosynthesis (Terao *et al*., 2010) [10].

Interaction of SOSAT-C-88 x Borno Brown x 1 weeks after sowing millet produced greater number of leaf branches, length of branches and grain yield/hectare. The low plant height, sparse canopy and early flowering of SOSAT-C-88 provided both spatial and temporal complementarities in resource use by the cowpea component which implies minimal competition for resource use.

However, the choice of relative sowing date is affected by weather, soil moisture, labour constraints and cowpea variety (Olufajo and Singh, 2002) [7]. Sowing cowpea at these times as an intercrop will ensure the crop have sufficient moisture for grain production towards the end of the growing season. Therefore, while overstretched delay in sowing of intercropped cowpea may lead to significant interaction; achieving acceptable yield should be the overriding factor in deciding appropriate time of introducing cowpea into the millet component to ensure adequate crop production.

Conclusion

In terms of cowpea, the variety Borno Brown sown 1 week after pearl millet had the highest grain yield. This suggests that SOSAT-C-88 + Borno Brown sown one week after sowing pearl millet component optimized both staple grain and cash returns from pearl millet + cowpea intercropping system. Growing SOSAT-C-88 and Borno Brown variety sown 1week after sowing millet is suitable for intercropping system, Where the Farmers objective is to maximize grain and fodder yields from pearl millet and cowpea intercrop, then LACRI-9702-IC could be used for such system in North eastern of Nigeria.

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