Effects of Year, Season and Sowing Period on Grain Yields and Yield Components of Maize-Cowpea Intercrop in Ile-Ife and Abeokuta, Southwestern Nigeria.

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Abstract
An investigation of the influence of cropping year (2003-2005), season (early and late) and cowpea sowing dates (0, 14, 28, 42 and 56 days after maize sowing) on yield and yield component of maize (cv *DMRE SR-Y*) and cowpea (cv *OLOYIN*) in intercrop was conducted at the Teaching and Research Farms of Obafemi Awolowo University, Ile-Ife (latitude 7^0 28′ N and longitude 4^0 33′ E.) and University of Agriculture, Abeokuta (latitude 7^0 9′ N and longitude $3^0$21′ E.). The two sites were located in the rain forest zone and derived savanna zone of south western Nigeria, respectively. The study was in a split-plot design with three replications. At Ile-Ife, maize grain yield increased from 2.47 t/ha in 2003 to 2.63 t/ha in 2004 and later decreased to 1.64 t/ha in 2005 also at Abeokuta the highest grain yield was obtained in 2004 (2.85 t/ha) followed by 2003 with 2.22 t/ha while the grain yield in 2005 was the least (0.75 t/ha). The sowing year and season effects of *OLOYIN* as component crop had no significant effect on grain yield and yield component of maize (cv *DMRE SR-Y*) but were highly significant on grain yield and yield component of *OLOYIN* at the two locations. The late season cowpea produced significantly higher grain yield compared to the early season crop. Sowing cowpea at 28 42 and 56 days after planting maize caused significantly decrease in yield and yield components of cowpea. Delay after 14DAP caused significant decrease in yield in the order of 56%, 72% and 90% at Ile-Ife, and 48%, 77% and 96% at Abeokuta for 28, 42 and 56 days, respectively after planting of maize.

Key words: *DMR ESR-Y*, Oloyin, Maize, Cowpea, Cultivar, Yield

INTRODUCTION

Maize (*Zea mays* L.) is the most widely grown cereal crop in south western Nigeria and the widest distributed of the cereals (Obilana and Fajemisin, 1977). Maize has been in the diet of Nigerian's for centuries. It started as a subsistence crop and has gradually become more important crop. Maize has now risen to a commercial crop on which many agro-based industries depend on as raw materials (Iken and Amusa, 2004). Among different income groups, maize is a relatively more important source of both calories and protein for the poorer proportion of consumers (Byerlee and Eicher, 1997; Mafongoye *et al.*, 2003), including HIV/AIDS-affected families, who cannot afford more expensive foods such as bread, milk or meat. With more than 50% of all households assigning over 50% of their cereal area to maize, it is rarely grown as sole crop but as intercrop with cassava, yam and groundnut or in mixture with vegetables. Maize production dominates the farming system in Nigeria and hence it is of strategic importance for food security and the socio-economic stability of the country (Ogunbodede and Olakojo, 2001).

Cowpea (*Vigna unguiculata* (L.) Walp) is the most economically important indigenous African grain legume which is adapted to the savanna where it matures it grains on residual moisture. Hardly, could there be any family that does not consume cowpea in one form or the other particularly in festive occasions in SW Nigeria. Cowpea is a grain legume with the potential of multiple contributions not only to household food production but as cash crop (grain and fodder), livestock feed, and soil ameliorant. Farmers in the south western Nigeria are desirous in cultivating cowpea, but a lot of constraints have hindered its effective cultivation in the forest agroecology. Apart from high precipitation which is unfavourable to podding, insect pest constraints is another major factor precluding its cultivation. Cowpea, being a crop that flowers toward the end of raining season and has its pods maturing under residual moisture the likelihood to capture this period is remote except in the late season in the forest zone of southwestern Nigeria and these have been a major obstacle to its cultivation.

Cowpea is generally grown as understory crop in cereal-or tuber-based system. Intercropping has been described as the most widespread cropping system in Africa where it is estimated that 99% of cowpea, 95% of groundnut, 89% of millet and 75% of maize grown in Nigeria are intercropped (Okigbo and Greenland, 1976). In North America, Fortin and Pierce (1996) reported that interest in this system is growing because it's potential for increasing whole field productivity. Francis *et al.* (1976) estimated that 60% of maize production and most of bean grown in Latin America come from intercropping. While little information is available on the time of sowing especially under sole cropping, no research information is available on cowpea sowing date in intercrop in the southwestern Nigeria, however, in the northern savanna, cowpea is usually relay planted into the cereal crops. Reddy and Vesser (1997) reported that cowpea should be sown simultaneously or soon after millet for maximum yield of cowpea. Delay in cowpea sowing up to seven weeks after millet led to significant lower crop growth, lower grain, and dry matter yield of cowpea with no effect on millet. Myaka (1995) suggested that competition from maize component could be reduced by sowing cowpea early in a maize based intercrop. Adetiloye (2001) reported that compatibility of intercrop components and the productivity of intercropping systems are affected by the levels of growth factors (light, soil moisture and nutrient) as well as differences in final plant height of components, the duration of crop growth, intercrop population, spatial arrangement and growth habit (Francis *et al.*, 1976). Generally, sowing period to depend on many factors including weather, soil, moisture, time and labour constraints faced by the farmer, variety, and crop production system (Olufajo and Singh, 2002).

The need to document detailed knowledge of how different species are able to coexist productively (Vandermeer, 1984) in the field environment is now more pressing than before because of the need to sustain crop productivity. This will require evaluation of the effect of appropriate sowing date of cowpea in maize/cowpea intercrop in the southwestern agroecology of Nigeria where such information is lacking. Experience has shown that agronomic research in SW Nigeria have concentrated on sole cropping thereby resulting in the neglect of intercropping evaluation. Since most farmers in SW Nigeria practice intercropping, there is the need for a field evaluation of such practice, especially in maize-cowpea system which is mostly practiced by peasant farmers. Hence the main objective of this study was to determine the effect of season and optimum sowing date of cowpea in a maize/cowpea intercrop in south western region of Nigeria.

MATERIALS AND METHODS

The study was conducted for three years (2003 to 2005) during the early and late seasons (March to July and August to December respectively) at the Teaching and Research Farm of the Obafemi Awolowo University Ile-Ife (OAU), Nigeria and the Teaching and Research Farm, University of Agriculture, Abeokuta (UNAAB). Geographically, OAU is situated within the rain forest zone, on latitude 7^0 28'N and longitude 4^0 33'E, at about 200 m above sea level. It experiences approximately eight months (March to October) of bimodal rainfall. It has about four months (November-

February) of dry season each year with slight irregularity in the rainfall distribution pattern. At Ile-Ife, over the three-year period, the average annual rainfall was 254.42mm and relative humidity was 74.2 %, while the minimum and maximum temperatures were 22.5°C and 32.4°C, respectively. At Ile-Ife, the physical and chemical properties of the experimental site showed pH 5.70, organic carbon 2.18%, sand 72.8%, silt 14.6% and clay 12.6%. On the other hand Abeokuta is located in the derived savannah zone on latitude 7^0 9' N and longitude 3^0 21' E. It also experiences approximately eight months (March to October) of bimodal rainfall. It has about five months (November – March) of dry season each year with slight irregularity in the rainfall distribution pattern. The weather data showed that, during the three-year period, Abeokuta recorded average annual rainfall of 228.59mm and average relative humidity of 71.23%. The minimum and maximum temperatures were 23.4°C and 34.8°C, respectively. The physical and chemical properties of the experimental site at Abeokuta showed pH 5.42, organic carbon 2.24%, sand 78.2%, silt 12.3% and clay 9.2%.

The study was carried out during the early and late seasons in a three-year period (2003-2005). One cowpea cultivar (*OLOYIN*) and one maize variety (*DMRE SRY*) were used for the study. These two varieties are popular in SW Nigeria. The cowpea sowing dates were 0, 14, 28, 42 and 56 days after maize sowing (DAP). About 90 kg N/ha was point applied as urea fertilizer to maize in two equal split-applications at three weeks after planting and tasseling. 26 kg P/ha as single super phosphate and 26 kg K/ha as muriate of potash was basally applied by broadcasting before harrowing. The seeds of cowpea and maize were treated with Aldrin® shortly before planting to control soil borne pest and pathogens. The maize and cowpea were planted in flat with strip arrangement of alternate double rows of 0.90 m between rows. The maize stands were maintained at 0.20 m within rows while the cowpea was at 0.30m. The net plot is made up of rows 3 to 6 (two rows of maize and two rows of cowpea) at the center of the plot which was used for yield determination while the rest rows were used as guide rows.

The established cowpea plants were protected against insects by spraying Multhrin® (*Cypermethrin* 10EC) at 60 ml/10 litres of water. Spraying commenced at flowering (35DAP) and continued at ten days interval until when the pods are ready for harvest. Chemical weed control was carried out using a formulated mixture of Metrobromuron and Metolachlor (Gallex®) applied as pre-emergence immediately after planting, at the rate of 3.0 kg a.i /ha. Supplementary hoe weeding was carried out at 6 and 8 weeks after planting (WAP) to allow crop establishment of the late cowpea sowing dates during the growing seasons at each site.

Data were collected on the growth traits, grain yield components and final grain yields of both cowpea and maize, and were subjected to analysis of variance (ANOVA) (SAS package, 1985) to determine the magnitude of the main and interaction effects of the treatment. Duncan Multiple Range Test (DMRT) and least significant differences (LSD) were used to separate means of significant treatments.

RESULTS AND DISCUSSION

The grain yield and yield component of maize (cv. *DRME-SRY*) as affected by cropping years and cowpea sowing pattern at Ile-Ife and Abeokuta are shown in Tables 1 and 2, respectively. Cropping year effect was highly significant on grain yields, hundred grain weights and shelling percentage but it has no significant effect on ear length, ear circumference, number of kernel/row and number of row/ear. Maize grain yield increased from 2.47 t/ha in 2003 to 2.63 t/ha in 2004 and later decreased to 1.64 t/ha in 2005. Similar increase was observed for hundred seed weight while shelling percentage decreased progressively from 2003 through 2005. The main effects of sowing period (early and late season) had significant effect on maize grain yield and number of kernel per row. Grain yield and other parameters were numerically higher during early season compared to the late season planting. Statistically significant effects were recorded on grain yield and number of kernel per ear row.

At Abeokuta, cropping year had significant effect on all the yield components except shelling percentage, ear circumference and number of row per ear (Table 2). The highest grain yield was obtained in 2004 (2.85 t/ha) followed by 2003 with 2.22 t/ha while the grain yield in 2005 was the least (0.75 t/ha). All other parameters showed similar trend in values. The sowing period also had significant effects on grain yield, hundred grain weight and number of kernels per row and the mean values were significantly higher in early season cropping than in the late season. The sowing date effect was only significant on number of maize kernels per ear row and not on any other parameters.

Table 1: Grain yield, hundred grain weight, shelling percentage and ear height of maize (cv. *DRME-SRY*) as affected by year, season and sowing dates at Ile-Ife.

Treatment	+Grain yield (t/ha)	Hundred grain weight (g)	Shelling percent-age (%)	Ear length (cm)	Ear circumfer ence (cm)	Number kernels per row	Number of row per ear
Year (Y)							
2003	2.47a	69.31a	70.12a	12.56	12.73	27.56	13.08
2004	2.63a	56.32b	68.09b	13.22	12.96	28.77	13.35
2005	1.64b	54.10b	65.26c	11.58	12.92	24.56	12.82
F-test	**	**	**	ns	ns	ns	ns
Sowing Season (P)							
Early	4.21a	21.32	68.09	13.32	12.99	38.24a	13.34
Late	2.94b	20.71	67.68	12.45	12.73	28.52b	12.33
F-test	**	ns	ns	ns	ns	**	ns
Sowing Dates (D)							
0	2.77	20.33	68.30	14.32	12.82	29.33	12.52
14	2.34	21.58	68.12	14.26	12.73	28.42	13.21
28	2.78	20.24	67.77	13.87	12.42	27.32	13.18
42	2.99	20.72	67.80	13.28	12.65	27.56	12.63
56	2.96	21.08	67.25	13.72	13.00	27.40	12.24
F-test	ns	ns	ns	ns	ns	ns	ns
Interaction							
Y x P	ns	ns	ns	ns	ns	ns	ns
Y x D	**	ns	ns	ns	ns	ns	ns
P x D	ns	ns	ns	ns	ns	**	ns
Y x P x D	ns	ns	ns	ns	ns	ns	ns

+ In each sub-group under each column, means followed by the same letters are not significantly different at 5% level of probability using DMRT
***, ** Significant at 5% and 1% levels of probability,**
ns Not significant

The cropping year and seasonal effects on grain yield of maize at the two locations may not be unconnected with the rainfall distribution. The effect of rainfall was evident in the grain yields of maize in 2003, 2004 and 2005 at both Ile-Ife and Abeokuta. The highest grain yields were obtained in 2004 when the highest rainfall was recorded and this was followed by 2003 while the least yields were recorded in 2005. Also the early season that recorded higher rainfall also produced higher grain yields of maize. These responses were in line with earlier reports of Rouanet (1995) and Onwueme and Sinha (1999) that unlike sorghum and millet, maize requires a lot of water

Table 2: Grain yield and yield components ear length, ear circumference, number of kernel per row and number of row per ear of maize (cv. *DRME SR-Y*) as affected by year, season and sowing dates at Ile-Ife.

Treatment	+Grain yield (t/ha)	Hundred grain weight (g)	Shelling percent-age (%)	Ear length (cm)	Ear circumference (cm)	Number kernels per row	Number of row per ear
Year (Y)							
2003	2.22a	20.46a	69.67	13.13a	12.97	26.52a	13.07
2004	2.85a	19.77a	69.45	12.25b	12.61	29.67a	13.09
2005	0.75b	18.84b	69.21	11.74c	12.35	20.08b	13.15
F-test	**	*	ns	*	ns	*	ns
Sowing Season (P)							
Early	2.37a	22.10a	70.00	13.48	12.84	30.25a	13.6
Late	1.84b	21.31b	69.25	12.21	12.00	23.42b	12.58
F-test	**	*	ns	ns	ns	**	ns
Sowing Dates (D)							
0	1.96	19.42	69.52	11.24	12.20	30.28a	12.26
14	1.94	20.20	69.93	11.35	12.00	36.05a	12.46
28	1.94	20.18	68.63	12.08	12.32	27.22b	12.08
42	1.91	20.29	69.30	12.23	12.16	25.46c	12.3
56	1.77	20.3	69.53	11.68	12.42	25.03c	12.11
F-test	ns	ns	ns	ns	ns	**	ns
Interaction							
Y x P	ns	ns	ns	ns	ns	ns	ns
Y x D	ns	ns	ns	ns	ns	ns	ns
P x D	ns	ns	ns	ns	ns	**	ns
Y x P x D	ns	ns	ns	ns	ns	ns	ns

+In each subgroup under each column means followed by the same letters are not significantly different at 5% level of probability using DMRT

*, ** Significant at 5% and 1% levels of probability,

ns Not significant

and it preferred rainfall not below 700 or 800 mm. Generally, maize best region are those which receive an annual precipitation of 600 to 1000 mm under rain fed condition (Onwueme and Sinha, 1999). Because of the low level of rainfall that characterize the late season, breeding efforts have produced early maturing varieties of maize that are tolerant to lower level of precipitation. The variety of maize used in this study (*DMRE SRY*) is an off shoot among the drought tolerant varieties. The availability of these early maturing varieties of maize was to create niches for maize production in areas with recurrent drought and to increase early access of maize to market

(Fakorede *et al.*, 2003).

The response of maize (*DMRE SRY*) yield component especially ear length, ear circumference and number of kernel per row to cropping year and season may be due to significant effect and positive response of the yield components to available moisture during ear filling period as available moisture enables proper ear fill with kernel and the elongation of ear length. The yield components are the elements of sink for the metabolites of maize and are strongly associated with crop growth rate during the bracketing silking period (Fischer and Palmer 1984),

The grain yield and yield component of cowpea (*OLOYIN* cv.) at Ile-Ife are shown in Table 3. Pod length was not affected by both cropping years and sowing period. Grain yield decreased from 2003 to 2005 with the highest grain yield obtained in 2003 while the least was in 2005. The hundred grain weights and threshing % were highest in 2005 while number of pod per plant was highest in 2004 and the least value was obtained in 2005. At Abeokuta (Table 4), cropping years had no significant effect on number of pod per plant and peduncle length but significantly affected other parameters; also sowing period only affected number of pods per plant, number and length of peduncle. Cowpea performance was best in 2004 as indicated by the grain yield and the yield components while the least values were obtained in 2005. Also the cultivar performed better in late season planting than early season with higher values of all the yield parameters.

The significant positive response of yield component of *OLOYIN* to available moisture did not correspond to the grain yield. While grain yield, Threshing % and number of obtainable grain per pod were higher in the late seasons other yield components had lower values in early season. At the two locations, the average grain yields varied across cropping years and seasons but were fairly stable at both Ile-Ife and Abeokuta. However, *OLOYIN* showed better grain performance at Abeokuta (derived savannah ecology) compared to Ile-Ife (forest agroecology). These results may be due to lower precipitation during late seasons across locations and at Abeokuta which favoured hundred grain weight, Threshing % and number of obtainable grain per pod which have been observed by Amujoyegbe and Obisesan (1997) to be major contributors to grain yield of cowpea. Hence, high rainfall during pod fill is detrimental to grain yield and quality.

Table 3: Grain yield, hundred grain weight, threshing percentage, number of pod per plant and number of grain per pod of cowpea (cv *OLOYIN*) as affected by year, season and sowing dates at Ile-Ife.

Treatment	+Grain yield (t/ha)	Hundred grain weight (g)	Threshing percentage (%)	Number of pod /plant	Numbe of grain /pod	Numberof peduncles /plant	Peduncle length (cm)	Pod length (cm)
Year (Y)								
2003	0.99a	14.99b	62.44b	32.85ab	12.15	33.77	36.79a	10.41
2004	0.97a	15.07b	69.95a	38.70a	12.09	30.39	31.34ab	11.03
2005	0.70b	18.00a	70.05a	25.43b	12.96	24.49	28.89b	12.50
F-test	*	**	**	*	ns	ns	*	ns
Sowing Season (P)								
Early	0.72b	20.32a	69.58b	32.83a	12.26a	37.46a	39.47a	12.13
Late	1.13a	16.65b	70.21a	21.36b	10.59b	34.67b	37.22b	12.35
F-test	**	**	**	*	**	**	**	ns
Sowing Dates (D)								
0	1.56a	18.07a	70.38	27.36b	14.63a	31.48b	31.53a	13.55a
14	1.74a	16.75b	71.56	34.45a	17.15a	34.37ab	34.89a	13.49a
28	0.75b	16.48b	71.67	34.00a	11.58b	39.50a	30.92b	10.42b
42	0.41c	12.42c	67.06	15.27c	10.47b	21.42c	26.08c	8.47b
56	0.14e	08.50d	70.56	5.27d	8.93c	6.57d	12.87d	8.22b
F-test	**	**	ns	**	**	**	**	**
Interaction								
Y x P	ns	ns	ns	ns	ns	ns	ns	ns
Y x D	ns	ns	ns	ns	ns	ns	ns	ns
P x D	ns	ns	ns	ns	ns	ns	ns	ns
Y x P x D	ns	ns	ns	ns	ns	ns	ns	ns

+ In each subgroup, under each column means followed by the same letters are not significantly different at 5% level of probability using DMRT
*, ** Significant at 5% and 1% levels of probability,
ns Not significant

The sowing date had highly significant effect on cowpea grain yield and other parameters except threshing percentage at the Ile-Ife and Abeokuta (Tables 3 and 4 respectively). Sowing cowpea at 14 days after planting maize had the highest significant effect on grain yield, number of pod per plant and number of grain per pod while the effect of sowing cowpea simultaneously with maize was highest on hundred grain weights and pod length. Generally, sowing cowpea at 28, 42 and 56 days after sowing maize resulted in progressive

Table 4: Grain yield, hundred grain weight, threshing percentage, number of pod per plant and number of grain per pod of cowpea (cv *OLOYIN*) as affected by year, season and sowing dates at Abeokuta

Treatment	+Grain yield (t/ha)	Hundred Grain Weight (g)	Threshing (%)	Number of pod/ plant	Number of grain/ pod	Number of peduncle/plant	Peduncle length (cm)	Pod length (cm)
Year (Y)								
2003	1.01a	17.84b	60.85b	24.11	11.78b	30.31ab	29.37	9.62b
2004	1.26a	18.36a	71.11a	17.17	12.83a	36.05a	29.19	11.58a
2005	0.29b	16.03c	62.06b	16.22	10.86c	23.98b	27.97	9.62b
F-test	**	**	**	ns	**	*	ns	*
Sowing Season (P)								
Early	1.20	18.48	69.30	46.32a	10.11	36.50a	31.20a	13.24
Late	1.28	18.68	71.01	30.17b	12.11	34.05b	28.34b	13.30
F-test	ns	ns	ns	**	ns	*	*	ns
Sowing Dates (D)								
0	1.56a	20.34	72.02	26.08	13.62	28.22b	32.36a	14.28a
14	1.41a	19.95	66.67	22.86	13.53	23.50b	34.22a	14.33a
28	0.96b	18.03	66.16	15.62	12.39	44.00a	26.50b	10.42b
42	0.28c	16.88	64.29	10.25	10.02	25.00b	27.25ab	08.22bc
56	0.04d	8.04	68.35	6.17	10.00	07.33c	20.25c	07.23c
F-test	**	**	ns	**	**	**	**	**
Interaction								
Y x P	ns	ns	ns	ns	ns	ns	ns	ns
Y x D	**	ns	ns	ns	ns	ns	ns	ns
P x D	ns	ns	ns	ns	ns	ns	ns	ns
Y x P x D	ns	ns	ns	ns	ns	ns	ns	ns

+ In each subgroup, under each column means followed by the same letters are not significantly different at 5% level of probability using DMRT
*, ** Significant at 5% and 1% levels of probability,
ns Not significant

decrease in cowpea grain yield and their yield component. The highest mean values for all the parameters were obtained at simultaneous sowing date of cowpea with maize (0DAP), though, the mean values were not significantly different from those obtained at 14DAP. However, increase in sowing date after 14DAP led to significantly decrease in the mean values of all the parameters measured.

Similar results were obtained by Reddy and Vesser (1997) and Olabanji *et al.* (2003) on the effect of sowing date of cowpea on cowpea growth in cowpea/millet intercrop. They reported that late planted cowpea intercepted significantly less photosynthetically active radiation (PAR) than early planted cowpea, thereby resulting in lower grain yield of late planted cowpea. Reddy and Vesser (1987) had earlier shown that decline in yield with progressive increase in sowing dates may not be unconnected with post establishment stress caused by the shading effect of well established maize plants and or due to insufficient available soil moisture because of high water requirement of maize during the reproductive stage which subsequently results in reduced water level available for the intercrop.

The results obtained in these studies suggested that grain yield and yield component of maize-cowpea in intercrop respond to seasonal effect due to rainfall distribution. While sowing date of cowpea component in the intercrop has no significant effect on the grain yield of maize, its effects were highly significant on grain yield and all yield parameters of cowpea.

CONCLUSION

The late season that is usually characterized by short rain period favoured cowpea (cv. *OLOYIN*) intercropped with maize (*DMRE SR-Y*). The result of this studies showed that *OLOYIN* could be produced effectively as companion crop with maize in intercrop under strip double row arrangement with little or no interspecific competition. Optimum grain yield could be obtained from cowpea in intercrop by planting cowpea at simultaneous or latest 14 day after planting of maize. The need to screen for the fertilizer requirement of maize in such intercrop as most fertilizer requirement of maize have been carried out under sole cropping and also determining the economic of production of such system in south western Nigeria

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