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EFFECT OF RELATIVE SOWING TIME ON GROWTH AND YIELD OF VEGETABLE COWPEA (*VIGNA UNGUICULATA* (L.) WALP) AND MAIZE (*ZEA MAYS* L.) IN VEGETABLE COWPEA/MAIZE INTER-CROPPING SYSTEM

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ABSTRACT

Improved varieties of both vegetable cowpea (IT92KD-263-4-1) and maize (OBA 98) were grown in mixture at Michael Okpara University of Agriculture, Umudike research farm for two cropping seasons (2006 and 2007) in order to determine the suitable relative sowing time of the component crops. The experiment was laid out in a randomized complete block design and with three replicates. The treatments were vegetable cowpea and maize separately planted in their pure stands, vegetable cowpea and maize simultaneously sown on the same day, vegetable cowpea sown 2, 3, 4 weeks before maize and vegetable cowpea introduced 2, 3 and 4 weeks after maize was sown. Widest leaf area, heaviest total aboveground dry matter and nodules per plant of vegetable cowpea were attributed to the vegetable cowpea sown 4 weeks before maize. Similarly, maize leaf area index, aboveground dry matter, number of grains per cob, 100-seed weight and grain yield per hectare were highest when maize was sown 4 weeks before introducing vegetable cowpea. The highest LER of 1.61 and 1.58 in 2006 and 2007, respectively were attributed to the vegetable cowpea sown 4 weeks after maize. It was therefore, recommended that the resource poor rural farmers should introduce the vegetable cowpea 4 weeks after sowing the maize seeds since they usually target the combined yield from the component crops of the farmland

Keywords: Vegetable cowpea, maize, varieties, relative sowing time

INTRODUCTION

Vegetable cowpea and maize intercropping system is prevalent in the traditional farming system of Nigeria. The cereal benefits immensely from the nitrogen fixing ability of the legume component of the mixture. Vegetable cowpea and maize respectively are among the legume and cereal component crops in the intercropping system, especially in South-eastern Nigeria. Most of

information on cowpea in Nigeria is on the grain cowpea. Agronomic information on vegetable cowpea is scarce (Udealor, 2002; Ano, 2006), hence it belongs to the group called "neglected legumes" (Ano and Ubochi, 2008). They are grown by resource-poor farmers.

Almost all parts of the vegetable cowpea are important; the seeds are major source of plant proteins and vitamins for man, the fodder serves as feed for animals, and also a source of income for farmers. The young leaves and immature pods are eaten as vegetables (Dugje *et al*., 2009). Nigeria is the world's leading cowpea producing country, followed by Brazil (DAFF, 2011). In fact, the region of West and Central Africa is the leading cowpea producers; this region produces 64 % of the estimated 3 million tons of cowpea seed pro-duced annually. Proximate analysis indicated that vegetable cowpea has high nutrient content. The protein content was 23.52% and 24.97%, respectively for the climbing ('akidienu') and prostrate ('akidiani') varieties (Ano and Ubochi, 2008), which compares favourably with a mean value of 24% Bressani (1985), 24.8% (Davis *et* al., 1991) and 24-28% (Ene-Obong, 1995) reported for grain cowpea.

Maize on the other hand, is a common staple usually eaten by human, livestock and used as a raw material in agro-allied industries. Every part of the maize plant has economic value: the grain, leaves, s talk, tassel, and cob from maize can all be used to produce a large variety of food and non -food products (IITA, 2006). In Nigeria, maize is one of the most frequently consumed staple (Ibikunle *et al*., 2009). Maize commonly features in the traditional intercropping system of Nigeria together with legume and non-legume crops such as cowpea, cassava, yam and cocoyam (Muoneke *et al*., 2012).

The staggered method of sowing of component crops maximizes productivity and minimizes interspecific competition between the component crops for growth resources (Ofori and Stern, 1987). Sullivan (2001) reported that having one crop mature before its companion crops lessens the interspecific competitions between the two component crops. Similarly, Okpara (2000) noted that relative sowing time of component crops in a vegetable cowpea/maize intercrop significantly increased the growth and yield of the component crops.

The determination of the most suitable time of introducing any of the component crops into a mixture is one of the agronomic challenges the small-holder farmers face, as this determines the final yield of the crops. It also reduces the severity of interspecific competition between and among the component crops for the limited growth factors. The most serious constraint of cowpea production in the tropics is pest (Omongo *et al*., 1997), also, poor weed management, improperly timed planting and low plant populations contribute to low yield (Obuo *et al*., 1998). Reddy and Visser (1997) suggested that improved resource utilization and therefore, increased yield can be achieved with proper manipulation of time of planting. Hence, the goal of the study was to determine the most suitable time of introducing maize and vegetable cowpea into vegetable cowpea and maize intercrop.

MATERIALS AND METHODS

The experiment was conducted at the Research Farm of Michael Okpara University of Agriculture, Umudike (05° 29´ N 07° 33´ E) during 2006 and 2007 cropping seasons. Umudike is within the forest agro-ecological zone of Nigeria with an average rainfall of 2200 mm per annum and situated at 122 m above sea level. The soil in the study site was ultisol, derived from coastal sediments. Prior to planting, ten core soil samples, randomly collected from 0-20 cm soil depth were bulked to form a composite sample which was analyzed for physicochemical characteristics (Table 1). The meteorological data during the study period (2006-August, 2007) are shown in Table 2.

Table 1: Physicochemical characteristics of the soil of the experimental site in 2006 and 2007

	2006	2007
Physical characteristics		
Sand (%)	81.80	65.80
Silt (%)	6.00	6.80
Clay (%)	12.20	27.40
Textural class	Sandy clay	Sandy clay
Chemical characteristics		
pH (H_2O)	5.26	5.13
Total nitrogen (%)	0.05	0.05
Available phosphorus (mg/kg)	11.01	10.96
Organic carbon (%)	0.09	0.74
Organic matter (%)	2.71	1.28
Exchangeable acidity (cmol/kg)	2.68	2.40
Potassium (cmol/kg)	0.10	0.12
Sodium (cmol/kg)	0.06	0.05
Calcium (cmol/kg)	3.10	1.60
Magnesium (cmol/kg)	1.40	1.20
Effective CEC (cmol/kg)	8.30	5.31
Base saturation (%)	56.30	54.83

Table 2: Monthly total rainfall, average atmospheric temperature, sunshine hours and relative humidity of the experimental data during 2006 and 2007 growing seasons

	Total rainfall (mm)			Temperature (°C)			Sunshine (hours)			Relative humidity (%)		
Month	2006	2007	1998-2007	2006	2007	1998-2007	2006	2007	1998-2007	2006	2007	1998-2007
January	76.6	0.0	15.8	28.5	26.5	29.7	5.7	4.2	4.8	70.0	36.5	49.4
February	81.9	62.9	53.7	28.5	29.5	28.8	6.0	5.0	5.2	70.5	60.0	57.3
March	131.9	35.5	87.0	29.0	29.4	28.9	5.7	5.3	4.5	70.0	65.5	65.4
April	136.0	78.4	160.4	29.0	28.5	28.5	6.6	5.3	5.4	70.5	70.0	71.5
May	202.8	444.9	273.5	27.0	27.0	27.6	4.8	4.7	5.4	77.0	82.5	76.8
June	237.3	354.0	314.2	26.5	27.5	26.8	5.2	3.2	4.4	78.0	78.5	79.4
July	303.4	187.3	295.1	26.5	26.0	26.3	3.0	3.3	3.0	82.5	78.5	82.2
August	133.7	464.8	292.3	25.5	25.5	25.9	2.7	2.6	2.4	83.5	82.0	82.3
September	483.1	-	333.5	25.5	-	26.1	2.4	-	2.5	83.0	-	81.1
October	237.4	-	263.6	26.5	-	26.6	4.5	-	3.6	78.0	-	78.2
November	14.2	-	50.4	27.0	-	27.5	5.5	-	5.1	70.0	-	72.2
December	0.0	-	2.2	26.0	-	26.7	6.4	-	5.5	55.0	-	60.5

IT92KD-263-4-1 vegetable cowpea variety an early maturing, procured at International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria was used for the experiment. The seeds are smooth and creamy in colour with green long pods (when fresh) that measures up to 22 cm. The vines are climbing type and could measure as long as 2.1 m. The fresh pod can be harvested at 10 weeks after planting (WAP). Seeds of early maturing and high yielding OBA-98 maize variety were obtained from National Agricultural Seed Council, Umudike, Nigeria. The experiment was laid out in a randomized complete block design (RCBD) with three replications. The treatments were vegetable cowpea and maize separately planted in their pure stands, vegetable cowpea and maize simultaneously sown on the same day, vegetable cowpea sown 2, 3, 4 weeks before maize and vegetable cowpea introduced after 2, 3 and 4 weeks after maize was sown.

The maize and vegetable cowpea seeds were hand-sown on an alternative rows; vegetable cowpea sown between maize rows. The maize and vegetable cowpea seeds were sown at the rate of two seeds per hole, but later thinned to one plant per stand, two weeks after planting (WAP) (Finnisa, 1997). The dimension of each plot was 4 m x 5 m (20 m^2). Weeding was manually done (hand weeding) at 3, 7 and 10 weeks after introduction of first component crop in both cropping seasons. Vegetable cowpea was first sprayed with Cypermethrin at the rate of 80 g/15L of water after flower bud formation to control insect pest (Omotunde, 1996). Further spraying was done at podding. Data were collected from three randomly selected plants in the middle rows in each plot. Data were collected on growth and yield characteristics of both maize and vegetable cowpea. Maize leaf area was determined according to the method of Hunt (1978) - the product of the length, width (of the upper, middle and basal leaves), number of leaves and 0.75. The vegetable cowpea leaf area was determined by the method of Osee-Yeboah *et al*. (1983). The growth parameters of both component crops were measured at 10 weeks after planting.

All the data collected were subjected to the analysis of variance (ANOVA) for a randomized complete block design (Steele and Torrie, 1980) and the separation of treatment means was done with the Fisher's Least Significant Difference (F-LSD) at 5% probability level. The land equivalent ratios (LER) for each cropping system were also calculated.

RESULTS AND DISCUSSION

Growth and yield of vegetable cowpea

There was no significant ($P>0.05$) difference among the relative sowing times of the component crops with respect to vine length in both cropping seasons (Table 3). The widest leaf area, heaviest total above ground dry matter and weight of nodules per plant were attributed to the vegetable cowpea sown 4 weeks before the maize. The total aboveground dry matter and nodule weight progressively increased with delayed introduction of maize after the cowpea but decreased with delayed introduction of the cowpea after maize had been sown. The growth characteristics of the vegetable cowpea were relatively lowest when they were sown 4 weeks after maize. Similarly, the introduction of maize 4 weeks after vegetable cowpea was sown enhanced highest number of fresh pods (29.3 and 30.6), longest pods (11.7 and 12.7 cm) and highest pod yields (4.4 and 4.2 t/ha) in both 2006 and 2007 (Table 3).

Table 3: Vegetable cowpea growth and yield in vegetable cowpea/maize intercrop as influenced by relative sowing time in 2006 and 2007

Relative sowing time	Vine length (cm)		Leaf area index		Weight of nodule (g/plant)		Above-ground total dry matter (g)		No. of fresh pods/ plant		Fresh pod length (cm)		Fresh pod yield (t/ha)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Sole vegetable cowpea	195.0	190.6	3.4	3.2	4.8	5.1	20.7	24.7	31.0	32.3	14.0	14.3	4.5	4.6
Veg. cowpea + Maize same day	210.6	211.6	2.3	2.2	3.8	4.0	17.1	18.3	25.0	26.0	11.0	11.7	3.2	2.9
Veg. cowpea 2 weeks before maize	211.6	210.6	2.7	2.5	3.8	4.1	17.4	19.5	27.0	28.6	11.0	11.3	3.5	3.4
Veg. cowpea 3 weeks before maize	223.1	218.6	2.2	2.1	4.0	4.6	18.1	20.8	26.0	26.0	11.5	12.1	3.8	3.5
Veg. cowpea 4 weeks before maize	216.0	212.6	3.1	2.9	4.1	4.7	20.5	22.2	29.3	30.6	11.7	12.7	4.4	4.2
Veg. cowpea 2 weeks after maize	204.3	210.3	2.4	2.0	4.3	3.8	15.4	16.4	27.0	22.3	11.0	12.0	3.0	2.8
Veg. cowpea 3 weeks after maize	189.3	194.3	1.8	1.3	3.3	3.4	14.4	13.9	21.0	19.3	10.2	11.4	2.5	2.1
Veg. cowpea 4 weeks after maize	170.0	177.3	3.0	0.6	3.0	3.4	12.0	11.4	16.0	16.3	9.5	10.3	2.0	1.7
LSD0.05	ns	ns	ns	0.12	0.36	0.39	0.53	0.58	0.52	0.63	0.44	0.32	0.14	0.22

ns = Non-significant

Table 4: Combined mean (2006 and 2007) of vegetable cowpea growth and yield in vegetable cowpea/ maize intercrop as influenced by relative sowing time

Relative sowing time	Vine length (cm) at 10 WAP	Leaf area index at 10 WAP	No. of branches at 10 WAP	Total dry matter (g) at 10 WAP	No. of fresh pod/ plant	Fresh pod yield (t/ha)	Pod length (cm)	No. of seed/ pod	100-seed weight (g)
Sole vegetable cowpea	195.67	3.28	5.28	22.77	31.67	4.63	14.22	22.00	10.53
Veg. cowpea + Maize same day	211.17	2.25	3.05	17.73	25.50	3.03	11.42	14.33	8.67
Veg. cowpea 2 weeks before maize	211.17	2.60	3.15	18.45	28.17	3.52	11.17	15.50	9.12
Veg. cowpea 3 weeks before maize	221.17	2.17	3.88	19.43	27.00	3.70	11.80	17.17	9.83
Veg. cowpea 4 weeks before maize	214.33	3.00	4.50	21.38	30.00	4.34	12.25	20.00	10.25
Veg. cowpea 2 weeks after maize	207.33	2.20	3.53	15.88	22.50	2.94	11.83	13.33	8.37
Veg. cowpea 3 weeks after maize	191.83	1.58	2.83	14.13	20.17	2.33	10.85	12.67	8.18
Veg. cowpea 4 weeks after maize	173.67	1.83	1.95	11.72	16.17	1.82	9.93	10.50	7.73
LSD0.05	8.218	ns	0.336	1.099	1.251	0.506	0.807	1.038	0.381

The combined results of the two cropping seasons presented in Table 4 show that the introduction of maize 4 weeks after vegetable cowpea produced longest vines (221.17 cm) although this value was statistically at par with the value for the sole crop (214.33 cm).

The leaf area index (3.28), number of branches (5.28), above ground total dry matter (22.77 g), number of fresh pod/plant (31.67), fresh pod yield (4.63 t/ha), pod length (14.22 cm), number of seeds/pod (22) and weight of 100-seeds (10.53 g) were significantly ($P<0.05$) highest with the vegetable cowpea sole crop. However, among the intercrops, the mean of the two cropping seasons indicated that the highest number of fresh pod (30), fresh pod yield (4.34 t/ha), number of seeds per pod (20), number of branches (4.5) were associated to vegetable cowpea sown 4 weeks before maize (Table 4). Longest pods (12.25 cm), widest leaf area at 10WAP (3.00) as well as heaviest aboveground total dry matter (21.38 g) and 100-seeds (10.25 g) were also obtained with sowing vegetable cowpea 4 weeks before maize. The growth and yield of vegetable cowpea were poorest when it was introduced at 4 weeks after maize was sown.

The delayed sowing of maize component may have resulted in advantageous utilization of available resources (light, nutrients, space, and moisture) by the cowpea in the growing environment which should have ordinarily been shared by the two component crops if they were sown on the same day. The progressive decline in both the growth and yield of the cowpea with delayed introduction after maize was sown indicated that there was inter-specific competition, as maize canopy may have been established resulting in the shading of vegetable cowpea. Earlier report (Akobundu, 1993) confirmed that when maize plant becomes taller than the associated cowpeas under intercropping, radiation becomes less available to the cowpeas. Maize had been reported to be a greater competitor in mixtures which has the advantage of being taller than cowpea and might intercept more light than cowpea (Muoneke and Asiegbu, 1997). Similar results were reported by Adipala *et al*. (2002). In comparison with the intercropped situations, the sole vegetable cowpea produced better and higher fresh pod yields of 4.5 and 4.6 t/ha in 2006 and 2007, respectively. This may be due to the absence of inter-specific competition, intra-specific competition as well as adequate plant population in the sole plots.

Growth and yield of maize

All the growth and yield characteristics of maize were significantly ($P<0.05$) different with the different sowing times of the component crops (Table 5). With the exception of the plant height, the sole maize performed best with respect to all the growth and yield attributes in both years. In the intercropped situations in both years leaf area index (2.9 and 2.8), above ground dry matter (203 and 200 g) number of grains per cob (407 and 406), 100 seed weight (23 and 24 g) and grain yield (3.1 and 3.3 t/ha) were highest when maize seeds were sown 4 weeks before vegetable cowpea. In the intercrop situation for the two years mean, the heights of the maize were tallest (210.83 cm) when maize was sown the same day with vegetable cowpea (Table 6) and was closely followed by the introduction of cowpea 4 weeks after maize.

Table 5: Maize growth and yield in vegetable cowpea/maize intercrop as influenced by relative sowing time in 2006 and 2007

Relative sowing time	Plant height (cm)		Leaf area index		Above ground total dry matter (g)		Cob length (cm)		No. of grains/ cob		100-seed weight (g)		Grain yield (t/ha)	
	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007	2006	2007
Sole maize	188.3	187.5	2.9	3.1	223.6	235.4	18.4	18.8	432.6	437.6	25.6	26.2	3.6	3.8
Veg. cowpea + Maize same day	210.0	211.6	2.8	2.8	187.0	190.0	16.3	16.8	296.3	372.6	23.2	23.0	2.5	2.5
Veg. cowpea 2 weeks before maize	187.6	187.0	1.9	1.8	181.6	185.0	16.3	16.2	391.0	372.0	22.7	23.0	2.3	2.5
Veg. cowpea 3 weeks before maize	187.0	176.0	1.7	1.6	175.6	171.6	15.9	15.8	383.3	389.0	22.2	22.9	1.9	1.8
Veg. cowpea 4 weeks before maize	173.3	168.3	1.2	1.2	167.3	166.6	15.3	15.3	375.6	373.6	21.5	21.9	1.7	1.6
Veg. cowpea 2 weeks after maize	191.0	187.0	2.1	2.3	188.6	184.0	16.5	16.6	384.0	391.3	21.5	22.4	2.1	2.2
Veg. cowpea 3 weeks after maize	194.0	196.3	1.7	2.7	196.5	188.6	16.8	17.6	387.3	400.3	22.1	22.3	2.8	2.6
Veg. cowpea 4 weeks after maize	192.0	196.0	2.9	2.8	203.0	199.6	16.3	17.0	407.0	406.0	23.1	23.9	3.1	3.3
LSD0.05	1.95	1.91	0.13	0.08	1.71	3.31	0.40	0.38	4.31	9.29	0.49	0.45	0.11	0.10

Table 6: Combined mean (2006 and 2007) of maize growth and yield in vegetable cowpea/maize intercrop as influenced by relative sowing time

Relative sowing time	Plant height (cm) at 10WAP	Leaf area index at 10WAP	No. of leaves at 10WAP	Total dry matter (g) at 10WAP	No. of grains/cob	Grain yield (t/ha)	Cob length (cm)	100-grain weight (g)
Sole maize	188.17	3.03	13.83	223.67	435.2	3.72	18.62	25.93
Veg. cowpea + Maize same day	210.83	2.82	13.33	188.50	384.5	2.43	16.63	23.12
Veg. cowpea 2 weeks before maize	187.33	1.88	12.67	183.33	381.5	2.43	16.28	22.90
Veg. cowpea 3 weeks before maize	181.50	1.70	11.33	173.67	386.3	1.87	16.05	22.58
Veg. cowpea 4 weeks before maize	170.83	1.217	11.83	167.00	374.7	1.65	15.42	21.73
Veg. cowpea 2 weeks after maize	189.67	2.23	12.33	186.33	387.7	2.20	16.55	21.97
Veg. cowpea 3 weeks after maize	192.17	2.72	12.67	192.50	393.8	2.75	16.57	22.22
Veg. cowpea 4 weeks after maize	194.00	2.88	13.33	201.33	411.5	3.22	17.22	23.52
LSD0.05	4.105	0.292	0.906	5.477	15.43	0.247	0.950	1.165

There could have been competition for light with the vegetable cowpea when the component crops were sown the same day, which may have resulted in the etiolation of the maize. Maize is a great competitor in mixtures and had the advantage of being taller than cowpea and might intercept more light than cowpea (Muoneke and Asiegbu, 1997). However, shortest plants (170.83 cm) were obtained when the maize was introduced 4 weeks after cowpea.

The intercrop situations also showed that the leaf area index, above ground dry matter, number of grains per cob, 100-seed weight and grain yield per hectare were significantly ($P<0.05$) highest when maize seeds were sown 4 weeks before the vegetable cowpea (Tables 5 and 6). Plants under this condition may have dominated the land with the corresponding utilization of the available resources for better growth and yield before the component crop was introduced.

This indicated that delaying the introduction of component crop (s) after the main target crop had been sown may result to its better growth and yield. However, some of the parameters (plant height, leaf area index, number of leaves and cob length) obtained for maize sown either at 3 or 4 weeks before vegetable cowpea introduction were statistically at par.

Productivity of the system

Table 7 shows that the land equivalent ratio (LER) for the different sowing times in both years were above unity (LER>1). This implied that irrespective of the time of sowing of the component crops, more lands will be required in the monoculture of either of the component crops to produce the same yield obtained from their intercropping. The highest LER was attributed to the vegetable cowpea introduced 4 weeks after sowing maize in both 2006 (1.61) and 2007 (1.58). At 4 weeks after sowing of maize seeds, the architecture of the maize plant may have been well established, as such may have contributed in supporting the climbing vines of the vegetable cowpea after emergence. This could have exposed the leaves of the cowpea for adequate photo-assimilate interception hence enhancing dry matter production. This explained why the LER was highest when the vegetable cowpea was introduced 4 weeks after the maize was sown. Since the total LER is the combined yield of both component crops, farmlands of the resource -poor farmers can be maximized with the adoption of this cropping system. The least LER was recorded when the vegetable cowpea was sown 3 weeks before maize in 2006 (1.41) and 2007 (1.32).

Table 7: Land equivalent ratio (LER) in vegetable cowpea / maize intercrop as influenced by relative sowing time in 2006 and 2007

	2006 Partial LER			2007 Partial LER		
Relative sowing time	Vegetable cowpea	Maize	Total LER	Vegetable cowpea	Maize	Total LER
Vegetable cowpea + Maize same day	0.83	0.71	1.54	0.79	0.60	1.39
Vegetable cowpea 2 weeks before maize	0.86	0.64	1.50	0.82	0.66	1.48
Vegetable cowpea 3 weeks before maize	0.89	0.52	1.41	0.85	0.47	1.32
Vegetable cowpea 4 weeks before maize	0.97	0.44	1.44	0.92	0.41	1.33
Vegetable cowpea 2 weeks after maize	0.82	0.60	1.42	0.79	0.58	1.37
Vegetable cowpea 3 weeks after maize	0.80	0.78	1.58	0.79	0.69	1.48
Vegetable cowpea 4 weeks after maize	0.75	0.86	1.61	0.72	0.86	1.58

CONCLUSION

The introduction of the vegetable cowpea (IT92KD-263-4-1) 4 weeks after sowing maize (OBA 98) seeds was recommended for the small-holder farmers of the study area since they usually target the combined yield of the mixture. However, the vegetable cowpea could be introduced 4 weeks before the maize seeds are sown, if the intercropping objective is for the yields of the individual component crops.

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