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Growth and Yield of Some Vegetable Cowpea Genotypes as Influenced by Planting Season

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Abstract Seven promising vegetable cowpea (*Vigna unguiculata* (L.) Walp)genotypes were evaluated at Michael Okpara University of Agriculture, Umudike, Nigeria (05° 29′ N, 07° 33′ E, 122 masl) in 2011 early and late cropping seasons using split plot in randomized complete block design with four replications. Planting season constituted the main plot while vegetable cowpea genotypes were assigned into the sub-plots. The objectives of the study was to evaluate the growth, yield and yield components of seven vegetables cowpea genotypes as influenced by planting seasons in the humid tropics of south eastern Nigeria. The results revealed that planting season significantly (P<0.01) influenced growth and yield parameters. Early season planting encouraged vegetative growth of cowpea such as number of branches per plant and plant height contrary to late season planting which induced higher dry matter yield, number of flowers per plant, pod retention percent per plant, number of fresh pod per sq. meter, number of seeds per plant and pod yield (kg/ha). On the average across the both planting seasons (early and late), pod yield of cowpea genotypes was significantly (P<0.01) depressed in this sequential order –IIT04K-339-1>IT98K-131-1>*Akidi-ani*>IT03K-324-9>*Akidi-enu*>IT98K-692>IT99K-377-1. Among the cowpea genotypes evaluated in the study, IT99K-377-1, IT98K-692 and *Akidi-enu* gave significant pod yields that were higher by 30.46%, 28.86% and 22.38%, respectively compared to the lowest pod yielding genotype (IIT04K-339-1). These promising high yielding genotypes can be evaluated on-farm for farmers' benefits as well as to enhance food security and improve the protein intake of people living in sub-Sahara Africa.

Keywords Vegetable cowpea, Genotype, Planting season, Growth, Yield

1. Introduction

Cowpea is a food legume that plays a critical role in the lives of millions of people in Africa and other parts of the developing world. Both the grain and the haulm, which serves to improve the nutrient level of the crop, are valuable dietary proteins for the African human population and their livestock (Fatokun, 2002). The grain contains between 20 - 25 per cent of protein, about twice the protein content of most cereals (Kay, 1979). The crop is also a valuable and dependable commodity that produces income for many small holder farmers and traders in sub-Saharan Africa (Langyintuo, 2003). Cowpea is a deep rooted crop and does well in sandy soils and more tolerant to drought than soybean (Dabsun *et al*., 2003). The crop cowpea is a major component of the tropical cropping system because of its ability to improve marginal lands through nitrogen fixation and as a cover crop (Sanginga *et al.,* 2003; Abayomi, 2008). The crop can fix about 240 kg/ha of atmospheric nitrogen and make available 60 – 70 kg/ha nitrogen for succeeding crops grown in rotation with it (Amira, and Oduwaye, 2007).

In Nigeria, cowpea is one of the most cultivated legumes, however until recently, its cultivation was restricted to the Sahel, guinea and derived savanna regions. In the humid forest fringes, the most widely grown varieties are the vegetable types whose immature pods are eaten by humans. The indigenous varieties are climbing and decumbent in character but recently, erect and bushy varieties have been developed at International Institute of Tropical Agriculture (IITA), Ibadan, Nigeria (Mittal *et al*., 1980 and Umaharan *et al*., 1997) with the objective of increasing yield. In the production of vegetable cowpea, the green pod which is expressed in kg/ha or t/ha serves as the yield while some researchers have argued that the yield should be expressed as the number of marketable pods/ha, because the pods are usually marketed in bundles (Brathwaite, 1982).

Farmers in South eastern, Nigeria usually plant vegetable cowpea in the rainy season periods of April – July and this contributes substantially to the dietary protein of the rural poor during one half of the year (Okpara and Oshilim, 2001) though the seeds can also be relied upon during the lean period (Uguru, 1996). Due to the importance of this vegetable legume in the dietary needs of the rural poor whose diets have been shown to be deficient of protein of high biological value (Latham, 2006), there is a need to have the

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fresh pods all year round. Hence, the objective of this study was to evaluate the growth, yield and yield components of seven genotypes of vegetable cowpea as influenced by planting seasons in the south eastern agro-ecological region of Nigeria.

2. Materials and Methods

Two field experiments were conducted in March (early planting) and September (late planting), 2011. Both experiments were carried out in the Research farm of Michael Okpara University of Agriculture, Umudike (05° 29′ N, 33 E, 122 masl). The weather data of the experimental site are shown in Table 2. The seven vegetable cowpea genotypes used in this study were obtained from the International Institute of Tropical, Agriculture (IITA), Ibadan and farmers at Nsukka, Enugu State, Nigeria and they are IT04k-339-1, IT98k-692, IT03k-324-9, IT98k-131-2, IT 99k-377-1, *Akidi-ani* and *Akidi-enu*. The experiment was laid out as a split-plot in a randomized complete block design (RCBD) replicated four times with planting season as the main plot and the vegetable cowpea genotypes as the sub-plot. The sub-plot size was 3 x 3 m. Two seeds each of the vegetable cowpea genotypes were hand sown two per hole on 22nd March and 15th September, 2011 at a spacing of 30 cm within row and 50 cm between rows. The seedlings were thinned to one plant per stand at two weeks after planting (WAP) to give a plant population of 133,333 plants per ha. All experimental plots were weeded at 4 and 8 WAP with hand hoe while insect pests were controlled with *Cypermethrin* 10 EC at 2.5 ml per litre of water using a knapsack sprayer at 2 weekly intervals from 21 days after planting (DAP). No fertilizer was applied in keeping with the farmers' practice in this -ecological region of Nigeria.

Growth and yield data such as plant height (cm), number of branches per plant, number of flowers per plant, dry matter (g), number of pods per plant, pod length (cm), pod width (cm), pod weight (g), Pod retention percentage per plant (%), number of pods per m^{-2}, number of seeds per plant, 100-seed weight (g) and fresh pod yield (kg/ha) were measured and recorded.

Data were processed by analysis of variances procedures using Genstat Discovery Edition 3 (Genstat, 2007) and treatment means separated by using the least significant difference as outlined by Obi (2002).

3. Results and Discussion

Planting season showed highly significant (P<0.01) difference for number of branches per plant at 4 and 8 weeks after planting (WAP) (Table 1). Early planting induced more branches per plant at the sampling dates than late planting. High significant (P<0.01) genotypic effect was observed among the cowpea genotypes for number of branches per plant and plant height at 4 and 8 WAP. The results corroborates the findings of Kelechukwu *et al*. (2007) who reported that cowpea height is dependent on the type of variety as certain varieties are genetically taller than others. The mean of the two seasons showed that *Akidi-enu* had the lowest number of branches per plant at the sampling dates contrary to *Akidi-ani,* a prostrate local cultivar. *Akidi-ani* had more branches per plant at 4 WAP, an indication that the peak of rains in early season planting encouraged vegetable cowpea branching, especially in the prostrate cultivar. The findings are in consonance with previous reports by Nanju (1979) on the effect of density, plant type and season on cowpea growth and yield. Further more, Ali *et al.* (2009) and Ichi *et al*. (2013) in their respective studies on cowpea observed that significant difference in number of branches per plant could be as a result of difference in cowpea varieties. The interaction between planting season and genotypes was not significant for the characters evaluated.

The ANOVA revealed that season had very high and significant (P<0.01) effect on dry matter per plant (Table 2). Contrary to the other plant traits such as dry matter per plant at 8 WAP and number of leaves per plant at 4 and 8 WAP, late planting induced the highest amount of dry matter per plant at 8WAP. Andrade and Ferreiro (1996) submitted that under intercropping, negative effect of shading (reduced solar radiation, which is a key weather factor in early season planting) on dry matter yield of component crops is expressed. On the contrast, Kiari *et al*. (2011) reported positive influence of late season planting which is characterized by low rainfall amount, reduced number of rain days, low cloudiness and increased sunshine hours per day on growth and yield of cowpea in the Sahel agro-ecosystem. Except dry matter per plant at 4 WAP, the cowpea genotypes showed strong genotypic variations for the parameters evaluated at the sampled dates. The mean of the dry matter per plant across the two seasons showed significant increase in dry matter production by *Akidi-enu* at 8 WAP relative to the others except *Akidi-ani*, IT98K-692, IT99K – 3771 and IT4K – 339-1 cowpea genotypes. Similarly, Singh *et al.* (1997) in their studies on some cowpea breeding lines as well as Adigbo *et al*. (2013) in cowpea/maize intercrop recorded consisted increase in biomass and dry matter yield in late season cowpea cultivation. This implied that seasonal differences in dry matter accumulation and partitioning, was due to differences in magnitude of growth resources that were without doubt more pronounced during the dry season. *Akidi-enu*, which was more vigorous in growth effectively exploited the environmental growth resources better, hence, gave higher dry matter yield.

The number of leaves per plant at 4 and 8 WAP ranged from 9.29 (IIT04K-3391) – 13.96 (*Akidi ani*) and 39.70 (IT03K-324-9) - 58.1 (1T98K – 692), respectively. The interaction between planting season and genotype did not show any significant (P>0.05) difference at the sampled dates for all the parameters studied.

Table 3 showed that at 4 and 8 WAP leaf area of the vegetable cowpea genotypes was highly significant (P<0.01) with *Akidi-ani* exhibiting the highest leaf area in early (1,796

cm^{-2}) and late (2,023 cm^{-2}) planting seasons compared to the other genotype at 4 WAP. *Akidi-ani* (a local and prostrate genotype) had the advantage of more ground cover. As a planophyll, it had more leaves exposed to better interception of solar radiation, which invariably increased the amount of assimilates stored in the pods. The results obtained are in consonance with findings by Uguru (1996) in his studies on Nigerian cowpea and Antwi *et al*. 2012 in their work on cultivar, season and year effect on cowpea in which they reported that strong variations among cultivars may be due to inherent genotypic characteristics as well as variation in weather patterns. However, the trend was not sustained at 8 WAP. Furthermore, interaction between planting season and genotype had no significant (P>0.05) effect on leaf area at all the sampled dates.

Significant effect of season on number of flowers per plant and percentage of pod retention per plant in the cowpea genotypes indicated that late planting induced high number of flowers and percentage pod retention by 9.45 and 14.15 per cent, respectively compared to early planting (Table 4). Among the cowpea genotypes, number of flowers per plant was highly (P<0.01) significant in both seasons. *Akidi-ani* significantly had the highest number of flowers per plant (61.36) but exhibited lower percentage of pod retention compared to IT99K-377-1 with the lowest number of flowers (51.15) though with high percentage of pod retention. Similarly, Ogunbodede and Brunner (1992) in their works on the effects of gamma rays on seedling traits of cowpea reported that differences in total flower production in cowpea in genetically motivated. The effect of genotype on percentage of pod retention as well as planting season by genotype interaction were not significant (P>0.05).

Table 1. Number of branches/plant and plant height (cm) at 4 and 8 WAP of seven genotypes of vegetable cowpea as influenced by planting season

Genotype	Attributes											
	Number of branches/plant at 4 WAP			Number of branches/ plant at 8 WAP			Plant height at 4WAP (cm)			Plant height of 8WAP (cm)		
	Early	Late	Mean	Early	Late	Mean	Early	Late	Mean	Early	Late	Mean
IIT04K-339-1	3.50	3.00	3.25	5.25	5.50	5.37	14.65	12.28	13.46	127.7	125.50	126.60
IT03K-324-9	4.08	3.17	3.62	4.67	4.42	4.54	16.71	15.80	16.25	56.0	77.6	66.80
IT99K-377-1	4.00	4.17	4.08	7.08	6.50	6.79	14.19	13.61	13.90	134.2	149.7	142.0
IT98K-131-1	4.50	3.75	4.12	4.83	4.92	4.88	21.73	22.11	21.92	159.5	137.8	148.60
IT98K-692	4.83	3.92	4.38	5.00	5.00	5.00	14.54	16.14	15.34	180.6	171.60	176.00
Akidi-ani	5.00	4.33	4.67	4.92	5.08	5.00	28.13	23.15	25.64	209.20	196.50	202.80
Akidi-enu	3.25	2.75	3.00	4.00	4.00	4.00	35.61	27.21	31.41	198.20	189.50	193.90
Mean	4.17	3.58		5.11	5.06		20.79	18.67		152.20	149.70	

$LSD_{0.05}$

Season = 0.495, **	ns
Genotype = 0.902, **	0.929, **
Season X Genotype = ns	ns

Table 2. Dry matter/plants and number of leaves/plant of 4 and 8 weeks after planting of seven genotypes of vegetable cowpea as influenced by planting season

Genotype	Attributes											
	Dry matter/plant (g) at 4WAP			Dry matter/plant (g) at 8WAP			No. of leaves/plant at 4WAP			No. of leaves/plant at 8WAP		
	Early	Late	Mean	Early	Late	Mean	Early	Late	Mean	Early	Late	Mean
IIT04K-339-1	9.91	11.46	10.69	78.20	79.20	78.90	10.33	8.24	9.29	50.1	46.8	48.40
IT03K-324-9	7.81	10.49	9.15	70.30	70.30	68.20	15.00	11.00	13.00	40.2	39.2	39.70
IT99K-377-1	8.85	11.05	9.95	77.50	77.50	78.00	11.42	10.50	10.96	64.3	65.0	64.70
IT98K-131-1	9.58	10.80	10.19	73.40	73.40	68.80	12.17	11.08	11.62	44.4	43.5	44.00
IT98K-692	8.70	10.12	9.41	79.40	70.40	74.30	13.17	10.75	11.96	59.5	56.8	58.10
Akidi-ani	7.97	10.48	9.23	78.70	78.70	76.90	13.08	14.83	13.96	60.8	52.7	56.70
Akidi-enu	9.18	9.75	9.46	82.10	82.10	79.10	11.08	11.17	11.12	43.6	46.2	44.90
Mean	8.86	10.59		77.10	77.10		12.32	11.08		43.60	46.20	

$LSD_{0.05}$

Season = 0.63, ***	ns	ns	ns
Genotype = ns	8.05, *	2.292, ***	10.22, ***
Season X Genotype = ns	ns	ns	ns

Table 3. Leaf area at 4 and 8 WAP of seven vegetable cowpea genotypes as influenced by planting season

Genotype	Attributes					
	Leaf area at 4 WAP			Leaf area at 8 WAP		
	Early	Late	Mean	Early	Late	Mean
IIT04K-339-1	873	647	760	5863	5373	5618
IT03K-324-9	922	665	794	2869	2772	2821
IT99K-377-1	992	758	875	7872	8384	8128
IT98K-131-1	1091	894	992	6449	6612	6531
IT98K-692	1087	908	997	8454	7748	8101
Akidi-ani	1796	2023	1910	8351	7024	7688
Akidi-enu	1242	1139	1190	5611	5785	5698
Mean	1143	1005		6496	6243	

LSD $_{0.05}$	
Season = n 3	ns
Genotype = 336.70, ***	1454.7, ***
Season X Genotype = ns	ns

Table 4. Number of flowers/plant and pod retention percentage/plant of seven vegetable cowpea genotypes as influenced by planting seasons

Genotype	Number of flowers/plant			Pod retention %/plant		
	Early	Late	Mean	Early	Late	Mean
IIT04K-339-1	48.70	57.95	53.33	60.1	73.0	66.5
IT03K-324-9	49.55	54.53	52.04	61.4	82.2	71.8
IT99K-377-1	47.15	55.15	51.15	75.7	77.4	76.5
IT98K-131-1	51.85	57.20	54.53	69.5	70.5	70.0
IT98K-692	54.20	60.08	57.14	66.6	71.6	69.1
Akidi-ani	56.30	66.43	61.36	57.2	77.7	67.5
Akidi-enu	62.50	57.55	60.03	55.3	67.5	61.4
Mean	52.89	58.41		63.7	74.2	

LSD $_{0.05}$	
Season = 3.03, **	7.99,*
Genotype = 5.525, **	ns
Season X Genotype = ns	ns

Table 5. Pod width (cm), number of seeds/pod, number of seeds/plant, 100- seed weight (g) of seven genotypes of vegetable cowpea as influenced by planting season

Genotype	Attributes											
	Pod width (cm)			Number of seeds/pod			Number of seeds/plant			100-seed weight (g)		
	Early	Late	Mean	Early	Late	Mean	Early	Late	Mean	Early	Late	Mean
IIT04K-339-1	2.39	2.46	2.42	13.37	14.04	13.71	388	593	491	14.46	14.97	14.72
IT03K-324-9	2.62	2.62	2.62	12.73	13.24	12.98	384	594	489	17.64	17.43	17.53
IT99K-377-1	2.26	2.20	2.28	16.35	16.53	16.44	574	702	638	13.20	11.99	12.59
IT98K-131-1	2.27	1.99	2.13	16.13	16.45	16.29	564	664	614	13.41	13.82	13.62
IT98K-692	2.29	2.46	2.37	10.56	11.14	10/.85	375	478	427	16.02	11.90	13.96
Akidi-ani	2.36	2.21	3.38	13.92	13.60	13.76	422	704	563	11.25	10.60	10.92
Akidi-enu	2.35	2.27	2.31	13.49	13.22	13.76	465	514	490	12.35	11.44	11.90
Mean	2.36	2.33		13.49	13.22		453	607		14.04	13.16	

LSD $_{0.05}$			
Season = 0.029, *	ns	45.2, **	ns
Genotype = 0.175, ***	0.80, ***	88.80, ***	2.198, ***
Season X Genotype = ns	ns	ns	ns

Table 6. Fresh pod yield (kg/ha), number of fresh pods/m^{-2}, number of pods/plant, pod length (cm) of seven genotypes of vegetable cowpea as influenced by planting season

Genotype	Attributes											
	Pod yield (kg/ha)			Number of fresh pods/m^{-2}			Number of pods/plant			Pod length (cm)		
	Early	Late	Mean	Early	Late	Mean	Early	Late	Mean	Early	Late	Mean
IIT04K-339-1	846	943	895	185.50	201.8	193.60	29.08	42.49	35.78	16.14	16.21	16.17
IT03K-324-9	1052	1121	1087	210.50	233.8	222.10	30.20	44.95	37.57	18.17	18.91	18.54
IT99K-377-1	1063	1511	1287	221.00	314.8	267.90	35.60	42.52	39.06	17.01	17.39	17.20
IT98K-131-1	972	1101	1036	198.50	260.2	229.40	35.03	40.66	37.84	14,13	17.48	15.81
IT98K-692	1168	1348	1258	247.50	325.0	286.20	35.75	42.78	39.26	15.16	14.99	15.07
Akidi-ani	958	1180	1069	215.80	291.0	253.40	30.35	51.63	40.98	21.90	21.21	21.56
Akidi-enu	1082	1224	1153	250.80	306.8	278.80	34.35	39.01	36.68	20.33	20.37	20.35
Mean	1020	1204		218.50	276.2		32.91	43.43		17.55	18.08	

LSD $_{0.05}$			
Season = 84.90, **	25.45,*	ns	ns
Genotype = 196.40, **	42.19, ***	2.899,*	1.799, ***
Season X Genotype = ns	ns	ns	ns

Table 5 revealed that the planting season effect was significant (P<0.05) while the genotypic effect was highly significant (P<0.01). Season increased pod width in early planting contrary to number of seeds per plant that was increased in late planting. Among the vegetable cowpea genotypes, pod width, number of seeds per pod, number of seeds per plant and 100-seed weight exhibited high significant (P<0.01) difference, an indication that genotypic variations affected the yield parameters. The findings are in consonance with studies by Muktar *et al*. (2010) on some cowpea varieties in which they reported that concentration of nitrogen and protein in leaves and grains of cowpea, respectively are usually higher during late (dry) season cowpea cultivation compared to early (wet) season production. Averaged over the two cropping seasons, pod width, number of seeds per pod, number of seeds per plant and 100-seed weight of the cowpea genotypes ranged between 2.13 - 3.38 cm, 10.85 – 16.44, 427 - 638 and 10.92 – 17.53 g, respectively. IT99K-337-1 had the highest number of seeds per pod (16.44) and number of seeds per plant (638) compared to the other genotypes. Late planting led to an increase in the number of seeds per plant and this increase in the number of seeds per plant and this increase could be as a result of weather changes during the planting season which affected seed production positively. The differences in 100 seed weight was quite pronounced with IT 03K – 324 – 9 having the biggest seeds (17.53 g/100 seeds) while Akidi-ani had small seed size (10.92 g/100 seeds). Planting season by genotype interaction was not significant.

Table 6 showed that season significantly influenced yield and yield parameters (Pod yield and number of fresh pods per m^{-2}). Late planting of vegetable cowpea induced more pod yield and number of fresh pods per m^{-2} by 18.0% and 26.4%, respectively when compared with early planting of cowpea. Genotype variations showed significant difference in pod yield, number of fresh pods per m^{-2}, number of pods per plant and pod length of vegetable cowpea. The genotype IIT04K-339-1 (P>0.01) had the lowest mean pod yield (895 kg/ha), number of fresh pods per m^2 (193.60) and number of pods per plant (35.78) while IT98K-692 gave the shortest pod length (15.07 cm) relative to the other vegetable cowpea genotypes. *Akidi-ani,* under late season planting, gave the highest number of pods per plant and increased pod length. The yield and yield components from the experiment agreed with the report of Agele *et al*. (2006), Antwic *et al*. (2012) and Nwadike *et al*. (2014) who in their various studies observed increase in yield and yield component of legume crops as a result of favourable environmental factors and inherent genotypic traits. Also, Egbe *et al*. (2010) on intercropping in the Guinea savannah using similar vegetable cowpea genotypes such as IT99K-377-1 and IT98K-692 indicated that these genotypes are known for their strength and absolute yield advantage. Interaction analysis showed that yield parameters did not differ from each other significantly (P<0.05).

4. Conclusions

The studies revealed that late season planting of cowpea significantly enhanced the growth and yield of the crop than early season planting. IT99K-377-1, IT98K-692 and *Akidi-enu* cowpea genotypes were found to be very promising (high yielding), across the two seasons, hence can be encouraged to be evaluated on-farm as farmer managed research studies to deepen the findings for farmers' benefit as well as enhance food security in sub-Sahara Africa in terms of increasing the protein content in the diet of the people.

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