African Journal of Agricultural Research Vol. 7(28), pp. 4097-4103, 24 July, 2012
Available online at http://www.academicjournals.org/AJAR
DOI: 10.5897/AJAR12.402
ISSN 1991-637X ©2012 Academic Journals

Full Length Research Paper

Yield and yield components in vegetable cowpea on an ultisol

Nwofia, G.E

Department of Agronomy, Michael Okpara University of Agriculture, Umudike, Nigeria. E-mail: enwofia@yahoo.co.uk.

Accepted 9 May, 2012

Field trials were conducted from 2001 to 2004 at the research farm of the Michael Okpara University of Agriculture, Umudike, South Eastern Nigeria to evaluate the yield and its components in nine vegetable cowpea cultivars. The cultivars differed significantly in yield and most of the components and the yield were not stable across the years of the study though, few cultivars seem to have stable yields. Pod yield was positively correlated with number of pods/m^2, pod length and width and these attributes could serve as selection indices for this crop.

Key words: Vegetable cowpea, yield, yield components.

INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp) is an important food crop in West and Central Africa but until recently its cultivation is restricted to the Sahel guinea and derived savannas. In the humid forest fringes (Hff), the most widely grown varieties are the vegetable types whose immature pods are eaten by humans. The indigenous varieties are climbing and decumbent but in recent times, erect, bushy varieties have been developed (Acosta and Petrache, 1960; Redden, 1981; Mittal et al., 1980; Umaharan et al., 1997), with the objective of increasing yield. Yield in vegetable cowpea is usually defined as green pod yield expressed in kg/ha or t/ha. Braithwaite (1982) however, showed that yield expressed as the number of marketable pods/ha is of great interest to growers because the crop is sold in bundles.

Yield in legumes is the result of many plant processes, which are usually expressed in yield components and this approach have been extensively used to explain variation in the yield of several grain legumes and have been shown to be affected by management, genotype and environment and can be of great help in explaining yield reduction (Garner et al., 1985; Mckenzie and Hill, 1991). The components that have been associated with yield in vegetable cowpea are pod clusters/plant (Singh and mehndirata, 1970; Khan and Stoffella, 1985); pods/cluster (Fernandez and Miller, 1985) and pod weight (Aggarwal et al., 1982; Braithwaite, 1982). Despite the importance and popularity of this nutritionally important vegetable legume, little information exists on its production and most of the information relies on work on grain cowpea and this is unsatisfactory hence, this study evaluates the yield and its component in some vegetable cowpea cultivars over a four year period.

MATERIALS AND METHODS

Vegetable cowpea cultivars

Seven of the vegetable cowpea cultivars used in this study was obtained from the International Institute of Tropical Agriculture (IITA) Ibadan namely; IT92kD-263-4-I, IT83S-899, IT97k-147-3, IT93k-915, IT86F-2062-5, IT81D-1228-14 and IT86F-2014-1, IT86F-2014-1 is a decumbent variety while the rest are semi-erect with long peduncles protruding well over the canopy and holding the pods above the ground. The other two cultivars Akidi-ani and Akidi-enu are local cultivars which are decumbent and climbing in habit and have coiled pods.

Site and soil characteristics

The experiment was conducted at the research farm of the Michael Okpara University of Agriculture, Umudike (05°29' N, 33' E; 122 m above sea level). The soil type was sandy clay loam with pH 4.8, 1.9% organic matter, 0.05% total N and 27 ppm phosphorus. The rainfall during the four year period of study was normal with total annual rainfall highest in 2002 and lowest in 2004 (Table 1). The site for the 2001 and 2002 experiment was under natural fallow for 2 and 3 years respectively while the 2003 experiment was repeated on the same site as used in 2002. Due to heavy disease build up on the 2003 experiment, the 2004 study was conducted on another 2 year old fallow field.

Table 1. Mean monthly rainfall in umudike.

Month	Rainfall (mm)			
	Year			
	2001	2002	2003	2004
January	0.00	3.10	0.00	0.20
February	7.80	107.10	37.90	11.90
March	175.90	68.50	119.50	22.40
April	224.10	259.00	159.80	134.50
May	194.30	436.30	231.40	217.60
June	522.50	240.40	282.40	279.40
July	273.50	359.80	447.50	309.50
August	179.00	333.70	372.60	304.30
September	317.20	238.50	340.80	324.90
Total	1894.30	2046.40	1991.90	1604.70

Land preparation and experimental design

In each year of study, the soil was disk ploughed and harrowed and the treatments laid out in a randomized complete block design replicated three times. Six rows of the appropriate cultivar was planted on the flat on plots measuring 3 × 3 m at a spacing of 25 × 20 cm intra and inter –row giving a plant population of 80,000 plants/ha. Two seeds were sown per stand on the 26^{th} April to the 2^{nd} of May in each year and later thinned down to one per stand at two weeks after planting (2 WAP).

Crop management

Weeding was done manually twice at 4 WAP and 8 WAP while insect infestation was controlled with cypermethrin 10 Ec at the rate of 2.5 ml/L of water at bud formation and full bloom. No fertilizer was applied to the crops in keeping with the practice of farmers in this area in the four-year period.

Data collection

Records on number of pods/plant were taken from six plants randomly selected in each plot while pod yield and number of pods/m^2 were recorded from 1 × 1 m quadrat in each plot. Data on pod length, width and seeds/pod were obtained from twenty fresh pods randomly selected while seed size were obtained by weighing one hundred air dried seeds.

Statistical analysis

The data collected was analyzed as a split-plot in randomized complete block design. Split- plot analysis was performed to enable the estimation of cultivars, year and cultivar x year effects. The vegetable cowpea cultivars constituted the subplot while the four years of evaluation were the main plots. The analysis was done using PROC Mixed procedure (Little et al., 1996) of SAS (SAS Institute, 2001) with replicate treated as random effect and year and cultivars as the fixed effects.

Mean separation was performed using the standard error while Pearson correlation coefficient between pod yield and the components was also computed using PROC CORR of SAS (SAS Institute, 2001).

RESULTS

Pod yield

The mean pod yield (t/ha) of the nine vegetable cowpea cultivars are presented in Table 2. Highly significant cultivars, year and cultivar × year interaction effects were observed ($P \leq 0.001$). Fresh pod yield ranged from 4.5 to 9.57 t/ha among the cultivars with IT 93k -915, IT86F-2062-5, and IT81D- 1228-14 giving the best pod yield in the four years. The lowest yield was observed in IT92KD-263-4-1 and the local cultivar Akidi-ani. Pod yield was highest in 2004 (11t/ha) than the other years while it was least in 2003 (4 t/ha) and the significant cultivars × year interaction effect, suggests that pod yield among these cultivars may not be stable.

Number of pods/m^2

IT86F-2014-1 had the highest number of pods/m^2 among the cultivars (261 pods/m^2) while the least was observed in IT 92KD-263-4-1 (70 pods/m^2, Table 3). Number of pods/m^2 differed significantly among the cultivars and there was a significant year and cultivars × year effects ($P < 0.001$). The highest number of pods/m^2 was observed in 2004 (229 pods/m^2). The higher significant cultivars × year interaction effects tend to suggest that the expression of this trait may not be independent of the environment.

Number of pods/plant

Number of pods/plant did not differ among the cultivars and the cultivars × year interaction also were not significant ($P>0.05$), while the year effect was significant. Though, cultivar effect was not significant. It is quite interesting to note that the cultivar (IT 86F-2014-1) with

Table 2. Mean pod yield (t/ha) of nine vegetable cowpea cultivars grown on an ultisol in 2001 to 2004.

Cultivar	Pod yield (t/ha)				Mean
	2001	2002	2003	2004	
IT92KD-263-4-1	5.71	4.06	4.89	5.15	4.95
Akidi-ani	4.67	4.03	2.27	7.01	4.50
IT 83S-899	5.92	10.42	1.88	8.72	6.74
IT97K-147-3	12.82	10.97	4.1	8.05	8.98
IT93K915	6.93	12.51	5.1	13.74	9.57
IT86F-2062-5	9.65	7.32	4.64	14.80	9.10
IT81D-1228-14	7.13	6.87	4.16	19.11	9.32
IT86F-2014-1	8.27	9.63	4.34	10.91	8.29
Akidi-enu	8.07	9.36	4.48	10.17	8.02
Mean	7.69	8.35	3.98	10.85	
			S.E	**P-values**	
Cultivars			0.82	0.0001	
Year			0.55	0.0001	
Cultivars x year			1.65	0.0016	

Table 3. Mean number of pods/m^2 of nine vegetable cowpea cultivars grown on an ultisol in 2001 to 2004.

Cultivar	Number of pods/m^2				Mean
	2001	2002	2003	2004	
IT92KD-263-4-1	89.67	56.00	4.89	69.00	70.17
Akidi-ani	158.00	157.33	2.27	218.67	150.58
IT 83S-899	113.00	115.00	1.88	155.33	103.83
IT97K-147-3	182.67	144.00	4.1	138.00	145.33
IT93K915	94.33	122.00	5.1	193.00	121.42
IT86F-2062-5	155.33	73.67	4.64	319.00	167.82
IT81D-1228-14	132.67	62.67	4.16	309.67	142.92
IT86F-2014-1	266.67	147.33	4.34	354.67	261.17
Akidi-enu	226.00	121.67	4.48	300.00	213.42
Mean	157.59	90.89	3.98	228.63	
			S.E	**P-values**	
Cultivars			13.87	0.0001	
Year			9.55	0.0001	
Cultivars x year			27.75	0.004	

the highest number of pods/m^2 also had the highest number of pods/plant (Table 4).

Pod length and width

Pod length and width differed significantly among the cultivars and there was also a significant year effect for the traits ($P < 0.01$). The longest pods were recorded in IT 92KD-263-4-1, IT 83S-899, IT 86F-2062-5, IT 81D-1228-14 and IT 93K-915 while the shortest pods were recorded in IT 86F-2014-1 (Table 5). The widest pods were observed in IT 92KD-263-4-1 while the narrowest pods were observed in Akidi-ani (Table 6). The significant cultivars × year interaction for the traits showed that the environment may have influenced it.

Number of seeds/pod

Number of seeds/pod differed significantly among the cultivars and there was a significant year effect ($p < 0.01$).

Table 4. Mean number of pods/plant of nine vegetable cowpea cultivars grown on an ultisol in 2001 to 2004.

Cultivar	Number of pods/plant				Mean
	2001	2002	2003	2004	
IT92KD-263-4-1	30.89	27.84	18.40	47.89	31.26
Akidi-ani	19.61	18.80	15.27	56.78	27.61
IT 83S-899	17.33	17.35	13.19	39.42	21.83
IT97K-147-3	22.92	22.28	28.83	25.45	23.87
IT93K915	18.83	18.17	18.83	37.33	23.39
IT86F-2062-5	78.58	13.77	17.56	40.11	37.51
IT81D-1228-14	24.00	26.60	20.64	59.11	32.59
IT86F-2014-1	28.08	28.96	18.39	82.89	39.58
Akidi-enu	12.75	16.74	18.86	51.56	24.98
Mean	28.11	21.17	18.44	48.95	
			S.E	**P-values**	
Cultivars			6.05	0.3572	
Year			4.03	0.0001	
Cultivars x year			12.10	0.2594	

Table 5. Mean pod length (cm) of nine vegetable cowpea cultivars grown on an ultisol in 2001 to 2004.

Cultivar	Pod length(cm)				Mean
	2001	2002	2003	2004	
IT92KD-263-4-1	18.05	20.79	20.60	27.77	21.80
Akidi-ani	15.77	15.84	17.71	16.32	16.41
IT 83S-899	23.14	25.27	24.57	19.23	23.05
IT97K-147-3	21.52	21.08	15.59	21.26	19.86
IT93K915	21.84	23.48	19.22	21.66	21.55
IT86F-2062-5	23.02	25.46	19.08	19.22	21.69
IT81D-1228-14	22.87	24.80	22.03	23.48	23.30
IT86F-2014-1	14.22	14.49	16.32	12.63	14.42
Akidi-enu	17.33	21.68	18.99	17.61	18.90
Mean	19.75	21.43	19.35	19.61	
			S.E	**P-values**	
Cultivars			0.64	0.0001	
Year			0.43	0.0059	
Cultivars x year			1.28	0.0001	

Akidi-enu had more seeds/pod while IT 83S-899 and IT 97K-147-3 had few seeds/pod (Table 7). More seeds were produced in 2004 and it appears that the performance of the cultivars for this trait was not independent of environmental effects.

Seed size

Significant cultivars and year effect ($P < 0.01$) were observed in this trait while the interaction effect was not significant. The biggest seeds were obtained in IT 97K-147-3 (16 g/100 seeds) while the smallest was recorded in the local cultivar, Akidi-ani (8 g/100 seeds, Table 8).

Correlation analysis

The correlation coefficients between pod yield and other attributes in the four years of study are shown in Table 9. The result shows that number of pods/m^2 was positively correlated with yield in all the years, though; it was

Table 6. Mean pod width (cm) of nine vegetable cowpea cultivars grown on an ultisol in 2001 to 2004.

Cultivar	Pod width (cm)				Mean
	2001	2002	2003	2004	
IT92KD-263-4-1	3.01	3.19	3.13	3.40	3.21
Akidi-ani	2.11	2.13	2.44	1.92	2.15
IT 83S-899	3.20	3.29	3.23	2.33	3.01
IT97K-147-3	2.72	3.07	3.09	2.61	2.87
IT93K915	3.30	3.24	2.85	2.53	2.98
IT86F-2062-5	2.87	2.80	2.72	2.36	2.69
IT81D-1228-14	3.22	3.38	2.92	2.74	3.07
IT86F-2014-1	2.75	2.74	2.74	2.00	2.56
Akidi-enu	2.49	2.64	2.47	2.11	2.43
Mean	2.86	2.94	2.84	2.43	
			S.E	**P-values**	
Cultivars			0.07	0.0001	
Year			0.05	0.0001	
Cultivars x year			0.13	0.0036	

Table 7. Mean number of seed/pod of nine vegetable cowpea cultivars grown on an ultisol in 2001 to 2004.

Cultivar	Number of pods/plant				Mean
	2001	2002	2003	2004	
IT92KD-263-4-1	14.38	13.53	13.38	11.27	13.14
Akidi-ani	14.33	17.10	12.16	16.33	14.98
IT 83S-899	11.39	10.67	9.20	14.25	11.38
IT97K-147-3	9.33	10.92	9.85	15.93	11.51
IT93K915	12.78	13.57	12.85	15.75	13.74
IT86F-2062-5	12.23	12.92	10.23	14.13	12.38
IT81D-1228-14	11.50	13.50	10.83	16.73	13.13
IT86F-2014-1	13.63	12.09	9.88	14.77	12.56
Akidi-enu	17.46	16.20	14.33	18.30	16.57
Mean	13.00	13.39	11.41	15.28	
			S.E	**P-values**	
Cultivars			0.49	0.001	
Year			0.33	0.001	
Cultivars x year			0.93	0.0079	

significant only in 2004. Pods/plant was positive except in 2002 while pod length, width and seeds/pod were either positively or negatively correlated with yield in the years. Seed size was also positively correlated with pod yield.

DISCUSSION

Evaluation of cultivars in contrasting environments and across years is an essential step in determining their desirability and cultivars with average response across the environments that have a wide scope of adaptation. The results obtained in this study showed highly significant cultivars, year and cultivar × year effects for yield and most of the components. The best performing cultivars with regard to yield were IT 93K-915, IT86F-2062-5 and IT81D-1228-4 while Akidi-ani and IT 92KD-263-4-1 had low yield. The performance of the cultivars in 2003 was generally low and may be attributed to the severe disease infestation experienced in that year

Table 8.100 seed weight (g) of nine vegetable cowpea cultivars grown on an ultisol in 2001 to 2004.

Cultivar	100 seed weight (g)				Mean
	2001	2002	2003	2004	
IT92KD-263-4-1	14.84	13.78	14.23	13.42	14.07
Akidi-ani	8.01	8.24	7.33	9.17	8.19
IT 83S-899	11.56	15.33	12.13	14.73	13.44
IT97K-147-3	15.37	16.45	14.47	16.47	15.69
IT93K915	14.15	16.83	15.33	15.50	15.45
IT86F-2062-5	12.59	13.78	13.33	14.03	13.41
IT81D-1228-14	10.65	12.05	9.50	13.20	11.35
IT86F-2014-1	9.64	10.61	10.00	10.97	10.30
Akidi-enu	11.15	9.72	9.77	10.60	10.31
Mean	11.99	12.98	11.78	13.12	
			S.E	**P-values**	
Cultivars			0.39	0.0001	
Year			0.26	0.0005	
Cultivars × year			0.78	0.2190	

Table 9. Correlation (r) coefficients between pod yield and the attributes in nine vegetable cowpea cultivars grown on an ultisol in 2001 to 2004.

Attributes	Year			
	2001	2002	2003	2004
Number of pods/m^2	0.419	0.345	0.526	0.658**
Number of pods/plant	0.299	-0.235	0.598	0.008
Pod length	0.259	0.259	-0.339	-0.003
Pod width	-0.033	0.383	-0.046	-0.069
100 seed weight	0.479	0.57	0.494	0.158
Number of seeds/pod	-0.475	-0.514	0.4	0.373

especially, *Sclerotium* stem rot. This disease infestation can be attributed to the fact that the 2003 study was sited on the previous year site, so there may have been disease build up in the soil prior to planting. The fact that the cultivars × year interaction were highly significant in this study and shows that there was inconsistent response to the environment by the cultivars. This shows that most of the cultivars were not stable across the years except IT 86 F-2014-1, Akidi-enu and IT 92KD-263-4-1 that had stable yield. The ability of some crop varieties to perform well over a wide range of environmental conditions has long been recognized (Finlay and Wilkinson, 1963) and yield reliability from year to year is of great interest to subsistence farmers than wide spatial adaptation (Evans, 1993; Ambrose and Hedley, 1984; Dashiell et al., 1994; Ma et al., 1998).

Yield evaluation usually involves the consideration of other characters that determine the overall performance of the cultivars. This is important because yield is a quantitative trait and hence, influenced by other traits acting singly or interacting together. In this study, IT 86 F-2014-1 had the highest number of pods/m^2. Number of pods/m^2 was positively correlated with pod yield. Yield variation in these cultivars was associated with significant variation in number of pods/m^2. This yield component could therefore, possibly be used as a primary criterion for selection at a late stage of a breeding programme especially, in countries where vegetable cowpeas are marketed in bundles (Braithwaite, 1982). Similarly, pod length and width are important components in vegetable cowpea, as they are known to influence the pod weight and the yield in this crop. In many countries, pod length is an important criterion governing consumer acceptability of vegetable cowpea and as such a good selection indices in its breeding programmes.

Number of seeds/pod was highly significant among cultivars and the years while the interaction were not significant. The non-significant interaction effect is an indication that the cultivars were consistent in their response for this trait. The local cultivar, Akidi-enu had more seeds/pod and this suggests that it can also be used as a grain cowpea, a practice prevalent among local farmers in Nigeria (Uguru, 1996).

Seed size was positively correlated with pod yield and most of the high yielder also has the biggest seeds while the low yielders have smaller seeds. The result also shows that this trait was not stable throughout the experimental period as shown by the significant interaction between cultivars × year for the trait. Ayaz et al. (2004a, b) have shown that plant population influences seed size and hence, not stable. Moot and McNeil (1995) also concluded that seed size is not a reliable character to use in pea improvement due to its instability.

A conclusion of this is that there are high degrees of instability in vegetable cowpea yield and yield components in this agro ecology. Irrespective of this, some of the cultivars had some degree of stable yield and number of pods/m^2; pod length and width could be food selection indices in this legume.

REFERENCES

Acosta JC, Petrache LW (1960). The transfer of the bushy character from cowpea to Sitao (*Vigna sesquipedalis* frow). Phil. Agric. 43:535-537.

Aggarwal VD, Natare RB, Smithson JB (1982). The relationship among yield and other characters in vegetable cowpea and the effect of different trellis management on pod yield. Trop. Grain leg. Bull. 25:8-14.

Ambrose NJ, Hedley CL (1984). A population study to acid the selection of improved dried pea (*Pisum sativum)* crop plants. Ann. Bot. 53:655-662.

Ayaz S, Mckenzie BA, Hill GD, McNeil DL (2004a). Variability in yield of four grain legume species in a sub humid temperate environment. I. Yields and harvest index. J. Agric. Sci. Camb. 142:9-19.

Ayaz S, Mckenzie BA, Hill GD and McNeil DL (2004b). Variability in yield of four grain legume species in a sub humid temperate environment. I. Yields and harvest index. J. Agric. Sci. Camb. 142:21-28

Braithwaite RAI (1982). Bodie bean response to changes in plant density. Agron. J. 745:93-596.

Dashiell KE, Ariyo OJ, Bellow L, Ojo K (1994). Genotype x environment interaction and simultaneous selection for high yield and stability in soyabeans (*Glycine max* (L) meir.) Ann. Appl. Biol. 124:133-139.

Evans LT (1993). Crop evolution, adaptation and yield. Camb. Univ. Press, p. 500.

Fernandez GCJ, Miller JC Jr. (1985). Yield component analysis of five cowpea cultivars. J. Am. Soc. Hort. Sci. 110(4):553-554.

Finlay KW, Wilkinson GN (1963). The analysis of adaptation in plant breeding programme. Aust. J. Agric. Res. 14:742-745.

Garner FP, Pearce RB, Mitchell RL (1985). Physiology of crop plants. Ames, IA : Iowa State Uni., Press.

Khan BA, Stoffella PJ (1985). Yield components of cowpeas grown in two environments. Crop Sci. 25:179-182.

Little RC, Milliken GA, Stroup WW, Wolfinger RD (1996). SAS systems for mixed models. Statistical Analysis Systems Inc. Cary, NC, USA, p. 633.

Ma Q, Longnecker N, Emery N, Alkins C (1998). Growth and yield in *Lupinus angustifolius* are depressed by early transient nitrogen deficiency. Aust. J. Agric. Res. 49:811-819.

McKenzie BA, Hill GD (1991). Intercepted radiation and yield of lentils (*Lens culinaris* Medik) in Canterbury, New Zealand. J. Agric. Sci. Camb. 117:339-346.

Mittal SP, Dabas BS, Thomas TA (1980). Evaluation of germplasm of vegetable cowpea for selecting desirable stocks. Indian J. Agric. Sci. 50:323-326.

Moot DJ, McNeil DL (1995). Yield components, harvest index and plant type in relation to yield difference in field pea genotypes. Euphy 86:31-40.

Redden RJ (1981). Vegetable cowpea breeding at the IITA. Trop. Grain Leg. Bul. 23:6-10.

Singh KB, Mehndiratta PD (1970). Path analysis and selection indices in cowpea. Indian J. Gent. Plant Breed. 30:471-475.

Uguru MI (1996). A note on the Nigerian vegetable cowpea. Gen. Res. Crop Evol. 43:125-126.

Umaharan P, Ariyanayagam RP, Haque SQ (1997). Genetic analysis of yield and its components in vegetable cowpea (*Vigna unguiculata* (L.) Walp). Euphy 96:207-213.