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SELECTION FOR EARLINESS, YIELD AND ITS COMPONENTS IN TWO POPULATIONS OF COWPEA

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ABSTRACT

In this study, two cowpea populations (TVU-21 x IT-85D-889) and (TVU-21 x IT-82D-812) were subjected to selection during the summer seasons of 2005, 2006 and 2007. The genetic parameters were estimated in the F_3, F_4 and F_5 generations. The main genetic parameters studied were the phenotypic (p.c.v) and genotypic (g.c.v.) coefficient, response to selection and selection differential, heritability (broad and narrow) sense and expected genetic advance. The measurements recorded were (days to 50% flowering, plant height, pod length, number of seeds/pod, weight of 100-seeds and dry seed yield (kg/feddan). Results indicated that obtained of this study could be that dry seed yield (kg/fed.) coud be increased by selection for pod length and number of pods/plant.

Key words: ***Cowpea, Phenotypic (p.c.v), Genotypic (g.c.v.), Heritability.***

INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp) is considered one of the most important legume crops grown in the summer season because of its high nutritional value. Thiyagarajan (1989) studied the genetic variability of yield and component characters in cowpea. He found that estimates of heritability and genetic advance were high for plant height, number of seeds/pod and 100-seed weight. Thiyagarajan *et al* (1989) showed that significant differences between 36 accessions together with marked genotypic and phenotypic variation were found in all traits studied. Estimates of heritability and genetic advance expected from selection were high for plant height, number of seeds/pod and seed yield/plant. Sawant (1994) indicated that phenotypic and genotypic coefficients of variation were high for plant height, seed yield/plant and 100-seed weight. High heritability and high genetic advance were observed for plant height, seed yield/plant, 100-seed weight and pod length. Hazra *et al* (1999) estimated variability and heritability of cowpea. Characters such as plant height and pod length, showed high phenotypic (p.c.v) and genotypic (g.c.v) coefficients of variation, very high heritability (above 95%) and high genetic advance as a percent of mean. Sharma (1999) studied the genotypic coefficients of variation (GCV), heritability (h^2) and genetic advance (GA) of cowpea. Genotypes differed significantly for all characters studied, plant height showed high genetic advance coupled with high h^2. Moderate GCV and GA estimates were observed for the other traits studied. Backiyarani *et al* (2000) evaluated genetic divergence among 32 genotypes of cowpea in some traits

viz. Plant height, days to 50% flowering and single plant yield. Geographic diversity was not related to genetic diversity. Single plant yield and earliness in flowering together accounted for 80% of the total genetic divergence. Manonmani *et al* (2000) studied the genotypic and phenotypic coefficient of variations (GCV and PCV, respectively), heritability (h^2) and genetic advance (GA) in cowpea genotypes. Among the traits observed, days to flowering recorded the highest heritability (96.9%). Mehta (2000) compered selection procedures. Pedigree selection for early flowering (PS (EF)), pedigree selection for high yield (PS (HY)), mass selection (MS), single seed descent (SSD) and random bulk (RB) populations, were initiated in the F_2 and compared in segregating F_3 and F_4 generations of four cowpea crosses. PS (HY) scheme of F_3 recorded the highest seed yield/plant in all the crosses. The widest phenotypic range and higher variances were exhibited by MS for seed yield/plant in all the four crosses in both generations. Ramesh Kumar and Sangwan (2000) estimated genotypic and phenotypic coefficients of variation, heritability and genetic advance in 72 diverse genotypes of cowpea. Significant differences in genotypic and phenotypic coefficient of variation were observed for all the characters. Moderate to high heritability coupled with high genetic advance as a percentage of mean were recorded for plant height, pod length and 100-seed weight. It was suggested that these traits may be used during selection for seed yield in cowpea. Rangaiah and Mahadevu (2000) estimated the genetic variability, in F_2 populations of two crosses of cowpea in plant height (PH), pod length (PL), number of seeds per plant (NS), total seed weight (TSW) and 100-seed weight (SW). The genotypic and phenotypic coefficient of variation, heritability and genetic advance were calculated. A wide range of variability was observed in PH, NS and TSW for both crosses. The difference between PCV and GCV was narrow with respect to GA. C2 had high GCV (20.025), PCV (22.910), GA (36.052%) and heritability of 76.418 for SW. Sawarkar *et al* (2000) studied the genetics of pod yield and its components in cowpea. The results indicated a major role of non-additive gene action in the inheritance of these characters and limited scope for improvement through straightforward selection. They estimated narrow-sense heritability as 12.99% (seeds/pod) and 45.51% (plant height). Sharma *et al* (2000) estimated genetic variability for physiological parameters and their association with grain yield in cowpea. High heritability coupled with high value of genetic advance were reported during growth stages I and II. Tyagi *et al* (2000) evaluated the coefficient of variability, heritability, genetic advance for days to 50% flowering, plant height, pod length, number of seeds per pod and 100-seed weight in 24 cowpea genotypes. High estimates for genotypic coefficient of variation, heritability (> 50%)

and genetic advance were observed for days to 50% flowering, plant height and seed yield per plant. Abd El-Hady (2003) in a study of inheritance of yield and its components in some cowpea crosses, found that heritability and actual response to selection showed high values for days to 50% flowering, plant height, pod length, number of seeds/pod, 100-seed weight and dry seed yield.

The present study aimed to improve cowpea cultivars by crossing with a high yield foreign cultivar. To reach this goal selection in some generations using breeding program such as a pedigree method, estimating the actual response to selection and the expected genetic gain through selection technique have been used. Also, estimation of the relationship among the plant characters under study from F_3 to F_5 generations was done.

MATERIALS AND METHODS

The present study was carried out during 2005, 2006 and 2007 growing summer seasons, at Shandaweel Agric. Res. Stat., Agric. Res. Center, Ministry of Agric., Egypt. Populations produced by Abd El-Hady (1998) during his study for the master degree were used as the main genetic material.The included population TVU-21 x IT-85D-889 and the second population was TVU-21 x IT-82D-812 in addition to a local check cultivar (Dokki-331 cv.). The three parents (TVU-21, IT-85D-889 and IT٠82D-812) originally introduced from International Institute of Tropical Agriculture (IITA) Ibadan, Nigeria and locally reproduced for ten years under Assiut conditions. These parents are good combiners for most characters (Abd El-Hady 1998). The objective of this study was improve cowpea cultivars by crossing with a high yield foreign cultivar and estimate the response of individual plant to selection (i.e. pedigree selection) for earliness and yield components in early generations. The genetic parameters were estimated in the F_3, F_4 and F_5 generations

Durig summer season of 2005, 1000 plants were selected from each of the two F_3 populations (Base). Also, the parents of each population were grown along side in three rows for each parent in addition to the local check cultivar. Data were collected from the plants of each population. The selection intensity was 10% for each of the studied populations.

Summer season of 2006, 100 F_4 families of each population were grown in three replications in a randomized complete block design. Plants were sown 30 cm apart within rows. An equal number of seeds composited from each F_3 plants to give F_4 bulk seeds, in addition to the parents and the check cultivar. These entries were grown in a single row plot.

Summer season of 2007, 10 F_3, F_4 and F_5 families of the two populations and bulk seeds in addition to the parents and the check cultivar

were grown with three replications in a randomized complete block design. Plants were sown 30 cm apart within rows. Sowing date was 15th of May and harvest date was 1st of October of the three seasons. The eria of plot 10.5 m^2.

Statistical procedures

Data were recorded for individual plants on a random sample of ten guarded plants from each family in F_3, F_4 and F_5 generations. The means of the ten plants were subjected to the statistical and genetic analysis for the following characters [pod length (cm), number of seeds per pod and weight of 100-seeds (g)].

The genetic parameters were estimated in F_3, F_4 and F_5 generations. Realized response to selection were expressed as percent change in the population mean relative to mid-parents, bulk population and check (Falconer 1981).

Expected response = $i\ H_n\ \sigma\ p$

Where:

$\sigma\ p$ = is the phenotypic standard deviation,

H_n = narrow sense heritability and i = selection intensity.

Heritability in broad sense "H" = $\sigma^2\ g\ /\ \sigma^2\ p$

Heritability in the narrow sense was estimated using the correlation and parent offspring regression according to Smith and Kinman (1965) as follow:-

Parent–off spring generation	**rxy**	**h = b/2rxy**
F_3, F_4	7 / 8	4 / 7 b F_4, F_3
F_4, F_5	15 / 16	8 / 15 b F_5, F_4

where r = correlation coefficients and b = regerssion coefficients.

The genotypic (g.c.v %) and phenotypic (p.c.v %) coefficient of variability were calculated as $\sigma g / \bar{x} \times 100$ and $\sigma p / \bar{x} \times 100$, respectively.

RESULTS AND DISCUSSION

Earliness

Population I (TVU-21 x IT-85D-889)

Average no. of days to 50% flowering is presented in Table (1), it was 41.60 days in F_3 generation, 40.20 days in F_4 generation and 37.60 days in F_5 generation, while the average the bulk population were 46.80 and 45.70 days from F_4 and F_5, respectively, compared with average no. of days to 50% flowering (Dokki-331 cv.) 47.00, 49.50 and 48.20 days from F_3, F_4 and F_5, respectively.

Table 1. Average number of days to 50% flowering, plant height (cm), pod length (cm), number of seeds/pod, 100-seed weight (g) and dry seed yield (kg/feddan) for base, selected and bulk populations as well as parents and check cultivar (Dokki-331) of cowpea.

Generation	Population I			Population II			TVU-21	IT-85D-889	IT-82D-812	Dokki-331 (control)
	Base	Selected	Bulk	Base	Selected	Bulk				
	No. of days to 50% flowering									
F_3	41.60	--	-	59.90	--	-	53.00	41.00	61.00	47.00
F_4	--	40.20	46.80	--	53.60	56.40	54.00	41.20	59.00	49.50
F_5	--	37.60	45.70	--	51.80	55.80	55.00	41.10	60.00	48.20
	Plant height (cm)									
F_3	62.10	--	--	89.20	--	--	73.00	54.00	84.50	67.23
F_4	--	56.20	62.50	--	73.50	87.50	75.20	54.50	92.00	65.30
F_5	--	53.20	61.20	--	67.20	84.50	76.10	53.40	93.00	65.30
	Pod length (cm)									
F_3	17.90	--	--	18.98	--	--	18.40	15.10	17.87	13.52
F_4	--	20.10	17.20	--	20.30	17.50	19.40	15.20	17.91	13.59
F_5	--	20.09	18.40	--	23.50	19.40	19.60	15.40	17.94	14.10
	Number of seed/pod									
F_3	6.70	--	--	7.89	--	--	4.10	7.20	12.40	9.87
F_4	--	7.30	6.20	--	9.50	7.80	4.60	7.80	12.50	9.98
F_5	--	9.20	7.20	--	9.90	8.70	5.40	8.10	12.60	9.40
	100-seed weight (g)									
F_3	18.80	--	--	16.90	--	--	24.12	16.50	15.60	18.21
F_4	--	20.30	18.50	--	17.80	17.70	24.08	16.80	15.70	18.24
F_5	--	22.50	18.90	--	18.10	17.90	24.07	16.90	15.80	18.40
	Dry seed yield (kg/feddan)									
F_3	738.42	--	--	772.30	--	--	804.1	712.0	860.0	817.7
F_4	--	814.90	650.40	--	832.30	687.00	811.5	730.2	865.0	822.1
F_5	--	914.90	712.00	--	951.80	743.00	818.0	735.0	870.0	819.1

The actual selection response (Table 2) showed values of –1.4 and –2.6 days in the F_4 and F_5 generations, respectively. The expected response was 1.81 in the F_4 and 2.09 days in the F_5 generation. The realized gain as percentage of the mid parent was highly significant (-15.55 and –21.75% in the F_4 and F_5 generations, respectively). It was also highly significant (-14.10 and –17.72%) in the F_4 and F_5 generations, respectively, as percentage of the bulk population, and (-18.79 and –21.99% in the F_4 and F_5

Table 2. The actual, expected and the realized response to selection relative to mid-parents, bulk and Dokki-331 populations for no. of days to 50% flowering, plant height (cm), pod length(cm), number of seeds/pod, 100-seed weight(g) and dry seed yield (kg/fed) of the two populations of cowpea.

Items	Population I		Population II		Population I		Population II	
	F_4	F_5	F_4	F_5	F_4	F_5	F_4	F_5
	No. of days to 50% flowering				Plant height (cm)			
Actual response	-1.4	-2.6	-6.3	-1.8	-5.9	-3.0	-15.7	-6.3
Expected response	1.81	2.09	1.84	2.34	9.81	11.55	13.32	12.12
Realized response to selection (%) relative to								
Mid-parents	-15.55**	-21.75**	-5.13**	-9.91**	-13.34**	-17.84**	-12.08**	-20.52**
Bulk population	-14.10**	-17.72**	-4.96**	-7.17**	-10.08**	-13.07**	-16.00**	-20.47**
Dokki-331	-18.79**	-21.99**	8.28**	7.47**	-17.11**	-18.53**	8.41**	2.91**
	Pod length (cm)				Number of seed/pod			
Actual response	2.2	0.8	1.3	3.2	0.6	1.9	1.6	0.4
Expected response	1.18	1.25	0.71	0.46	0.84	0.79	0.66	0.71
Realized response to selection (%) relative to								
Mid-parents	16.18**	19.43**	8.82**	25.20**	17.74**	36.30*	11.11**	10.00**
Bulk population	16.86**	13.59**	16.00**	21.13**	17.74**	27.78**	21.79**	13.79**
Dokki-331	47.90**	48.23**	49.37**	66.67**	-26.85**	-2.13**	-4.81**	5.32**
	100-seed weight (cm)				Dry seed yield (kg/feddan)			
Actual response	1.5	2.2	0.9	0.3	76.5	100.0	60.0	119.5
Expected response	1.40	1.34	0.71	0.70	32.99	28.31	10.07	14.55
Realized response to selection (%) relative to								
Mid-parents	-0.68	9.84**	-10.51**	-9.20**	5.71**	17.82**	-0.71	12.77**
Bulk population	9.73**	19.05**	0.56	1.12*	25.29**	28.50**	21.15**	28.10**
Dokki-331	11.29**	22.28**	-2.41**	-1.63**	-0.88*	11.70**	1.24**	16.20**

*, ** = Significant at 0.05 and 0.01% probability levels, respectively.

generations, respectively) as percentage of the chick cultivar. These results are in line with those reported by Backiyarani *et al.* (2000), Abd El-Hady (2003) and Hussein (2004), who found that the realized gain as percentage of the mid parent was highly significant for this character.

Phenotypic and genotypic coefficients of variation computed are presented in Table (3) were 9.13 and 7.16% in the F_4 generation and 9.88 and 8.72% in the F_5 generation, respectively. Small differences were observed between p.c.v and g.c.v in all generations, indicating the importance of the genetic effects in controlling the inheritance of no. of days to 50% flowering. These results are in agreement with those obtained by Sharma (1999), Manonmani *et al* (2000) and Abd El-Hady (2003), who reported that the difference between p.c.v and g.c.v was narrow with respect to GA and heritability.

Estimates of broad sense heritability values were 61.51% in the F_4 generation and 77.84% in the F_5 generation, respectively (Table 3). While, narrow sense heritability was 28.00 and 32.00% for the F_4 and F_5 generations, respectively. These results reveal that no. of days to 50% flowering was mostly controlled by genetic factors and less affected by environmental variations. These results are in line with those obtained by Sharma (1999), Manonmani *et al.* (2000) Tyagi *et al* (2000) and Abd El-Hady (2003) who obtained high value of heritability of this character in cowpea.

Population II (TVU-21 x IT-82D-812)

Average no. of days to 50% flowering is presented in Table (1), it was 59.90 days in F_3 generation, 53.60 days in F_4 generation and 51.80 days in F_5 generation. While, average bulk population were 56.40 and 55.80 days from F_4 and F_5 respectively, compared with average no. of days to 50% flowering (Dokki-331 cv.) 47.00, 49.50 and 48.20 days from F_3, F_4 and F_5, respectively.

The actual selection response (Table 2) showed values of –6.3 and –1.8 days in the F_4 and F_5 generations, respectively. The expected response was 1.84 days in the F_4 and 2.34 days in the F_5 generation. Increasing value expected response in the F_3 generation might be due to increase selection density in the F_3 generation. The realized gain as percentage of the mid parent was highly significant (-5.13 and –9.91%) in the F_4 and F_5 generations. It was highly significant (-4.96 and –7.17%) in the F_4 and F_5 generations, respectively, as percentage of the bulk population. Also, it was highly significant (8.28 and 7.47%) in the F_4 and F_5 generations, respectively, as percentage of the check cultivar.

Phenotypic and genotypic coefficients of variation computed are presented in Table (3), was 7.22 and 5.94% in the F_4 generation and 8.29 and 6.79% in the F_5 generation, respectively. Small differences were observed between p.c.v and g.c.v in all generations, indicating the importance of the genetic effects in controlling the inheritance of no. of days to 50% flowering.

Estimates of broad sense heritability values were 67.63% in the F_4 generation and 67.08% in the F_5 generation, (Table 3). While, narrow sense heritability was 27.00 and 31.00% for the F_4 and F_5 generations, respectively. These results revealed that no. of days to 50% flowering was mostly controlled by genetic factors and less affected by environmental variations.

Table 3. The genetic parameters of no. of days to 50% flowering, plant height, pod length (cm), number of seeds/pod, 100-seed weight (g) and dry seed yield Kg/feddan for F_4 and F_5 generations for two populations' cowpea.

Items	F_4	F_5	F_4	F_5
	No. of days to 50% flowering		Plant height (cm)	
Population I				
P.C.V. %	9.13	9.88	29.16	28.68
G.C.V. %	7.16	8.72	26.42	28.19
Broad sense heritability %	61.51	77.84	82.13	96.61
Narrow sense heritability %	28.00	32.00	34.00	43.00
Population II				
P.C.V. %	7.22	8.29	24.77	25.57
G.C.V. %	5.94	6.79	23.95	24.23
Broad sense heritability %	67.63	67.08	93.54	89.79
Narrow sense heritability %	27.00	31.00	42.00	41.00
	Pod length (cm)		Number of seed/pod	
Population I				
P.C.V. %	7.87	8.39	15.87	18.22
G.C.V. %	7.50	8.04	14.09	16.04
Broad sense heritability %	90.84	91.81	78.91	77.50
Narrow sense heritability %	43.00	41.00	41.00	37.00
Population II				
P.C.V. %	4.82	3.56	10.68	16.10
G.C.V. %	4.26	2.99	9.30	14.45
Broad sense heritability %	78.17	70.63	75.90	80.55
Narrow sense heritability %	41.00	31.00	37.00	35.00
	100-seed weight (gm)		Dry seed yield Kg/feddan	
Population I				
P.C.V. %	7.27	6.29	5.61	5.49
G.C.V. %	7.25	6.23	5.32	4.84
Broad sense heritability %	99.36	98.05	89.83	77.52
Narrow sense heritability %	54.00	54.00	41.00	32.00
Population II				
P.C.V. %	5.37	5.26	1.68	2.89
G.C.V. %	5.21	5.19	1.55	2.18
Broad sense heritability %	94.41	97.35	85.86	56.80
Narrow sense heritability %	43.00	42.00	41.00	30.00

Plant height (cm)

Population I (TVU-21 x IT-85D-889)

Average plant height is presented in (Table 1), it was 62.10, 56.20 and 53.20 cm in F_3, F_4 and F_5 generations, respectively. While, the average bulk

population was 62.50 and 61.20 cm from F_4 and F_5 generations, respectively, compared with (Dokki-331 cv.) 67.23, 65.30 and 65.30 cm from F_3, F_4 and F_5, respectively.

The actual selection response (Table 2) showed values of –5.9 and –3.0 cm in the F_4 and F_5 generations, respectively. The expected response was 9.81 cm in the F_4 and 11.55 cm in the F_5 generation. These results showed that the expected gain was higher than the actual one. Increasing value of expected response could be due to the increase of selection density in the F_3 generation. The realized gain as percentage of the mid parent was highly significant of –13.34 in the F_4 and –17.84% in the F_5 generations. It was highly significant of –10.08 and –13.07% in the F_4 and F_5 generations, respectively, as percentage of the bulk population. Also, it was highly significant of –17.11 and –18.53% in the F_4 and F_5 generations, respectively, as percentage of the check cultivar. These results are in line with those reported by Thiyagarajan (1989), Abd El-Hady (2003) and Hussein (2004), who reported that the realized gain as percentage of the mid parent was highly significant in this character.

Phenotypic and genotypic coefficients of variation presented in Table (3), were 29.16 and 26.42% in the F_4 generation and 28.68 and 28.19% in the F_5 generation, respectively. Small differences were observed between p.c.v and g.c.v in all generations, indicating the importance of the genetic effects in controlling the inheritance of plant height. These results were in agreement with those obtained by Hazra *et al* (1999), Sharma (1999), Rangaiah and Mahadevu (2000) and Abd El-Hady (2003), who found that the difference between p.c.v and g.c.v was narrow with respect to heritability.

Estimates of broad sense heritability values were 82.13% in the F_4 generation and 96.61% in the F_5 generation. While, narrow sense heritability was 34.00 and 43.00% for the F_4 and F_5 generations, respectively. These results revealed that plant height was mostly controlled by genetic factors and less affected by environmental conditions. These results were in agreement with those obtained by Thiyagrajan (1989), Thiyagrajan *et al* (1989), Sawant (1994), Hazra *et al* (1999), Sharma (1999), Rangaiah and Mahadevu (2000), Sawarkar *et al* (2000), Tyagi *et al* (2000) and Abd El-Hady (2003) who found high value of heritability of this character.

Population II (TVU-21 x IT-82D-812)

Average plant height was 89.20, 73.50 and 67.20 cm in F_3, F_4 and F_5 generations, respectively. While, average bulk population was 87.50 and 84.50 cm from F_4 and F_5 respectively, compared with (Dokki-331 cv.) 67.23, 65.30 and 65.30 cm from F_3, F_4 and F_5, respectively (Table 1).

The actual selection response (Table 2) showed values of –15.7 and –6.3 cm in the F_4 and F_5 generations, respectively. The expected response was 13.32 cm in the F_4 and 12.12 cm in the F_5 generation. The realized gain as percentage of the mid parent was highly significant (-12.08 and –20.52%) in the F_4 and F_5 generations, respectively. It was highly significant (-16.00 and –20.47%) in the F_4 and F_5 generations, respectively, as percentage of a bulk population. Also, the realized gain as percentage of the check cultivar was highly significant (8.41 and 2.91%) in the F_4 and F_5 generations, respectively.

Phenotypic and genotypic coefficients of variation computed (Table 3), was 24.77 and 23.95% in the F_4 generation and 25.57 and 24.23% in the F_5 generation, respectively. Slight differences were observed between p.c.v and g.c.v in all generations, indicating the importance of the genetic factors in controlling the inheritance of plant height.

Estimates of broad sense heritability values were 93.54% in the F_4 generation and 89.79% in the F_5 generation. While, narrow sense heritability was 42.00 and 41.00% for the F_4 and F_5 generations, respectively. These results revealed that plant height was mostly controlled by genetic factors and less affected by environmental variations.

Pod length (cm)

Population I (TVU-21 x IT-85D-889)

Average pod length is presented in Table (1), it was 17.90, 20.10 and 20.09 cm in F_3, F_4 and F_5 generations, respectively. While, the bulk average population were 17.20 and 18.40 cm from F4 and F_5 respectively, compared with average (Dokki-331 cv.) 13.52, 13.59 and 14.10 cm from F_3, F_4 and F_5, respectively.

The actual selection response (Table 2) showed values of 2.2 and 0.8 cm in the F_4 and F_5 generations, respectively. The expected response was 1.18 cm in the F_4 and 1.25 cm in the F_5 generation. These results showed that the expected gain was higher than the actual one in the F_5 generation. Increasing value of expected response in the F_5 generation could be due to the increase of selection intensity in the F_4 generation. The realized gain as percentage of the mid parent was highly significant of 16.18 in the F_4 and 19.43% in the F_5 generations. It was highly significant of 16.86 and 13.59% in the F_4 and F_5 generations, respectively, as percentage of the bulk population. Also, it was highly significant of 47.90 and 48.23% in the F_4 and F_5 generations, respectively, as percentage of the check cultivar. Abd El-Hady (2003) and Hussein (2004) found that the realized gain as percentage of the mid parent was highly significant in this character.

Phenotypic and genotypic coefficients of variation presented in Table (3), were 7.87 and 7.50% in the F_4 generation and 8.39 and 8.04% in the F_5 generation, respectively. Small differences were observed between p.c.v and g.c.v in all generations, indicating the importance of the genetic effects in controlling the inheritance of pod length. These results agreed with those obtained by Hazra *et al* (1999), Rangaiah and Mahadevu (2000) and Abd El-Hady (2003) who found that the difference between p.c.v and g.c.v was narrow with respect to heritability.

Estimates of broad sense heritability values were 90.84% in the F_4 generation and 91.81% in the F_5 generation. While, narrow sense heritability was 43.00 and 41.00% for the F_4 and F_5 generations, respectively. These results revealed that pod length was mostly controlled by genetic factors and less affected by environmental conditions. These results were in line with those obtained by Hazra *et al* (1999), Ramesh Kumar and Sangwan (2000), Rangaiah and Mahadevu (2000), Tyagi *et al* (2000) and Abd El-Hady (2003) who found high value of heritability of this character.

Population II (TVU-21 x IT-82D-812)

Average pod length was 18.98, 20.30 and 23.50 cm in F_3, F_4 and F_5 generations, respectively. While, average the bulk population were 17.50 and 19.40 cm from F_4 and F_5 respectively, compared with average (Dokki-331 cv.) 13.52, 13.59 and 14.10 cm from F_3, F_4 and F_5, respectively (Table 1).

The actual selection response (Table 2) showed values of 1.30 and 3.2 cm in the F_4 and F_5 generations, respectively. The expected response was 0.71 cm in the F_4 and 0.46 cm in the F_5 generation. The realized gain as percentage of the mid parent was highly significant (8.82 and 25.20%) in the F_4 and F_5 generations, respectively. It was highly significant (16.00 and 21.13%) in the F_4 and F_5 generations, respectively, as percentage of the bulk population. However, the highly sizeable gain obtained in cycle 1 was partially lost in the last cycle. This could be due to the large and/or the masking effects of overall mean of the selected families, since the low means cancels the high ones and give a misleading picture of the effect of direct selection in isolating lines for one or more characters. Also, the realized gain as percentage of the check cultivar was highly significant (49.37 and 66.67%) in the F_4 and F_5 generations, respectively.

Phenotypic and genotypic coefficients of variation (Table 3), 4.82 and 4.26% in the F_4 generation and 3.56 and 2.99% in the F_5 generation, respectively. Slight differences were observed between p.c.v and g.c.v in all generations, indicating the importance of the genetic factors in controlling the inheritance of pod length.

Estimates of broad sense heritability values were 78.17% in the F_4 generation and 70.63% in the F_5 generation While, narrow sense heritability was 41.00 and 31.00% for the F_4 and F_5 generations, respectively. These results revealed that pod length was mostly controlled by genetic factors and less affected by environmental variations.

Number of seeds/pod

Population I (TVU-21 x IT-85D-889)

Average number of seeds/pod is presented in Table (1), it was 6.70 seeds in F_3 generation, 7.30 seeds in F_4 generation and 9.20 seeds in F_5 generation. While, the bulk average population was 6.20 and 7.20 seeds from F_4 and F_5, respectively, compared with the control (Dokki-331 cv.) 9.87, 9.98 and 9.40 seeds from F_3, F_4 and F_5, respectively.

The actual selection response (Table 2) showed values of 0.6 and 1.9 seeds in the F_4 and F_5 generations, respectively. The expected response was 0.84 seed in the F_4 and 0.79 seeds in the F_5 generation. The estimates of the predicted response to selection were too high because heritability estimates obtained were upward. The realized gain as percentage of the mid parent was highly significant (17.74 and 36.30%) in the F_4 and F_5 generations respectively,. It was highly significant (17.74 and 27.78%) in the F_4 and F_5 generations, respectively, as percentage of the bulk population. Also, it was highly significant (-26.85 and –2.13%) in the F_4 and F_5 generations, respectively, as percentage of the check cultivar. These results are in line with those reported by Thiyagarajan (1989), Abd El-Hady (2003) and Hussein (2004), who found that the realized gain as percentage of the mid parent was highly significant in this character.

Phenotypic and genotypic coefficients of variation presented in Table (3), was 15.87 and 14.09% in the F_4 generation and 18.22 and 16.04% in the F_5 generation, respectively. Small differences were observed between p.c.v and g.c.v in all generations, indicating the importance of the genetic effects in controlling the inheritance of number of seeds/pod. These results agreed with those obtained by Rangaiah and Mahadevu (2000) and Abd El-Hady (2003) who found that the difference between p.c.v and g.c.v was narrow with respect to heritability..

Estimates of broad sense heritability values were 78.91% in the F_4 and 77.50% in the F_5 generation, (Table 3). While, narrow sense heritability was 41.00 and 37.00% for the F_4 and F_5 generations, respectively. These results revealed that number of seeds/pod was mostly controlled by genetic factors and less affected by environmental variations. These results were in line with those obtained by Thiyagrajan (1989), Thiyagrajan *et al* (1989),

Sawarkar *et al* (2000), Tyagi *et al.* (2000) and Abd El-Hady (2003) who found high value of heritability of this character.

Population II (TVU-21 x IT-82D-812)

Average number of seeds/pod are presented in Table (1), it was 7.89 seeds in the F_3 generation, 9.50 seed in the F_4 generation and 9.90 seed in the F_5 generation. While, average bulk population was 7.80 and 8.70 seed from F_4 and F_5 respectively, compared with average (Dokki-331 cv.) 9.87, 9.98 and 9.40 seed from F_3, F_4 and F_5, respectively.

The actual selection response (Table 2) showed values of 1.6 and 0.4 seed in the F_4 and F_5 generations, respectively. The expected response was 0.66 seed in the F_4 generation and 0.71 seed in the F_5 generation. The realized gain as percentage of the mid parent was highly significant (11.11 and 10.00%) in the F_4 and F_5 generations. It was highly significant (21.79 and 13.79%) in the F_4 and F_5 generations, respectively, as percentage of the bulk population. Also, it was highly significant (-4.81% and 5.32%) in the F_4 and F_5 generations, respectively, as percentage of the chick cultivar.

Phenotypic and genotypic coefficients of variation computed are presented in Table (3), were10.68 and 9.30% in the F_4 generation and 16.10 and 14.45% in the F_5 generation, respectively. Small differences were observed between p.c.v and g.c.v in all generations, indicating the importance of the genetic effects in controlling the inheritance of number of seeds/pod.

Estimates of broad sense heritability values were 75.90% in the F_4 generation and 80.00% in the F_5 generation, (Table 3). While, narrow sense heritability was 37.00 and 35.00% for the F_4 and F_5 generations, respectively. These results revealed that number of seeds/pod was mostly controlled by genetic factors and less affected by environmental variations.

100-seed weight (gm)

Population I (TVU-21 x IT-85D-889)

Average 100-seed weight is presented in Table (1), it was 18.80 g in F_3 generation, 20.30g in F_4 generation and 22.50g in F_5 generation. While, average the bulk population were 18.50 and 18.90g from F_4 and F_5, respectively, compared with average (Dokki-331 cv.) 18.21, 18.24 and 18.40g from F_3, F_4 and F_5, respectively.

The actual selection response (Table 2) showed values of 1.5 and 2.2g in the F_4 and F_5 generations, respectively. The expected response was 1.40g in the F_4 and 1.34gm in the F_5 generation. The realized gain as percentage of the mid parent was –0.68% the F_4 generations, but was highly significant (9.84%) in the F_5 generations. It was highly significant (9.73 and 19.05%) in

the F_4 and F_5 generations, respectively, as percentage of the bulk population. Also, it was highly significant (11.29 and 22.28%) in the F_4 and F_5 generations, respectively, as percentage of the check cultivar. These results are in line with those reported by Thiyagarajan (1989), Abd El-Hady (2003) and Hussein (2004), who found that the realized gain as percentage of the mid parent was highly significant in this character.

Phenotypic and genotypic coefficients of variation presented in Table (3), was 7.27 and 7.25% in the F_4 generation and 6.29 and 6.23% in the F_5 generation, respectively. Small differences were observed between p.c.v and g.c.v in all generations, indicating the importance of the genetic effects in controlling the inheritance of 100-seeds weight. These results agreed with those obtained by Hazra *et al* (1999), Rangaiah and Mahadevu (2000) and Abd El-Hady (2003), who reported that the difference between p.c.v and g.c.v was narrow with respect to heritability.

Estimates of broad sense heritability values were 99.36% in the F_4 generation and 98.05% in the F_5 generation, (Table 3), While, narrow sense heritability was 54.00 and 54.00% for the F_4 and F_5 generations, respectively. These results revealed that 100-seeds weight was mostly controlled by genetic factors and less affected by environmental variations. These results were in line with those obtained by Thiyagrajan (1989), Sawant (1994), Rangaiah and Mahadevu (2000), Tyagi *et al* (2000) and Abd El-Hady (2003) who found high value of heritability of this character.

Population II (TVU-21 x IT-82D-812)

Average 100-seed weight is presented in Table (1), it was 16.90g in F_3 generation, 17.80g in F_4 generation and 18.10g in F_5 generation, respectively. While, the bulk average population was 17.70 and 17.90g from F_4 and F_5 respectively, compared with average (Dokki-331 cv.) 18.21, 18.24 and 17.90g from F_3, F_4 and F_5, respectively.

The actual selection response (Table 2) showed values of 0.9 and 0.3gm in the F_4 and F_5 generations, respectively. The expected response was 0.71gm in the F_4 and 0.70gm in the F_5 generation. The realized gain as percentage of the mid parent was highly significant (-10.51 and –9.20%) in the F_4 and F_5 generations, respectively. It was (0.56) in the F_4 generations and it was significant (1.12%) in the F_5 generations, as percentage of the bulk population. While, it was highly significant (-2.41 and -1.63%) in the F_4 and F_5 generations, respectively, as percentage of the check cultivar.

Phenotypic and genotypic coefficients of variation presented in Table (3), were 5.37 and 5.21% in the F_4 generation and 5.26 and 5.19% in the F_5 generation, respectively. Small differences were observed between p.c.v and g.c.v in all generations, indicating the importance of the genetic effects in controlling the inheritance of 100-seeds weight.

Estimates of broad sense heritability values were 94.41% in the F_4 generation and 97.35% in the F_5 generation, (Table 3). While, narrow sense heritability was 43.00 and 42.00% for the F_4 and F_5 generations, respectively. These results revealed that 100-seeds weight was mostly controlled by genetic factors and less affected by environmental variations.

Dry seed yield (kg/feddan)

Population I (TVU-21 x IT-85D-889)

Average dry seed yield (kg/fed) are presented in Table (1), it was 738.4, 814.9 and 914.9 kg in F_3, F_4 and F_5 generation, respectively. While, average bulk population was 650.4 and 712.0 kg from F_4 and F_5 respectively, compared with Dokki-331 cv. 817.7, 822.1 and 819.1 kg from F_3, F_4 and F_5, respectively. These results indicated again that the application of pedigree selection method was more effective in improving.

The actual selection response (Table 2) showed values of 76.5 and 100.0 kg in the F_4 and F_5 generations, respectively. The expected response was 32.99 kg in the F_4 and 28.31 kg in the F_5 generation. The realized gain as percentage of the mid parent was highly significant (5.71 and 17.82%) in the F_4 and F_5 generations. It was highly significant (25.29 and 28.50%) in the F_4 and F_5 generations, respectively, as percentage of the bulk population. While, it was significant (–0.88%) in the F_4 generation and it was highly significant (11.70%) in the F_5 generations, as percentage of the check cultivar. These results are in line with those reported by Thiyagarajan (1989), Abd El-Hady (2003) and Hussein *et al* (2004) who found that the realized gain as percentage of the mid parent was highly significant in this character.

Phenotypic and genotypic coefficients of variation presented in Table (3), was 5.61 and 5.32% in the F_4 generation and 5.49 and 4.84% in the F_5 generation, respectively. Slight discrepancies were observed between p.c.v and g.c.v in all generations, indicating the importance of the genetic effects in controlling the inheritance of dry seed yield (kg/fed). These results agreed with those obtained by Hazra *et al* (1999), Rangaiah and Mahadevu (2000) and Abd El-Hady (2003), who found that the difference between p.c.v and g.c.v was narrow with respect to heritability..

Estimates of broad sense heritability values were 89.83% in the F_4 generation and 77.52% in the F_5 generation, respectively (Table 3). While, narrow sense heritability was 41.00 and 32.00% for the F_4 and F_5 generations, respectively. These results revealed that dry seed yield (kg/fed) was mostly controlled by genetic factors and less affected by environmental variations. These results were in line with those obtained by Thiyagrajan *et al* (1989), Sawant (1994), Mehta (2000), Ramesh Kumar and Sangwan

(2000), Tyagi *et al* (2000) and Abd El-Hady (2003) who found high value of heritability of this character.

Population II (TVU-21 x IT-82D-812)

Average dry seed yield (kg/fed) are presented in Table (1), it was 772.3, 832.3 and 951.8 kg in F_3, F_4 and F_5 generations, respectively. While, average bulk population were 687.0 and 743.0 kg from F_4 and F_5 respectively, compared with average (Dokki-331 cv.) 817.7, 822.1 and 819.1 kg from F_3, F_4 and F_5, respectively.

The actual selection response (Table 2) showed values of 60.0 and 119.5 kg in the F_4 and F_5 generations, respectively. The expected response was 10.07 kg in the F_4 and 14.55 kg in the F_5 generation. The realized gain as percentage of the mid parent was –0.71% in the F_4 generation and was highly significant (12.77%) in the F_5 generations. It was highly significant (21.15 and 28.10%) in the F_4 and F_5 generation, as percentage of the bulk population. As in the population I, it should be stressed that the results of the response to selection which contradict to some extent in this population was based upon the overall mean of the selected families. Also, it was highly significant (1.24 and 16.20%) in the F_4 and F_5 generations, respectively, as percentage of the check cultivar.

Phenotypic and genotypic coefficients of variation showed 1.68 and 1.55% in the F_4 generation and 2.89 and 2.18% in the F_5 generation, respectively reflecting the differential response to selection and the sensitivity of both studied gene pools to environmental effect. Small differences were observed between p.c.v and g.c.v in all generations, indicating the importance of the genetic effects in controlling the inheritance of dry seed yield (kg/fed).

Estimates of broad sense heritability values were 85.86% in the F_4 generation and 56.80% in the F_5 generation, (Table 3). While, narrow sense heritability was 41.00 and 30.00% for the F_4 and F_5 generations, respectively. These results revealed that dry seed yield (kg/fed) was mostly controlled by genetic factors and less affected by environmental variations.

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الإنتخاب للتبكير والمحصول ومكوناته فى عشيرتين من اللوبيا

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أجريت هذه الدراسة بمزرعة البحوث الزراعية لمحطة بحوث جزيرة شندويل خلال مواسم الصيف 2005 ، 2006 ، 2007م بهدف محاولة الحصول على سلالات جديدة من اللوبيا مبكرة وذات محصول عالى بواسطة الإنتخاب للمحصول ومكوناته ودراسة المكونات الوراثية الناتجة عن هذا الإنتخاب فى دورتين من الأجيال الإنعزالية بداية من الجيل الثالث لعشيرتين من اللوبيا (TVU-21xIT-85D-889) ،(TVU-21 x IT-82D-812).

تم تقدير عددا من القياسات الوراثية فى هذه الدراسة منها: (الإستجابة للإنتخاب ، درجة التوريث على النطاق الضيق والواسع ، التقدم الوراثى بين الأجيال)

وقد قدرت صفات مكونات المحصول وهى: عدد الأيام حتى 50% تذهير ، طول النبات (سم)، طول القرن (سم)، عدد بذور القرن، وزن 100 بذرة (جم) ومحصول بذور الفدان (كجم/فدان) .

وظهر من النتائج زيادة صفات مكونات المحصول قيد الدراسة فى الجيل الخامس الإنتخابى عن الأجيال السابقة كذلك عن متوسط الأباء وصنف المقارنة . مما أدى إلى زيادة المحصول الكلى للفدان (فى العشيرة الأولى) فى الجيل الخامس الإنتخابى بمقدار 176.5 كجم (عن جيل الأساس) وعن الصنف دقى-331 (كنترول) بمقدار 95.8 كجم وعن الأب الأول بمقدار 96.9 كجم وعن الأب الثانى بمقدار 179.9 كجم.

أما فى العشيرة الثانية فقد زاد المحصول الكلى للفدان فى الجيل الخامس الإنتخابى بمقدار 179.5 كجم (عن جيل الأساس) وعن الصنف دقى-331 (كنترول) بمقدار 132.7 كجم وعن الأب الأول بمقدار 133.8 كجم وعن الأب الثانى بمقدار 81.8 كجم.

أظهرت درجة التوريث قيماً عالية لصفات مكونات المحصول مما يدل على أن الإنتخاب يكون فعالاً لهذه الصفات وبالتالى يوصى بالاستمرار فى عملية الإنتخاب فى الأجيال التالية .