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GENETIC VARIABILITY, HETEROSIS, NARROW SENSE HERITABILITY AND CORRELATIONS OF YIELD AND YIELD RELATED CHARACTERISTICS OF COWPEA (*VIGNA UNGUICULATA* (L.) WALP.)

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ABSTRACT

Cowpea, (*Vigna unguiculata* (L). Walp) is a major grain legume grown in Sri Lanka. It is a comparatively drought tolerant crop and well adapted to rainfed conditions of the Dry and Intermediate zones of Sri Lanka. Improved varieties with better attributes are essential to increase the productivity with better adaptability. The present study was designed to estimate genetic variability, degree of hybrid vigour and extent of narrow sense heritability of yield and yield related characteristics of cowpea based on F_1 hybrids and their parents. Six F_1 hybrids with respective parents were established in RCBD design with two replications under field conditions at the Grain Legumes and Oil Crops Research and Development Centre (GLOCRDC), Angunukolapallessa during *yala* 2012 season. Days to 50% flowering, plant height pod length, number of seeds per pod, pods per plant, seed length, hundred seed weight and yield showed genetic variability among inbred parents and cross combinations. Significance of heterosis and heterobeltiosis for yield and yield related characteristics appeared cross combination specific. Cp 108 x Cp 179, Cp 128 x MI 35 and Cp 114 x Cp 113 were identified as cross combinations where probability of producing promising segregants in subsequent generations. Only seed width and seed length, were resulted with significant heritability while yield and yield related characteristics were insignificant, therefore, these characteristics will not be able to improve through exploiting additive genetic variability present in the cowpea populations studied. Correlation studies indicated that direct selection possible to be performed using several yield related characteristics aiming indirect selection for high yield.

KEYWORDS: Cowpea, Genetic variability, Heritability, Heterosis, Yield.

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp.) is a major food legume crop grown in many parts of the tropics. Africa, Southern Europe, Southern USA and Central and South America are the major cowpea producing regions in the world. Cowpea is cultivated in 12.5 million ha globally with an annual production of over 3 million tons (Singh, 1998). It plays an important role in the agricultural economy of rainfed areas of Sri Lanka. In year 2011, cowpea was cultivated in 9,267 ha and produced approximately a grain yield

of 10,453 mt (DOA, 2012). Ampara, Anuradapura, Badulla, Batticaloa Hambantota, Kurunagala, Monaragala, Polonnaruwa, Putlum and Rathnapura and are the main areas of cultivation of cowpea. Cowpea is an inexpensive source of vegetable protein and a hardy crop well adapted to relatively dry environments. In combination or association with cereals and other grain legumes, it contributes to the sustainability of cropping systems in marginal lands of semiarid areas, with its ability to fix nitrogen, covering ground, and improve soil by providing plant residues (Singh and Matsui, 1997).

Although it has paramount importance in our dietary requirements, its production does not meet the demand of the population, yet country imports 3% of the annual requirement (DOA, 2012). Reasons for low production of cowpea in Sri Lanka are susceptibility to pest and diseases, narrow range of genetic diversity, inefficient plant type and low yielding potential, lack of suitable varieties specific to different agro-ecological conditions and competition from weeds (Jayamanne, 1989). Therefore, plant breeding is essential to satisfy the varietal needs of the cowpea farmers. One of the effective and practical methods to improve varieties is to create genetic variability and selection in subsequent generations for interested characteristics. Identification of hybrid vigour for tolerance and adaptation could play a pivotal role in variety improvement of self-pollinated crops (Bakhsh *et al.*, 2007). Breeders have been utilizing the available genetic resources to improve varieties to meet the ever changing requirements. In this regard the most important development in plant breeding of recent time is the extensive use of heterosis (Malik *et al.*, 1987). Heterosis refers to the superiority of F1 hybrids in one or more characters over its patents. However, in self-pollinated crops the heterosis cannot be exploited directly. Heterosis is used to identify superior hybrids as they offer comparatively higher probability of getting better segregants. The knowledge of heritability and genetic advance help to identify characters with potential improvement and to decide upon the selection pressure in breeding material (Hamid and Cheema, 1997). The present study was designed to estimate genetic variability, degree of hybrid vigour and extent of narrow sense heritability of yield and yield related characteristics of cowpea based on F1 hybrids and their parents. The information obtained could be used to select comparatively better cross combinations that are expected to produce superior segregants for higher adaptability and productivity.

MATERIAL AND METHODS

Parent material selection and hybridization

Selection of parental materials for the crossing program aimed to incorporate characteristics associated with yield such as large seed size, high number of pods per

plant, high number of seed per pod and seed coat appearance while improving the plant structure with high number of peduncles and better root characteristics. Selection of parent materials was based on previous germplasm evaluations under field and green house evaluations. Using the selected parental materials (Cp121, Bombay, Cp114, Cp113, Cp110,Waruni, Cp128 MI35, Cp108 and Cp179), six testing hybrids (Cp114 × Waruni, Cp108 × Cp179, Cp128 × MI35, Cp110 × Waruni, Cp114 × Cp113 and Cp121 × Bombay) were developed during *maha* 2011/2012 season at Grain Legume & Oil Crops Research and Development Centre, Agunakolapallassa.

Field experiment

The field experiment was conducted during *yala* 2012 season. Seeds of ten parents and six F1 hybrids were planted in 3.5 m long single rows using randomized complete block design with two replications. Rows were spaced 45 cm apart and plant to plant distance with in a row was maintained at 30 cm. Recommended variety (Waruni) was planted around two replicate as the border. Data were recorded by using randomly selected five plants from each treatment from each replicate. All the agronomic practices were carried out according to DOA recommendations.

Data recording

Morphological characteristics were assessed based on cowpea descriptors of DOA (1995). Days to flowering, days to maturity, plant heights at maturity, root length and root spread (using 1 cm x 1cm grid), number of pods per plant, number of peduncles per plant were recorded randomly selected five plants from each treatment from each replicate. Number of seed per pod and pod length were recorded on randomly selected five pods from five plants from each treatment from each replicate. Weight of 100 seed (g) was recorded using randomly selected 100 seeds from five plants from each treatment from each replicate. Seed length and seed width (cm) were recorded by using ten mature seeds excluding those from the extremities of pods from randomly selected five plants from each treatment from each replicate. Yield per plant (g) was recorded by using randomly selected five plants from each treatment from each replicate.

Data analysis

Analysis of variance was carried out for all the measured quantitative characteristics and DNMRT was used for mean separation. Based on the means heterosis and hererobeltiosis for each quantitative characteristics were calculated based on means of hybrids and parents by using the formula based on Bakhsh *et al.* (2007). Significance

of heterosis and heterobeltiosis was tested using t test defined by Wynne *et al.* (1970). Narrow sense heritability was calculated by regression of offspring means (F1) over mid parental means. Significance was tested with t test. Correlations between the quantitative characteristics were estimated using Pierson correlation analysis method in SPSS based on parental values.

$$\text{Heterosis} = \left(\frac{F1-MP}{MP}\right) \times 100$$

$$\text{Hererobeltiosis} = \left(\frac{F1-BP}{BP}\right) \times 100$$

Where, MP = Mid parent value; BP = Better parent value

$$\text{Heterosis} \quad t_{ij} = F1\ ij - MP/\sqrt{3/8EMS}$$

$$\text{Heterobeltiosis} \quad t_{ij} = F1\ ij - BP/\sqrt{1/2EMS}$$

Where,

$F1_{ij}$ = the mean of the ijth F1 cross; MP_{ij} = the mid parent for the ijth cross; BP_{ij} = the better parent values for ijth cross; EMS = error mean square

Simple Regression Coefficient, b

$$b_{x1x2} \text{ (Regression of } x_1 \text{ on } x_2) = \frac{Cov(x1x2)}{Var\,(x2)}$$

Where, x_1 = offspring mean, x_2 = parental mean

RESULT AND DISCUSSION

Mean performance of cowpea F1 hybrids and parents for agronomic characteristics

Results of analysis of variance for days to 50% flowering, plant height, number of peduncles per plant, days to maturity, number of pods per plant, pod length, number of seeds per pod, seed width, seed length, hundred seed weight, yield per plant, root area and tap root length of cowpea hybrids and their parents are presented in Tables 1, 2 and 3. Days 50% to flowering and plant height significantly varied among the tested genotypes. Mean value range for days to flowering was grater in parents (36.8 to 44.4 days) than that of the crosses (36 to 40.2 days). Cp108 x Cp179 was the earliest flowering F_1 recording 36 days for 50% flowering. Cp114 x Waruni and Cp108 x Cp179 F_1s also exhibited early maturing characteristic than that of their respective parents. Cp108 x Cp179, Cp128 x MI35 and Cp110 x Waruni F_1s recorded comparatively higher number of peduncles per plant. Plant height ranged from 31 cm to 58 cm in F_1s and from

28 cm to 60 cm in parents (Table 1). Pod length, number of seeds per pod and pods per plant were significantly varied among cowpea F_1s and parents. The highest number of pods per plant was recorded by Cp108 x Cp179 F_1s while Cp128 x MI35 F_1s had the lowest number of pods per plant. The parent Cp128 has recorded the longest pod length and Cp108 recorded the shortest. Number of seeds per pod ranged from 7.4 to 15.9 in parents and 7.32 to 10.7 in F_1 hybrids. The highest seed width was recorded by Cp114 and MI 35 recorded the lowest seed width (Table 2).

Table 1. Mean values of days to 50% flowering, plant height, number of peduncles per plant and days to maturity of F_1 hybrids and their parents in cowpea.

F_1 hybrids and parents	Characteristics			
	Days to 50% flowering	Plant height (cm)	Number of peduncles per plant	Days to maturity
Cp114 x War	38.0±3.8c	32.0±4.6de	5.2±4.7abcd	54.1±2.2c
Cp108 x Cp179	36.0±0.0c	42.8±5.1cd	12.3±4.1a	55.0±0.0bc
Cp128 x MI35	39.4±3.3bc	58.3±20.7ab	12.3±1.9b	58.2±1.5bc
Cp110 x War	38.0±1.6c	48.1±7.8bc	12.2±4.5a	57.0±0.0bc
Cp114 x Cp113	39.0±0.0c	31.4±8.9de	10.5±3.0abcd	57.0±0.0bc
Cp121 x Bom	40.2±1.5bc	50.3±5.8abc	8.7±4.2abcd	56.2±1.0bc
Cp121	43.6±7.0ab	49.6±10.7abc	7.6±3.7ab	57.7±5.6bc
Bombay	40.0±2.3c	62.0±12.7a	11.8±5.0abcd	54.3±2.2bc
Cp114	37.2±2.8c	37.0±5.9cde	6.3±3.7cd	57.0±5.5bc
Cp113	37.6±3.2c	43.2±8.4cd	3.7±2.2ab	56.1±1.7bc
Cp110	37.6±1.2c	41.8±9.0cd	11.1±2.0abc	55.8±1.3bc
Waruni	36.8±1.5c	42.5±5.1cd	10.9±6.0abc	55.0±0.0bc
Cp128	36.9±4.7c	42.0±10.6cd	4.1±3.6bcd	56.0±4.2bc
MI35	38.2±12.3c	42.3±17.0cd	11.9±8.6ab	60.8±19.3ab
Cp108	47.4±2.9a	34.4±5.8de	6.5±3.0abcd	65.1±11.0a
Cp179	36.6±2.6c	28.3±5.5e	8.2±5.7abcd	54.7±0.9bc
CV%	4.93	12.89	33.05	4.72

Note: Within each column, the means followed by the same latter are not significantly different at p=0.05.

Analysis of variance revealed that seed length, hundred seed weight, and yield varied significantly among F_1 hybrids and parents of cowpea. Seed length ranged from 5.8 to 8. 95 cm and Cp114 x Cp113 recorded the highest value. The highest hundred seed weight was recorded by Cp128 and the second highest value was recorded by Cp114 x Cp113. In parents, yield was ranged to 6.8 g to 37 g. Highest yield was recorded by Bombay and the second highest yield was recorded Cp108 x Cp179 cross (Table 3). The tap root length was significantly varied among F_1 and their parents. The parents, Cp128

and Bombay had comparatively higher tap root length and root spread area than that of other parents. The respective hybrids of better parents such as Cp128 x MI35 and Cp121 x Bombay recorded a good tap root lengths and root spread areas (Table 3).

Table 2. Mean values of pods per plant, pod length, number of seeds per pod and seed width of F_1 hybrids and their parents of cowpea.

F_1 hybrids and parents	Characteristics			
	Pods per plant	Pod length (cm)	Number of seed per pod	Seed width (cm)
Cp114 x War	9.8±6.5bcd	14.7±2.4bcdef	7.3±2.0d	5.7±0.4ba
Cp108 x Cp179	25.6±9.0a	13.1±1.8cdef	10.1±1.6bcd	5.1±0.3ba
Cp128 x MI35	2.26±0.4d	16.65±1.9b	9.7±3.1ba	6.2±0.8ba
Cp110 x War	14.5±8.6bc	14.8±3.0bcdef	7.4±3.3bcd	5.7±0.4ba
Cp114 x Cp113	11.6±8.1bcd	15.2±2.5bcde	10.1±1.8d	5.9±0.3ba
Cp121 x Bom	13.3±9.7bc	15.6±1.9bc	10.7±3.1bcd	4.9±0.4b
Cp121	14.2±13.3bc	12.8±1.9cdef	10.6±2.2bcd	8.4±0.4ba
Bombay	7.5±4.6cd	16.3±2.4b	8.1±1.8cd	5.1±0.4ba
Cp114	11.8±4.7bcd	14.0±3.0bcdef	9.9±2.8bcd	10.1±0.3a
Cp113	7.7±3.6cd	12.6±1.9def	9.9±3.4bcd	4.6±0.4b
Cp110	9.2±4.4cd	15.1±2.0bceb	11.1±2.8bcd	5.9±0.3ba
Waruni	19.8±5.6ab	15.4±0.8bcd	15.9±1.7bcd	4.9±0.3b
Cp128	8.0±3.0cd	19.3±1.4a	13.7±2.1a	5.1±0.2ba
MI35	11.3±14.7bcd	11.9±1.0fg	11.6±2.0bc	4.3±0.1b
Cp108	12.7±8.3bc	9.6±2.4g	7.4±2.4d	5.1±0.3ba
Cp179	15.1±5.5bc	12.3±1.3feg	12.4±4.0b	5.4±0.2ba
CV%	35.29	8.49	15.22	35.37

Note: Within each column, the means followed by the same latter are not significantly different at p=0.05

Heterosis and heterobeltiosis of agronomic characteristics of cowpea

Cp108 x Cp179 was the better performing cross having significant heterosis for days to 50% flowering (-14.28) number of peduncles per plant (67.9%) pods per plant (83.9%) days to maturity (-8.18) and pod length (19.9%; Table 4). Due to negative heterosis the F_1 has flowered quite earlier than respective parents. Several studies on heterosis of cowpea have show that hybrids can exhibit considerable heterosis for time to flowering and days to maturity (Adu-Dapha *et al.*, 1988; Lodhi *et al.*, 1990). Cp128 x MI35 cross recorded significant positive heterosis for plant height while Cp114 x Cp113 recorded significant negative heterosis for plant height. Adu-Dapha *et al.* (1988) reported that cowpea hybrids can exhibit considerable heterosis for plant height.

The cross between MI35 and Cp128 has shown significant positive heterosis of 53.8% for number of peduncles per plant. The cross Cp108 x Cp179 and Cp114 x Cp113 were also recorded significant very high positive heterosis for number of peduncle per plant. This is in agreement with Patil and Shete (1987) who reported that cowpea hybrids can exhibit considerable heterosis for number of peduncle per plant. Highest mean value for pods per plant was recorded by the cross Cp108 x Cp179 and the exhibited significant positive heterosis by the same cross over the mid parent value (13.9) of respective parents was 83.9% (significant at 0.01 level). Cp114 x Cp113 recorded the second highest significant positive heterosis value for pods per plant. The positive heterosis on pod number per plant is an important characteristic which leads to produce transgressive segregants in latter generation. Lodhi *et al.* (1990) observed positive heterosis for pods per plant character based on the studies of cowpea and Patil and Shete (1987) also recorded positive heterosis in number of pods per plant. In addition the cross Cp108 x Cp179 also recorded significant positive heterosis for pod length (19.9%).

Table 3. Mean values of seed length, hundred seed weight, yield per plant, root spread area and tap root length of F_1 hybrids and their parents in cowpea.

F_1 hybrids and parents	Characteristics				
	Seed length (cm)	Hundred seed weight (g)	Yield per plant (g)	Root spread area (cm^2)	Tap root length (cm)
Cp114 x War	8.8±0.8ab	15.1±2.7abcd	17.7±14.8bcdefg	52.0±21.5abc	18.9±4.8de
Cp108 x Cp179	6.9±0.2fg	12.5±0.6bcdef	31.1±20.8abc	42.5±10.3bc	25.9±4.8bcde
Cp128 x MI35	8.4±0.3abcd	13.4±2.0abcd	7.9±3.9fg	45.5±14.0bc	22.9±3.5cde
Cp110 x War	7.8±0.3bcdef	15.4±0.8abcd	19.3±19.2bcdefg	26.8±17.3c	23.0±5.3cde
Cp114 x Cp113	8.95±0.5a	16.3±1.2ab	16.2±9.5cdefg	44.9±15.3bc	20.1±4.1cde
Cp121 x Bom	7.6±0.7cdef	11.2±1.2bcdef	14.2±14.0defg	83.5±24.9a	32.46±4.5abcd
Cp121	6.3±0.4gh	10.2±0.8def	20.7±16.7bcdefg	64.7±25.1ab	32.9±4.7bc
Bombay	7.2±0.5defg	15.6±1.1abc	37.1±20.4a	64.2±15.4ab	42.7±2.8a
Cp114	8.7±0.3abc	14.9±2.5abcd	15.9±8.0cdefg	52.8±24.9abc	23.1±9.2cde
Cp113	7.5±0.4def	8.4±1.4ef	8.9±5.3efg	35.7±6.0bc	16.6±5.7e
Cp110	7.9±0.4abcde	15.4±0.6abc	26.9±16.5abcd	47.6±10.5abc	37.8±4.5ab
Waruni	7.2±0.4efg	11.6±0.6bcdef	32.7±14.3ab	34.2±8.5bc	32.9±4.1abc
Cp128	8.2±0.3abcde	17.8±1.7a	23.9±16.8abcdef	68.7±10.5ab	40.5±5.0a
MI35	5.85±0.5h	8.0±0.4f	24.7±7.4abcde	34.3±13.7bc	19.3±3.8cde
Cp108	7.9±0.3abcdef	10.4±1.3cdef	6.8±4.2g	54.8±16.2abc	17.4±7.0e
Cp179	7.4±0.4def	12.3±1.5bcdef	13.7±9.9defg	43.5±12.0bc	23.2±4.5cde
CV %	5.96	16.53	16.53	30.23	20.80

Note: Within each column, the means followed by the same latter are not significantly different at p=0.05.

Although Cp121 x Bombay cross recorded the highest positive heterosis for number of seeds per pod it was not significant. However, Adu-Dapha *et al.* (1988) have observed heterosis for number of seed per pod in cowpea. The cross Cp128 x MI35 recorded significantly very high positive heterosis for seed length (18.3%). In addition the crosses Cp121 x Bombay and Cp114 x Cp113 recorded significantly positive heterosis for seed length. Highly significant positive heterosis for hundred seed weight was recorded by the cross Cp114 x Cp113. Cp121 x Bombay recorded significantly positive heterosis for roots spread area (29.5%). The highest yield was recorded by the cross of Cp108 x Cp179 with highly significant heterosis (202%). This is due to the improvement in seed weight, number of seed per pod, number of pod per plant, pod length, and, number of peduncles per plant. Patil and Shete (1987) and Adu-Dapha *et al.* (1988) reported positive heterosis for grain yield per plant, seed width and seed length.

Table 4. Estimation of heterosis of agronomic characteristics in six F_1 hybrids of cowpea

	Characteristics					
Cowpea F_1 hybrids	Days to 50% flowering	Plant height (cm)	Number of peduncle per plant	Days to maturity	Pods per plant	Pod length (cm)
Cp114 x War	2.70	-0.19*	-0.40*	-0.03	-0.37*	0.00
Cp108 x Cp179	-14.28**	36.52	67.92**	-8.18**	84.00**	19.92**
Cp128 x MI35	5.16	38.4**	53.75*	-0.34	-78.1*	6.28
Cp110 x War	2.15	14.12	10.91	2.88	0	-2.71
Cp114 x Cp113	4.27	-21.75*	109*	0.79	18.59*	14.10*
Cp121 x Bom	-2.54	-9.85	-11.19	0.35	22.86	7.43

Note: **, * denote heterosis is significant at the 0.01 and 0.05 probability levels, respectively.

Table 5. Estimation of heterosis of agronomic characteristics in six F_1 hybrids of cowpea.

	Characteristic						
Cowpea F1 hybrids	Number of seeds per pod	Seed width (cm)	Seed length (cm)	Hundred seed weight (g)	Yield (g)	Roots spread area (cm^2)	Tap root length (cm)
Cp114 x War	-0.4**	-0.2	0.1**	0.1	-0.3	0.2	-0.3*
Cp108 x Cp179	1.3	-2.4	-9.8	10.2	202.1**	-13.6	27.1
Cp128 x MI35	-21.9**	32.7	18.3**	3.8	-67.3**	-11.8	-23.5*
Cp110 x War	-45.2**	3.3	3.4	14.1	-35.3*	-34.4	-35.0**
Cp114 x Cp113	1.91	-19.1	9.4*	39.6**	30.9	1.46	1.2
Cp121x Bom	14.0	-26.5	13.1**	-13.0	-50.8**	29.46*	-14.5

Note: **, * heterosis is significant at the 0.01 and 0.05 probability levels, respectively.

According to Patel *et al.* (2009), information about the estimates of heterosis will help to identify crosses which could lead to superior transgressive segregants in segregating generations. Evaluation of segregating populations of F_2 and other subsequent generations of these crosses can be utilized to have a better understanding of the genetic behavior of characteristics of interest. If these crosses can produce transgressive segregants in subsequent generations, and if they are fixable in latter generations better improvement of varieties can be expected. No cross combination recorded positive or negative significant heterobeltiosis for days to 50% flowering. Cp128 x MI35 recorded positive highly significant heterobeltiosis recoding crosses for plant height (38.8%). No cross combination recorded significant positive heterobeltiosis for number of peduncles per plant, days to maturity and pod length. Only the cross combination of Cp108 x Cp179 recorded positive significant heterobeltiosis of 69.4% for pods per plant (Table 6).

Table 6. Estimation of heterobeltiosis of agronomic characters in six F_1 hybrids of cowpea.

Cowpea hybrids	Days to 50% flowering	Plant height (cm)	Number of peduncle per plant	Days to maturity	Pods per plant	Pod length (cm)
Cp114xWar	3.26	-24.71*	-52.98**	-1.64	-50.12**	-4.45
Cp114xCp113	4.84	-27.37**	65.87	1.60	-2.11	8.35
Cp108xCp179	-1.64	24.42	50	0.55	69.37**	6.84
Cp110xWar	1.064	13.17	9.91	3.64	-26.77	-3.77
Cp128xMI35	6.92	38.81**	3.36	3.93	-81.24**	-14.1**
Cp121xBom	3.34	-18.87**	-27.1	3.5	-6.01	-3.98

Note: Heretobeltiosis is significant at the 0.01 (**) and 0.05 (*) probability levels, respectively.

Cp108 x Cp179 cross was recorded highest positive heterobeltiosis (126.4%) for yield and significant at 0.01 level. And only positive heterobeltiosis for tap root length (11.4%) was recorded by Cp108 x Cp179. For root spread area character Cp121 x Bombay cross was only exhibited positive heterobeltiosis. As indicated in Table 7, the Cp114 x Cp113 cross was recorded highest heterobeltiosis for seed weight (8.8%).

Correlations among the tested morphological characteristics

According to Pearson correlation analysis for morphological characteristics (Table 8) days to flowering and days to maturity were significantly ($p \leq 0.01$) correlated with a correlation coefficient of Musvosvi (2009) also recorded 0.7 correlation coefficient between days to flowering and days to maturity. Yield per plant was significantly

positively correlated with plant height and number of peduncles per plant. Pod length was significantly correlated with hundred seed weight (r=0.79) and Musvosvi (2009) also has recorded higher r value (r=0.9) for the above two characteristics. Seed length was positively correlated with seed weight and hundred seed weight was positively correlated with root area and tap root length. Pod length, hundred seed weight, and yield per plant were recorded positive correlations with tap root at p $\leq$0.01.Inter correlation between descriptive characteristics can be used for indirect selection in germplasm evaluation. However, repeated testing with large number of accessions would provide better estimation of correlation among descriptive characters.

Table 7. Estimation of heterobeltiosis of agronomic characters in six F_1 hybrids of cowpea.

	Characteristic						
Cowpea F1 hybrids	**Number of seed per pod**	**Seed width (cm)**	**Seed length (cm)**	**Hundred seed weight (g)**	**Yield (g)**	**Root spread area (cm^2)**	**Tap root length (cm)**
Cp114 x War	-54.13**	-43.5**	0.8	0.80	-45.95**	-1.57	-42.53**
Cp114 x Cp113	1.81	-40.76**	1.88	8.87	2.27	-14.97	-12.88
Cp108 x Cp179	-18.91*	0.58	-12.51**	1.62	126.41**	-22.50	11.40
Cp110 x War	-53.63**	13.91	-1.14	-0.10	-41.00**	-43.52	-39.24**
Cp128 x MI35	-27.2**	21.87	1.46	-24.72**	-67.86**	-33.82*	-43.44**
Cp121 x Bom	0.52	-40.74*	6	-28.120**	-61.68**	29.96	-24.25*

Note: ** Heretobeltiosis is significant at the 0.01 level, * Heretobeltiosis is significant at the 0.05 level.

Table 8. Correlations among yield and morphological characteristics based on parents.

	Ph	Npepp	Dm	Ppp	Pl	Nsp	Sw	Sl	Hsw	Yild	Ra	Tr
Df	-0.16	-0.10	0.84**	-0.01	-0.58	-0.64	-0.16	0.06	-0.27	-0.42	0.26	-0.35
Ph		0.38	-0.32	-0.47	0.47	-0.22	-0.21	-0.24	0.25	0.71*	0.31	0.6
Npepp			-0.12	0.27	-0.01	0.12	-0.19	-0.62	-0.04	0.72*	-0.24	0.34
Dm				0.04	-0.67*	-0.45	-0.11	-0.12	-0.47	-0.51	-0.04	-0.59
Ppp					-0.27	0.57	0.03	-0.16	-0.28	0.03	-0.50	-0.21
Pl						0.44	0.06	0.27	0.79*	0.67	0.51	0.87**
Nsp							-0.16	-0.17	0.08	0.36	-0.36	0.25
Sw								0.69*	0.41	-0.15	0.22	-0.04
Sl									0.62	-0.32	0.55	0.16
Hsw										0.43	0.80**	0.82**
Yild											0.15	0.81**
Ra												0.56

Note: **, * Correlation is significant at the 0.01 and 0.05 probability levels respectively. Df=days to 50% flowering, Ph=plant height, Npepp=number of peduncles per plant, Dm=days to maturity, Ppp=pods per plant, Pl=pod length, Nsp=number of seed per pod, Sw=seed width, Sl=seed length, Hsw=hundred seed weight, Yid=yield, Ra=root spread area, Tr=tap root length.

Narrow sense heritability

Except for seed width and seed length narrow sense heritability was not significant for other tested characteristics.

Table 9. Narrow sense heritability estimates based on parent- offspring regression

Characteristics	Regression coefficient	T-cal	Narrow sense heritability
Days to 50% flowering	-0.08	-1.37	-8
Plant height	0.40	0.18	40
Number of peduncles per plant	-0.07	-0.705	-7
Pods per plant	0.27	0.32	27
Days to maturity	-0.012	0.66	-1.2
Pod length	0.46	-1.7	46
Number of seeds per pod	-0.58	-1.35	-58
Seed width	-0.049*	-4.06	-4.9
Seed length	0.52*	2.54	52
Hundred seed weight	0.138	1.028	13.8
Yield	-0.42	-0.26	-42
Root spread area	-0.46	-0.49	-46
Tap root length	0.27	0.41	27

Note: *Significant at 0.05 probability level.

CONCLUTIONS

Yield and all the yield related characteristics showed genetic variability among inbred parents and cross combinations. Heterosis and heterobeltiosis for yield and yield related characteristics appeared cross combination specific. Except seed width and seed length, yield and yield related characteristics not shown significant heritability indications, therefore these characteristics will not be able to improve through exploiting additive genetic variability present in the cowpea populations studied. Based on correlation studies indirect selection for high yield appeared to be possible through direct selection at several yield related characteristics. Cp 108 x Cp 179, Cp 128 x MI 35 and Cp 114 x Cp 113 were identified as cross combinations where probability of having promising segregants are high.

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