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Genetic Variability and Heritabilty for Fodder and Grain Yield Related Characters in F_2 Populations of Cowpea (*Vigna unguiculata* (L.) Walp.)

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A B S T R A C T

Available variability in cowpea is meagre due to its breeding behaviour. However, variability is the prerequisite for improvement of yield levels in cowpea. In present study an experiment was conducted to estimate genetic variability, heritability and genetic advance expressed as per cent of mean, an investigation was carried out with two F_2 populations of MFC-09-1 × PL-3 and MFC-09-12 × UPC-8705 in cowpea. Considerably high amount of variability was observed for the thirteen quantitative and qualitative characters under study. Environmental influence was minimum for the expression of most of the traits which is evident from narrow difference between phenotypic co-efficient of variation (PCV) and genotypic co-efficient of variation (GCV) estimates. Heritability in broad sense was high for most of the traits coupled with high genetic advance as per cent over mean indicated presence of additive gene action for the characters in both the populations. Good number of superior segregants was isolated for seed and green fodder yield related traits in both the F_2 populations.

Introduction

Cowpea *(Vigna unguiculata)* is extensively grown in southern india particularly in the states of Andhra Pradesh, Karnataka and Tamil Nadu. Cowpea fits well in a variety of cropping systems and is grown as cover crop and green manure crop. Farmers often grow a short-duration spreading variety for grain and a long-duration spreading variety for fodder, but the grain and fodder yields are poor due to low yield potential of the spreading varieties and also due to early cessation of rains. Since majority of cultivars derive their high productivity from an erect growth habit (Singh and Sharma, 1996). The use of cowpea as a dual-purpose crop, providing both grain and fodder, is attractive in mixed crop/livestock systems where land and feed are becoming increasingly scarce (Tarawali *et al.*, 1997) especially in the dry season. The productivity levels of legume crops including cowpea have remained static unlike jumps witnessed in some cereals and oil seed crops. Cowpea, member of this family is strictly an autogamous species and hence yield

improvement has to come through selection in the variable population. Variability thus becomes an important prerequisite for created variability through hybridization and irradiation. Hybridization is the most commonly used approach for creating variability since the variation created is not random like in irradiation but is directed one. But selection of parents for generating variability is rather restricted to only few genotypes. Thus there has been no broadening of the genetic base, which perhaps is one of the reasons for lack of progress in cowpea improvement work.

The success of any crop improvement programme depends on the magnitude of genetic variability and the extent to which the desirable trait is heritable (Falconer, 1960). Keeping all these points in view, cowpea improvement programme was initiated at Indian Grassland and Fodder Research Institute (IGFRI), Southern Regional Research Station, Dharwad aiming at generating desirable variability, which inturn can be used for selecting and identifying productive lines, with this background an attempt was made to study the variability for dual purpose traits in F_2 populations of cowpea. Similarly, the emphasis on the development of dual purpose types in other crops also were reported by Pal and Kumar (2009) in barley and Sah *et al* (2016) in maize.

Materials and Methods

The released varieties and advanced breeding lines were evaluated for dual purpose traits. Based on these traits five lines (fodder types) and three testers (grain types) were crossed in Line × Tester fashion and 15 F_1's were generated. All the package of practices followed to raise the crop. The F_1 plants were allowed for self pollination to generate F_2 seeds. Based on combining ability of fifteen crosses for seed yield and green fodder yield related traits, two crosses viz. MFC-09-1 × PL-3 and MFC-09-12 × UPC-8705 were advanced to F_2 generation. These F_2 populations along with their parents were evaluated at Indian Grassland and Fodder Research Institute, SRRS, Dharwad during *rabi*/summer 2016-17. All recommended packages of practices were followed to raise a good crop. At first flowering stage, plants were harvested for green fodder yield leaving three nodes from base of the plant. It was followed by application of fertilizer and irrigation for regeneration of the crop. Observations were recorded on 81 plants in MFC-09-1 × PL-3 and 123 plants in MFC-09-12 × UPC-8705 *viz*. number of pods per plant, number of seeds per pod, pod length, seed yield per plant, and days to maturity were recorded on regenerated plant while, observations like plant height, days to first flowering, number of primary branches per plant, number of secondary branches per plant, green fodder yield per plant, leaf to stem ratio, dry matter content, and crude protein content, were recorded prior to harvest.

Results and Discussion

Wide range of variation was observed among the selected F_2 populations for almost all the characters under study when compared with their parents (Tables 1 and 3). The mean performance of F_2 populations of crosses MFC-09-1 × PL-3 and MFC-09-12 × UPC-8705 were lower than both the parents for most of the characters *viz.*, plant height, number of secondary branches per plant, number of pods per plant, number of seeds per pod, pod length, seed yield per plant and green fodder yield per plant. The lower mean performance of F_2 populations compared to their parents for most of the characters *viz.*, plant height, number of secondary branches per plant, number of pods per plant, number of seeds per pod, seed yield per plant and green fodder yield per plant in cowpea recorded by Satish *et al.*, (2017).

Table.1 Mean performance and variance of parents for thirteen characters in cowpea

Statistical parameters	Generation (Parental/F_2)	Plant height (cm)	No. of primary branches	No. of secondary branches	Leaf to stem ratio	Days to first flowering	Days to maturity	No. of pods per plant	No. of seeds per pod	Pod length (cm)	Seed yield per plant (g)	Green fodder yield per plant (g)	Dry matter content (%)	Crude protein content (%)
Mean	MFC-09-12	87.60	4.40	3.50	1.21	70.50	115.40	16.40	13.92	16.49	16.50	182.38	13.56	22.23
	UPC-8705	94.40	5.00	5.40	0.76	74.00	118.00	15.80	13.60	15.92	15.20	176.80	13.30	20.10
Variance	MFC-09-12	128.80	1.10	1.06	0.16	4.76	3.90	4.60	0.53	0.61	3.56	260.80	5.68	0.62
	UPC-8705	178.30	0.50	2.30	0.14	3.56	2.60	3.40	0.33	0.31	2.20	534.20	4.78	0.97

Table.2 Estimation of genetic parameters for thirteen quantitative characters in F_2 population of MFC-09-12 × UPC-8705

SI. No.	Characters	Mean	Range		PV	GV	PCV	GCV	h^2 (%)	GA	GAM (%)
			Min	**Max**							
1	Plant height (cm)	52.39	24.00	150.00	557.74	189.79	45.08	26.30	34.03	16.55	31.60
2	No. of primary branches per plant	4.95	2.00	11.00	2.92	1.12	34.52	21.38	38.36	1.35	27.28
3	No. of secondary branches per plant	3.12	0.00	11.00	6.61	3.40	82.41	59.12	51.47	2.73	87.38
4	Leaf to stem ratio	1.24	0.77	2.18	0.43	0.19	52.84	34.82	43.43	0.59	47.27
5	Days to first flowering	74.76	66.00	83.00	24.61	14.07	6.64	5.02	57.17	5.84	7.82
6	Days to maturity	125.48	91.00	138.00	43.12	35.42	5.23	4.74	82.14	11.11	8.86
7	No. of pods per plant	14.27	7.00	38.00	43.48	37.18	46.21	42.73	85.51	11.62	81.40
8	No. of seeds per pod	13.22	9.80	16.60	2.83	1.91	12.73	10.45	67.49	2.34	17.69
9	Pod length (cm)	15.16	12.09	20.22	3.64	2.68	12.58	10.81	73.76	2.90	19.12
10	Seed yield per plant (g)	14.45	6.20	34.50	30.01	25.05	37.91	34.64	83.47	9.42	65.19
11	Green fodder yield per plant (g)	159.83	48.00	332.00	1380.32	899.32	23.31	18.76	64.78	49.72	31.11
12	Dry matter content (%)	12.38	9.42	21.60	43.05	34.98	52.99	47.77	81.26	10.98	88.70
13	Crude protein content (%)	20.80	19.75	22.40	14.52	12.62	18.32	17.08	86.88	6.82	32.79

Table.3 Mean performance and variance of parents for thirteen characters in cowpea

Statistical parameters	(Parents)	Plant height (cm)	No. of primary **Branches**	No. of secondary **branches**	Leaf to stem ratio	Days to first flowering	Days to maturity	No. of pods per plant	No. of seeds per pod	Pod length (cm)	Seed yield per plant (g)	Green fodder yield per plant (g)	Dry matter content (%)	Crude protein content (%)
Mean	MFC-09-1	86.40	4.60	3.80	0.89	58.30	98.50	17.23	14.68	15.20	17.47	186.20	13.28	20.63
	PL-3	74.23	2.70	2.40	1.16	54.20	86.70	14.20	14.32	15.54	14.23	142.00	12.87	23.42
Variance	MFC-09-1	268.70	1.10	2.20	0.05	3.34	11.35	4.20	1.63	0.76	11.47	608.20	0.38	0.56
	PL-3	228.20	1.60	1.70	0.09	4.63	15.47	3.77	2.10	0.49	6.60	174.20	0.61	1.23

Table.4 Estimation of genetic parameters for thirteen quantitative characters in F_2 population of MFC-09-1 × PL-3

SI. No.	Characters	Mean	Range		PV	GV	PCV	GCV	h^2 (%)	GA	GAM (%)
			Min	**Max**							
1	Plant height (cm)	56.79	23.00	109.00	1445.03	953.06	66.94	54.36	65.95	51.65	90.95
2	No. of primary branches per plant	3.66	1.00	7.00	2.41	0.94	42.42	26.50	39.02	1.25	34.10
3	No. of secondary branches per plant	2.72	0.00	8.00	6.24	1.49	91.84	44.88	23.88	1.23	45.17
4	Leaf to stem ratio	1.52	0.81	2.26	0.19	0.07	28.72	17.43	36.84	0.33	21.80
5	Days to first flowering	76.71	60.00	87.00	45.10	31.47	8.76	7.31	69.78	9.65	12.58
6	Days to maturity	111.88	95.00	128.00	48.07	24.20	6.20	4.40	50.35	7.19	6.43
7	No. of pods per plant	12.26	6.00	34.00	29.60	19.17	44.38	35.71	64.75	7.26	59.19
8	No. of seeds per pod	13.05	8.00	16.00	5.76	1.68	18.39	9.93	29.14	1.44	11.04
9	Pod length (cm)	14.80	11.24	21.01	5.33	4.03	15.60	13.57	75.68	3.60	24.32
10	Seed yield per plant (g)	12.05	8.40	30.20	24.83	9.73	41.35	25.89	39.19	4.02	33.38
11	Green fodder yield per plant (g)	137.85	60.00	242.00	1588.97	827.43	28.92	20.87	52.07	42.76	31.02
12	Dry matter content (%)	12.75	8.67	16.81	13.47	11.88	28.79	27.05	88.22	6.67	52.33
13	Crude protein content (%)	21.40	18.20	27.46	13.17	11.30	16.96	15.71	85.83	6.42	29.98

Table.5 Superior segregants in F_2 population for economically important characters over checks considered for dual purpose in cowpea

Population	No. of plants	Green fodder yield per plant (g)	Seed yield per plant (g)	Days to maturity	No. of plants common for three characters
F_2 (MFC-09-12 × UPC-8705)	123	27 (21.95)[a]	30 (24.39)[a]	33 (26.82)[a]	13 (10.56)
		22 (17.88)[b]	26 (21.13)[b]	28(22.76)[b]	
F_2 (MFC-09-1 × PL-3)	81	15 (18.51)[a]	21 (25.92)[a]	43 (53.08)[a]	8(9.87)
		11 (13.58)[b]	17 (20.98)[b]	36 (44.44)[b]	
MFC-08-14 (check I)	-	173.6.2	16.4	109.4	-
MFC-09-1 (Check II)	-	186.2	17.47	106.8	-

* Values in parenthesis are percentage fig

a - superior segregants scored over checks I

b - superior segregants scored over checks II

Table.6 Superior segregants identified for economically important traits in F_2 populations

Cross IV: F_2 (MFC-09-12 × UPC-8705) Plant No.	Green fodder yield per plant (g)	Seed yield per plant (g)	Days to maturity	Crude protein content (%)	Cross MFC-09-1 x PL-3 **Plant No**	Green fodder yield per plant (g)	Seed yield per plant (g)	Days to maturity	Crude protein content (%)
5	171	24	98	21.08	10	192	18	107	21.74
18	210	30	99	20.24	31	158	23	103	19.32
43	198	19	97	19.62	73	218	28	103	22.31
73	174	21	107	19.84	109	174	24	112	23.67
91	161	28	110	19.16	112	188	21	113	21.83
137	180	22	106	20.79	145	209	18	115	20.42
208	224	28	105	21.24	189	228	27	117	22.4
240	264	20	114	21.78	271	167	26	130	24.55
317	184	16	119	19.74	MFC-08-14 (check I)	173.6.2	18.4	109.4	20.45
411	158	16	114	22.1	MFC-09-1 (check II)	186.2	19.47	106.8	20.63
424	242	18	116	20.84					
461	194	22	101	20.34					
479	178	24	113	21.22					
MFC-08-14 (check I)	173.6.2	18.4	109.4	20.45					
MFC-09-1 (check II)	186.2	19.47	106.8	20.63					

In addition to this, it was also observed that the value of upper range for most of the characters was double than mean value of F_2 populations which clearly indicates greater scope for isolation of more number of segregants for different characters.

Superior segregants were isolated for green fodder yield per plant, seed yield per plant and days to maturity (Table 5) since these traits directly contribute to the dual purpose nature of cowpea. It was observed that maximum per cent of segregants were obtained for seed yield per plant in both F_2 population of crosses MFC-09-1 × PL-3 and MFC-09-12 × UPC-8705 in comparison to MFC-08-14 and MFC-09-1. Whereas in the cross MFC-09-1 × PL-3, highest per cent of segregants were obtained for days to maturity indicating development of early types from this population. Eight and thirteen plants from MFC-09-1 × PL-3 and MFC-09-12 × UPC-8705, F_2 populations were identified superior for all these traits (Table 6).

The F_2 population of cross MFC-09-1 × PL-3 exhibited highest phenotypic and genotypic co-efficient of variation, heritability in broad sense and genetic advance expressed as per cent mean (GAM) for number of pods per plant, green fodder yield per plant and dry matter content whereas for number of pods per plant, seed yield per plant, green fodder yield per plant, and dry matter content in F_2 population of cross MFC09-12 × UPC-8705 (Tables 2 and 4). The present findings are in accordance with reports of Satish *et al.*, (2017) found high GCV and PCV for number of pods per plant, seed yield per plant, green fodder yield per plant and leaf to stem ratio in F_2 populations of dual purpose cowpea. Mary and Gopalan (2006) and Shivakumar *et al.*, (2013) in F_2 and F_2 derived F_3 progenies of cowpea and chickpea, respectively.

Moderate PCV and GCV was observed for pod length, number of seeds per pod and crude protein content in both F_2 populations of crosses MFC-09-1 × PL-3 and MFC-09-12 × UPC-8705. Similar results were reported by Satish *et al.*, (2017) in F_2 populations of dual purpose cowpea, Salimath *et al.*, (2007) and Mary and Gopalan (2006) in F_2 and F_3 populations in cowpea, whereas in chickpea by Shivakumar *et al.*, (2013).

Lower values of PCV and GCV was recorded for days to first flowering and days to maturity in both the F_2 populations of crosses (MFC-09-1 × PL-3 and MFC-09-12 × UPC-8705) which was in accordance with Satish *et al.*, (2017) in F_2 populations of dual purpose cowpea, Salimath *et al.*, (2007) in F_3 population and Mary and Gopalan (2006) in F_3 and F_4 population

In conclusion, the variability found in the F_2 populations of the evaluated crosses (MFC-09-1 × PL-3 and MFC-09-12 × UPC-8705) would provide greater scope for the recovery of superior segregants for dual purpose in cowpea in further generations. The promising segregants identified from such population may be useful in the future plant breeding programmes.

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