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Estimation of Correlation and Path Analysis in Quantitative Characters of Cowpea (*Vigna unguiculata* (L.) Walp.)

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

The experiment was carried out in Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj, U.P. The experiment included 20 cowpea genotypes with three replications in a Randomized Block Design. The study was carried out to estimate the genetic variability, heritability, genetic advance, correlation coefficient analysis and yield contributing traits, direct and indirect effects of yield component on yield through path analysis. The analysis of variance revealed the existence of all the traits. Hence the data on the all 14 traits which showed significance difference among the entries were subjected to further statistical analysis. Maximum genotypic coefficient of variation and phenotypic coefficient of variation for harvest index and biological yield. At the phenotypic and genotypic levels positive significant connection with Harvest index, Days to 50% flowering and Days to 50% pod setting. Genotypes EC 58905, IC 259063, IC 201098, IC 34009, and IC 20854 were found to be superior for seed yield per plant.

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Keywords: Cowpea; genetic variability; correlation; path analysis.

1. INTRODUCTION

"Cowpea (*Vigna unguiculata* (L.) Walp) a legume is one of the most ancient crops known to man. It belongs to the family Papilionaceae and subfamily Fabaceae with a chromosome number of 2n = 2x = 22. Its primary centre of origin is in Africa. Its cultivar of green pods is referred to as southern pea, black eye pea, crowder pea, lobia. Cowpea seeds are rich in antioxidants, folic acid, phenols and other essential minerals" [1]. In India, cowpea is grown in major states like Gujrat, West Bengal, Tamil Nadu, Andhra Pradesh, Kerala and Orissa. It is also referred to as "Poor man's meat". "The cowpea green pods contain moisture 84.6 percent, protein 23.4 percent, carbohydrate 60.3 per cent, fats 1.8 percent and it's also rich in vitamins and phosphorus. It is a versatile crop covering an area of 14.4 million hectares with production of 8.9 million tonnes and productivity of 616.3kg, respectively" [2]. "In India, the cowpea is grown in an area about of 3.9 million ha with a production of 2.21 million tones with a productivity of 625 kg per ha". The correlation coefficient provides an idea of association between two or more quantitative characters between yield and yield contributing characters. Thus correlation helps in the selecting superior genotypes from diverse genetic population. Correlation coefficient indicates the nature of association among the different traits. Path analysis splits the correlation coefficient into the measures of direct and indirect effects, thus providing understanding of the direct and indirect contribution of each character towards yield [3-5,6,7].

2. MATERIALS AND METHODS

Twenty cowpea genotypes along with the check were randomly raised in randomized block design with three replications during *Kharif,* 2021 at experimental fields of Naini Agriculture College, Sam Higginbottom University of Agricultural Technology and Sciences, Prayagraj, U.P. Through RBD design the three replications are divided into 60 plots. The gross area of the experiment was 144.5 m^2 and the plot size was 1× 1 m. spacing between the row-to-row is 30 cm and plant-to-plant is 60 cm. Observations were recorded on five randomly selected for plants in each treatment and replication for 14 quantitative characters viz., Days to 50% Flowering, Days to 50% Podding, Days to Maturity, Number of branches per plant, Number of pods per plant, Number of seeds per pods, Pod length (cm), Plant height (cm), Peduncle length (cm), Petiole length (cm), Seed index (g), Harvest index (%), Biological yield per plant (g), and Seed yield per plant (g). Correlation coefficient and path analysis was worked out as per the method suggested by [8].

3. RESULTS AND DISCUSSION

3.1 Analysis of Variance for Quantitative Characters in Cowpea (*Vigna unguiculata* (L.) Walp)

Analysis of variance for different characters is presented in Table 1. The mean squares due to genotypes showed highly significant differences (α=0.01) for all characters indicating the presence of substantial amount of genetic variability among the cowpea genotypes. Among 20 genotypes, genotype EC 58905 (24.18gm), IC 259063 (21.06gm), IC 201089 (19.067gm) were found to be superior in seed yield.

In the present study phenotypic coefficient of variation were higher than genotypic coefficient variation indicating that these characters are influenced by the environment for all the characters. High PCV and GCV were observed for the harvest index (26.281), and Biological yield (25.143). Moderate PCV and GCV were observed for the Seed yield per plant (16.281), Days to 50% Flowering (14.446), Number of pods per plant (14.182), Days to maturity (13.976), Days to 50% pod setting (12.706), Pod length (10.992), Petiole length (10.906). Low PCV and GCV were observed for the Plant height (9.501), Number of branches per plant (9.433), Peduncle length (9.318), Seed index (8.737), Number of seeds per pod (5.669) [9-12].

3.2 Heritability

[13] Classified "heritability as low (<30%), medium (30-60%), and high (>60%)".

The following traits like Harvest index (93.971), Biological yield (93.756), Seed index (81.27), Seed yield per plant (80.199), Days to 50% pod setting (73.059), Number of pods per plant (72.064), Days to 50% flowering (71.81), and

Pod length (67.005) expressed high heritability. Days to maturity (55.058), Peduncle length (48.543) Number branches per plant (45.748), Petiole length (45.139), Plant height (38.944), Number of seeds per pod (33.732) expressed moderate heritability. None of the character under study shows low heritability values [14-17].

3.3 Genetic Advance as Percent Mean

The estimation of genetic advance as percent mean is classified as low (<10%), moderate (10 to 20%) and high (>20%) proposed by Johnson et al. 1955.

High GAM was observed for Harvest index (52.229), Biological yield (48.561), Seed yield per plant (26.898), Days to 50% Flowering (21.37), Number of pods per plant (21.053). Moderate GAM was observed for Days to 50% pod setting (19.122), Days to maturity (15.852), Pod length (15.173), Seed index (14.627). Low GAM was observed for Petiole length (10.142), Peduncle length (9.318), Number of branches per plant (8.889), Plant height (7.623), Number of seeds per pod (3.939) [18,19].

Table 1. Analysis of Variance for 14 quantitative characters of 20 cowpea genotypes during *kharif,* 2022

Sl.No.	Source	Mean Sum of Squares (MSS)		
		Replication	Treatment	Error
	Degrees of freedom	2	19	38
1	Days to 50% flowering	25.0170	134.929**	15.613
2	Days to 50% pod setting	3.050	154.957**	16.962
3	Days to Maturity	4.650	211.294**	45.194
4	Peduncle length (cm)	0.5150	25.308**	6.608
5	Petiole length (cm)	0.0240	4.483**	1.293
6	Number of Branches per plant	4.2990	6.973**	1.976
7	Number of pods per plant	0.8240	7.396**	0.846
8	Pod length (cm)	0.2210	6.153**	0.868
9	Number of seeds per pod	0.6320	0.802**	0.317
10	Plant height (cm)	286.2850	673.412**	231.133
11	Seed Index (g)	0.0190	1.011**	0.072
12	Biological yield (g)	44.1890	851.442**	18.491
13	Harvest Index (%)	5.820	192.105**	4.022
14	Seed yield per plant (g)	0.6620	20.929**	1.591

** and ** indicate significant at 5% and 1% level of significance*

Table 2. Estimation of variability and genetic parameters for 14 quantitative characters in cowpea germplasm for *kharif*, 2022

Sl.No.	Characters	ECV	GCV	PCV	h2 (Broad Sense)	Genetic Advancement 5%	Gen.Adv as % of Mean 5%
1	Days to 50% flowering	7.67	12.242	14.446	71.81	11.009	21.37
2	Days to 50% pod setting	6.595	10.86	12.706	73.059	11.942	19.122
3	Days to Maturity	9.37	10.371	13.976	55.058	11.374	15.852
4	Peduncle length (cm)	6.684	6.492	9.318	48.543	3.583	9.318
5	Petiole length (cm)	8.078	7.328	10.906	45.139	1.427	10.142
6	Number of Branches per plant	6.948	6.38	9.433	45.748	1.798	8.889
7	Number of pods per plant	7.496	12.039	14.182	72.064	2.584	21.053
8	Pod length (cm)	6.314	8.998	10.992	67.005	2.238	15.173
9	Number of seeds per pod	4.615	3.292	5.669	33.732	0.481	3.939
10	Plant height (cm)	7.424	5.929	9.501	38.944	15.609	7.623
11	Seed Index (g)	3.781	7.876	8.737	81.27	1.039	14.627
12	Biological yield (g)	6.283	24.346	25.143	93.756	33.237	48.561
13	Harvest Index (%)	6.625	26.155	26.981	93.971	15.812	52.229
14	Seed yield per plant (g)	7.245	14.58	16.281	80.199	4.684	26.898

h^2 = heritability, GCV= Genotypic coefficient of variation, PCV= Phenotypic coefficient of variation

Table 3. Correlation coefficient analysis

Trait	Days to 50% flowering	Days to 50% pod setting	Days to Maturity	Peduncle length (cm)	Petiole length (cm)	Number of Branches per plant	Number of pods per plant	Pod length (cm)	Number of seeds per pod	Plant height (cm)	Seed Index (g)	Biological yield (g)	Harvest Index (%)	Seed yield per plant (g)
Days to 50% flowering (P)	1.0000	0.816**	0.781**	0.0731	0.0411	-0.0059	0.0496	-0.1970	0.1219	0.0023	0.0242	-0.0728	0.2401	0.326*
(G)	1.0000	0.814**	0.770**	0.0771	0.0420	0.0085	0.0519	-0.1905	0.0922	-0.0152	0.0263	-0.0730	0.2446	0.322*
Days to 50% pod setting (P)		1.0000	0.768**	-0.0165	0.0489	-0.0399	0.1032	-0.1329	0.0810	0.0524	0.0201	-0.1083	0.2291	0.295*
(G)		1.0000	0.765**	-0.0149	0.0490	-0.0327	0.1046	-0.1306	0.0705	0.0470	0.0204	-0.1074	0.2308	0.294*
Days to Maturity (P)			1.0000	0.1035	-0.0395	0.0116	-0.0361	-0.2020	0.0791	-0.0138	-0.0058	-0.0476	0.1887	0.2017
(G)			1.0000	0.1020	-0.0395	0.0042	-0.0385	-0.2036	0.0852	-0.0102	-0.0057	-0.0485	0.1861	0.2024
Peduncle length (cm) (P)				1.0000	-0.0052	0.1065	-0.0101	-0.1707	0.0194	-0.344*	-0.1166	0.404*	-0.1353	0.1387
(G)				1.0000	-0.0048	0.1086	-0.0092	-0.1689	0.0111	-0.345*	-0.1157	0.402*	-0.1330	0.1382
Petiole length (cm)					1.0000	0.0370	0.0206	0.1656	0.1029	0.0105	0.0769	-0.2159	0.301*	0.1109
(G)					1.0000	0.0348	0.0192	0.1651	0.0988	0.0077	0.0776	-0.2165	0.300*	0.1115
Number of Branches per plant (P)						1.0000	-0.1832	-0.0889	-0.0061	-0.0310	0.1097	-0.0728	-0.0900	0.0175
(G)						1.0000	-0.1606	-0.0763	-0.0338	-0.0330	0.1035	-0.0602	-0.0801	0.0078
Number of pods per plant (P)							1.0000	0.1475	-0.0727	0.1386	0.278*	-0.1885	0.1142	0.1101
(G)							1.0000	0.1512	-0.0780	0.1404	0.274*	-0.1806	0.1157	0.1043
Pod length (cm) (P)								1.0000	0.2216	0.374*	0.315*	-0.2216	0.460**	0.1307
(G)								1.0000	0.2075	0.367*	0.314*	-0.2181	0.461**	0.1280
Number of seeds per pod (P)									1.0000	0.1669	0.2223	-0.0931	0.318*	0.0551
(G)									1.0000	0.1883	0.2142	-0.0910	0.299*	0.0563
Plant height (cm) (P)										1.0000	0.0573	-0.340*	0.293*	-0.0374
(G)										1.0000	0.0510	-0.328*	0.282*	-0.0403
Seed Index (g) (P)											1.0000	-0.311*	0.375*	0.0791
(G)											1.0000	-0.313*	0.375*	0.0808
Biological yield (g) (P)												1.0000	-0.721**	0.0301
(G)												1.0000	-0.718**	0.0261
Harvest Index (%) (P)													1.0000	0.337*
(G)													1.0000	0.336*

Table 4. Path coefficient analysis

TRAIT	Days to 50% flowering	Days to 50% pod setting	Days to Maturity	Peduncle length (cm)	Petiole length (cm)	Number of Branches per plant	Number of pods per plant	Pod length (cm)	Number of seeds per pod	Plant height (cm)	Seed Index (g)	Biological yield (g)	Harvest Index (%)	Seed yield per plant (g)
Days to 50% flowering (P)	0.1887	0.1539	0.1475	0.0138	0.0078	-0.0011	0.0094	-0.0372	0.0230	0.0004	0.0046	-0.0137	0.0453	0.326*
(G)	0.1441	0.1172	0.1109	0.0111	0.0061	0.0012	0.0075	-0.0274	0.0133	-0.0022	0.0038	-0.0105	0.0352	0.322*
Days to 50% pod setting (P)	0.1290	0.1582	0.1215	-0.0026	0.0077	-0.0063	0.0163	-0.0210	0.0128	0.0083	0.0032	-0.0171	0.0362	0.295*
(G)	0.1299	0.1597	0.1222	-0.0024	0.0078	-0.0052	0.0167	-0.0209	0.0113	0.0075	0.0033	-0.0172	0.0369	0.294*
Days to Maturity (P)	-0.1539	-0.1513	-0.1970	-0.0204	0.0078	-0.0023	0.0071	0.0398	-0.0156	0.0027	0.0011	0.0094	-0.0372	0.2017
(G)	-0.1148	-0.1141	-0.1491	-0.0152	0.0059	-0.0006	0.0057	0.0304	-0.0127	0.0015	0.0009	0.0072	-0.0278	0.2024
Peduncle length (cm) (P)	-0.0058	0.0013	-0.0082	-0.0789	0.0004	-0.0084	0.0008	0.0135	-0.0015	0.0272	0.0092	-0.0319	0.0107	0.1387
(G)	-0.0041	0.0008	-0.0055	-0.0537	0.0003	-0.0058	0.0005	0.0091	-0.0006	0.0185	0.0062	-0.0216	0.0071	0.1382
Petiole length (cm) (P)	-0.0007	-0.0008	0.0007	0.0001	-0.0167	-0.0006	-0.0003	-0.0028	-0.0017	-0.0002	-0.0013	0.0036	-0.0050	0.1109
(G)	-0.0002	-0.0002	0.0002	0.0000	-0.0046	-0.0002	-0.0001	-0.0008	-0.0005	0.0000	-0.0004	0.0010	-0.0014	0.1115
Number of Branches per plant (P)	-0.0012	-0.0082	0.0024	0.0218	0.0076	0.2050	-0.0376	-0.0182	-0.0013	-0.0063	0.0225	-0.0149	-0.0184	0.0175
(G)	0.0012	-0.0047	0.0006	0.0155	0.0050	0.1430	-0.0230	-0.0109	-0.0048	-0.0047	0.0148	-0.0086	-0.0115	0.0078
Number of pods per plant (P)	0.0087	0.0181	-0.0063	-0.0018	0.0036	-0.0322	0.1756	0.0259	-0.0128	0.0244	0.0489	-0.0331	0.0201	0.1101
(G)	0.0074	0.0149	-0.0055	-0.0013	0.0027	-0.0229	0.1423	0.0215	-0.0111	0.0200	0.0390	-0.0257	0.0165	0.1043
Pod length (cm) (P)	0.0101	0.0068	0.0104	0.0088	-0.0085	0.0046	-0.0076	-0.0513	-0.0114	-0.0192	-0.0162	0.0114	-0.0236	0.1307
(G)	0.0107	0.0073	0.0114	0.0095	-0.0092	0.0043	-0.0085	-0.0560	-0.0116	-0.0205	-0.0176	0.0122	-0.0258	0.1280
Number of seeds per pod (P)	-0.0161	-0.0107	-0.0105	-0.0026	-0.0136	0.0008	0.0096	-0.0293	-0.1322	-0.0221	-0.0294	0.0123	-0.0421	0.0551
(G)	-0.0086	-0.0066	-0.0079	-0.0010	-0.0092	0.0031	0.0072	-0.0193	-0.0929	-0.0175	-0.0199	0.0085	-0.0278	0.0563
Plant height (cm) (P)	-0.0002	-0.0039	0.0010	0.0255	-0.0008	0.0023	-0.0103	-0.0277	-0.0124	-0.0741	-0.0042	0.0252	-0.0218	-0.0374
(G)	0.0010	-0.0031	0.0007	0.0226	-0.0005	0.0022	-0.0092	-0.0240	-0.0123	-0.0655	-0.0033	0.0215	-0.0185	-0.0403
Seed Index (g) (P)	-0.0020	-0.0017	0.0005	0.0096	-0.0063	-0.0090	-0.0228	-0.0259	-0.0182	-0.0047	-0.0820	0.0255	-0.0308	0.0791
(G)	-0.0015	-0.0012	0.0003	0.0068	-0.0046	-0.0061	-0.0161	-0.0184	-0.0126	-0.0030	-0.0587	0.0184	-0.0220	0.0808
Biological yield (g) (P)	-0.0523	-0.0778	-0.0342	0.2902	-0.1551	-0.0523	-0.1354	-0.1591	-0.0669	-0.2442	-0.2232	0.7183	-0.5179	0.0301
(G)	-0.0466	-0.0686	-0.0310	0.2571	-0.1384	-0.0385	-0.1154	-0.1394	-0.0582	-0.2096	-0.1997	0.6390	-0.4586	0.0261
Harvest Index (%) (P)	0.2213	0.2112	0.1740	-0.1247	0.2770	-0.0830	0.1052	0.4241	0.2933	0.2705	0.3460	-0.6648	0.9219	0.337*
(G)	0.2038	0.1923	0.1551	-0.1108	0.2503	-0.0668	0.0964	0.3842	0.2491	0.2353	0.3125	-0.5980	0.8332	0.336*

, indicates 5% and 1% significant*

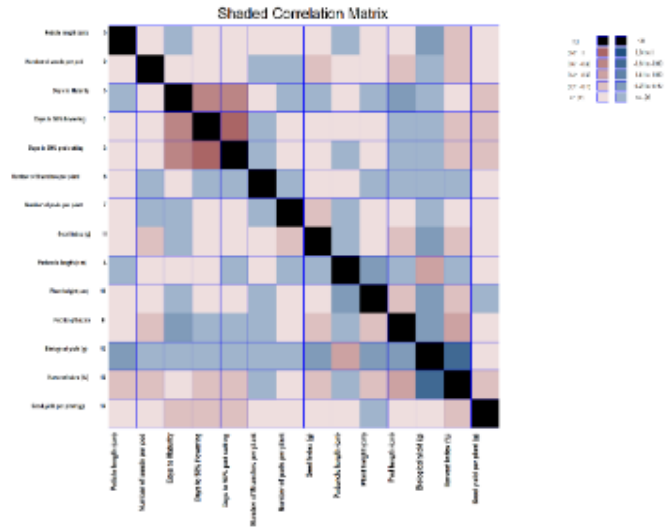

Fig. 1. Phenotypic correlation matrix

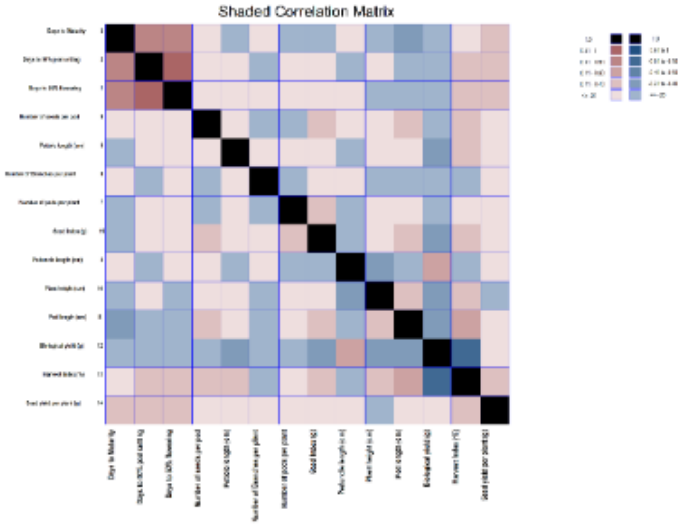

Fig. 2. Genotypic correlation matrix

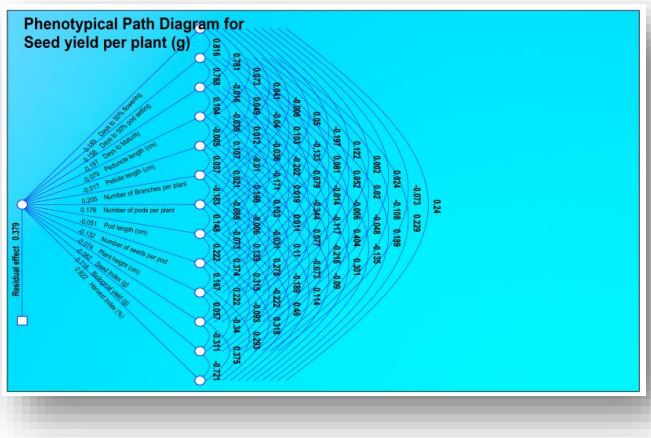

Fig. 3. Phenotypical Path Diagram for Seed yield per plant

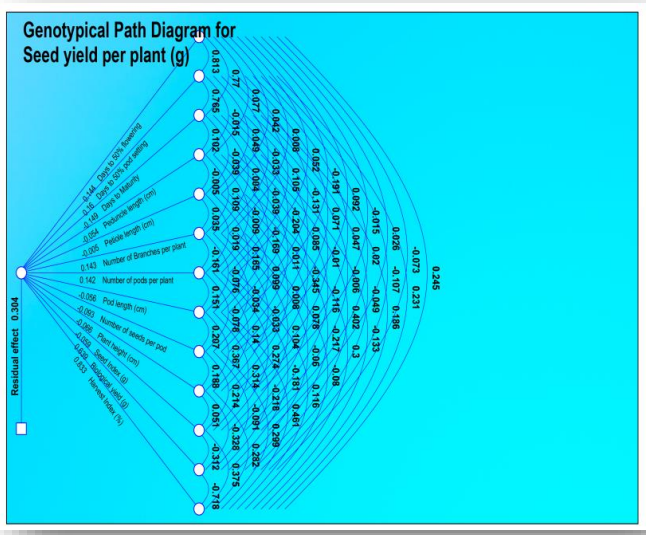

Fig. 4. Genotypical Path Diagram for Seed yield per plant

3.4 Correlation Coefficient of Analysis

In the present investigation, at phenotypic and genotypic correlation coefficient analysis revealed that Seed yield per plant exhibited positive and significant correlation with Harvest index, Days to 50% flowering and Days to 50% pod setting. Days to maturity, Peduncle length, Pod length, Petiole length, Number of pods per plant, Seed index, Number of seeds per pod, Biological yield, Number of branches per plant exhibited positive and non-significant correlation.

Seed yield per plant exhibited negative and non-significant correlation with Plant height [20-22].

3.5 Path Analysis

"In Path analysis at both phenotypic and genotypic levels Seed yield per plant exhibited high positive and significant at Harvest index, Days to 50% flowering, Days to 50% Pod setting". Days to maturity, Peduncle length, Pod length, Petiole length, Number of pods per plant, Seed index, Number of seeds per pod, Biological yield, Number of branches per plant exhibited positive and non-significant [22,23].

Seed yield per plant exhibited negative and non-significant path analysis with Plant height.

4. CONCLUSION

It is concluded from the experimental results that among 20 genotypes of cowpea, EC58905 for seed yield per plant followed by IC 259063 for seed yield per plant, for days to 50%flowering KASHI NIDHI CHECK and USM KONARK is the earliest, the earliest days to 50% podding KASHI NIDHI CHECK and IC 259106, the earliest days to maturity was recorded by KASHI NIDHI CHECK. High PCV and GCV were recorded for harvest index and biological yield. High heritability was recorded for harvest index, genetic advance as percent of mean recorded was revealed that harvest index is the highest character. Correlation coefficient analysis revealed that harvest index, days to 50% flowering, days to 50% pod setting exhibited a significant and positive correlation with grain yield per plant at both genotypic and phenotypic level. High direct positive effect on seed yield per plant at both genotypic and phenotypic levels with harvest index, days to 50% flowering, days to 50% pod setting. These characters may be given due consideration during selection for crop improvement.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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