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RESEARCH PAPER

Genetic variability and character association among vegetable soybean genotypes for yield and components traits

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Abstract: Seveenteen vegetable soybean genotypes were evaluated for eleven characters at the Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during *kharif* 2015. Analysis of variance revealed significant differences among the genotypes for all the traits. The phenotypic variance was higher than the corresponding genotypic variance for all the characters. All the characters exhibited moderate to low phenotypic and genotypic coefficient of variation. Genotypic coefficient of variation was the highest for100 seed weight (22.91%). All the traits except green pod yield (49.3%) had the highest heritability. Number of branches per plant, number of pods per plant, number of pods per plant, hundred seed weight, sugar and oil content revealed significant positive genotypic and phenotypic correlation with green pod yield. In path analysis, plant height, number of branches per plant, number of pods per plant, hundred seed weight, protein and oil content exhibited positive direct effect on green pod yield. Considering genetic variability, correlation and path analysis, emphasis should be given on plant height, number of branches per plant, number of pods per plant and hundred seed weight during selection to improve green pod yield of soybean.

Key words : Correlation, Genetic variability, Genetic advance, Heritability

Introduction

Vegetable soybean [*Glycine max* (L.) Merrill] is a speciality soybean harvested when the seeds are immature (R6 stage) and have expanded to fill 80- 90 per cent pod width and still green. These being comparatively richer and better source of human nutrition,dietary fiber and health promoting phytochemicals than the other traditional vegetables, they serve as good source of vegetable and/or snack foods for Indians specially the vegetarians representing 65-70 per cent of total population of over one billion.Vegetable soybeans are also used in the preparation of innovative products such asgreen milk, green tofu and green noodles (Mebrahtu, 2008). Vegetablesoybeans are characterised by large pods with bigger sized seeds besides seed being green, soft and sweet in taste. These are rich in protein, fat, phosphrous, calcium, iron, thiamin, riboflavin,vitamin E and isoflavones. A wide range of vegetable soybean varieties have been cultivated and there is an increased consumption of vegetable soybean in South-East Asian countries (Mebrahtu and Ali, 2006).

As far as India is concerned, soybean is mainly cultivated as an oilseed crop. Considering the nutritional importance of vegetable soybean, efforts are being made to breed vegetable soybean varieties. In order to increase yield, genetic variability is the prerequisites since it is the source of variation and raw material for yield improvement work. Furthermore, characters associated with yield are to be determined by correlation and path coefficient analysis to assist selection in yield improvement work. Though correlation analysis indicates the association pattern of component traits with yield, they also represent the overall influence of a particular trait on yield rather than providing cause and effect relationship. The path coefficient analysis technique facilitates the partitioning of genotypic correlation into direct and indirect contribution of various characters on yield. Such information would be of great value in enabling the breeder to specifically identify the important component traits of yield and utilize them for improvement in a planned way. So, present study was carried out to estimatethe genetic variability and character association among vegetable soybean genotypes for yield and component traits.

Material and methods

The present investigation was carried out at Main Agricultural Research Station, University of agricultural Sciences, Dharwad during *kharif* 2015. The experimental material consisted of 15 vegetable soybean genotypes *viz.,* EC 175324, EC 175330, EC 175332, EC 175329, NRC 105, Seminol, Cockerstraut, GP 1055, GP 15, Karune, Swarnavasundra, DSb 15, 2000-05, Himso 1585, Himso 1563 (C)including tworeleased grain types JS 335 and DSb 21.These genotypes were sown in randomized block design. Each genotype was grown in five rows of 5m length with a spacing of 30 x 10 cm in three replications. Five individual plants from each genotype were randomly selected and tagged from each replication for recording observations. Data were recorded for days to 50 per cent flowering, days to maturity, plant height, number of branches per plant, number of pods per plant, pod length, pod width, 100 seed weight, sugar, protein and oil content.

The mean of different characters were calculated on the basis of these individual data recorded for each character in each replication and subjected for analysis of variance, coefficient of variation, heritability and genetic advance. Correlation coefficients at genotypic and phenotypic level were computed from the variance and covariance components as suggested by and the correlation coefficients were further partitioned into components of direct and indirect effects by path coefficient analysis.

Table 1. Analysis of variance for different characters in vegetable soybean genotypes

Source of variation	df	Days to 50% flowering	Days to maturity	Plant height (cm)	No. of branches per plant	No. of pods per plant	Pod length (cm)	Pod width (cm)	100 seed weight (g)	Sugar content (mg/g)	Protein content (%)	Oil content (%)	Green pod yield (kg/ha)
Replication	2	0.137	0.225	2.64	0.142	2.693	0.061	0.001	0.04	0.338	21.075	0.039	1560210.529
Genotypes	16	13.52**	14.324**	172.24**	0.457**	211.46**	0.592**	0.059**	73.047**	501.95**	53.09**	2.13**	4666113.13**
Error	32	0.325	0.463	21.376	0.041	0.563	0.012	0.001	0.076	0.154	17.029	0.026	912694.321
S.Em±	-	0.329	0.393	2.669	0.117	0.433	0.064	0.021	0.16	0.227	2.383	0.093	551.57
C.D. at 1%	-	1.274	1.522	10.338	0.453	1.678	0.246	0.079	0.618	0.878	9.227	0.359	2136.126

Results and discussion

Analysis of variance

The analysis of variance exhibited significant difference among genotypes for all the charactersindicating that there is variability in genotypes studied (Table 1).Based on the mean performance of 15 genotypes, DSb 15 and 2000-05 were found to be the best genotypes for green pod yield.

Analysis of genotypic and phenotypic coefficient of variance

The data on estimates of genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability and genetic advance are presented in Table 2. Considerable range of variation was observed for all the traits under study indicating enough scope for bringing about improvement in the desired direction. High PCV and GCV was observed for 100 seed weight (22.94, 22.91 respectively).Moderate value of GCV and PCV were observed for Plant height (13.61, 16.25respectively), number of pods per plant (17.92, 17.99 respectively), pod length (10.59, 11.22 respectively), Pod width (13.26, 13.68 respectively), 100 seed weight (22.91, 22.94 respectively), sugar content (19.58, 19.61respectively),oil content (15.33, 15.38 respectively) and green pod yield (14.21, 18.69 respectively). Similar findings were reported by Hina kausar (2005), Gupta and Punetha (2007), Aditya *et al.* (2011) and Malek *et al.* (2014) for plant height. For number of pods per plant similar findings were reported by Malek *et al.* (2014) and Pawar *et al.* (2014). Similarly for pod length by Swathi (2009). Low differences between GCV and PCV for these traits indicate lower influence of environment and reflect on reliability of selection based on phenotypic performance.

The characters like days to 50 per cent flowering (5.25, 5.44 respectively), days to maturity (2.72, 2.85 respectively), number of branches per plant (8.67, 9.88 respectively) and protein content (9.6,9.96 respectively) revealed lower values of GCV and PCV. Similar kinds of results were obtained for number of branches per plant by Gohil *et al.* (2006), Showkat and Tyagi (2010) for days to 50 per cent flowering, Aditya *et al.* (2011) and Ashok kumar *et al*. (2014) for days to maturity. A lower value of GCV and PCV for these traits suggests that there is ample scope to enhance the variation for these traits.

Analysis of heritability and genetic advance

Heritability estimates of the 17 genotypes revealed that high heritability coupled with high genetic advance as per cent mean was observed for plant height, number of pods per plant, pod length, pod width, 100 seed weight, sugar content and oil content. Similar results for high heritability coupled with high genetic advance as per cent mean for plant height were reported by Pawar *et al.* (2014) and Aditya *et al.* (2011) and Malek *et al.* (2014) for number of pods per plant and Swathi (2009) for pod length, pod width and sugar content. Malek *et al.* (2014) for 100 seed weight. The results indicated lesser influence of environment on expression of these characters and prevalence of additive gene action in their inheritance. Hence they are amenable for selection.

The high heritability coupled with moderate genetic advance as per cent mean was recorded for the traits *viz.,* days to 50 per cent flowering, number of branches per plant and protein content. Similar results were reported by Malek *et al.* (2014) for days to 50 per cent flowering. Sujatha *et al.* (2011) for number of branches per plant. These results indicate that the characters were less influenced by environment and are governed by both additive and nonadditive gene action.

Table 2. Genetic variability parameters for different characters in vegetable soybean genotypes

Characters	Mean	Range		GCV	PCV	h^2	GA	GAM
		Min	Max					
Days to 50 % flowering	39.98	37.33	44.00	5.25	5.44	93.1	4.169	10.43
Days to maturity	79.10	74.67	82.00	2.72	2.85	90.9	4.22	5.34
Plant height (cm)	52.11	41.79	62.58	13.61	16.25	70.2	12.24	23.48
No. of branches per plant	4.29	3.67	4.87	8.67	9.88	77.1	0.673	15.69
No. of pods per plant	46.79	35.13	70.93	17.92	17.99	99.2	17.20	22.05
Pod length (cm)	4.12	3.19	4.75	10.59	11.22	89.1	0.848	20.60
Pod width (cm)	1.05	0.93	1.51	13.26	13.68	93.9	0.277	26.46
100 seed weight (g)	21.54	15.47	35.18	22.91	22.94	99.7	10.15	47.11
Sugar content (mg/g)	66.03	45.38	89.71	19.58	19.61	99.1	26.43	40.33
Protein content (%)	36.12	32.73	41.45	9.6	9.96	92.82	6.88	19.05
Oil content (%)	17.35	15.54	18.53	15.33	15.38	99.6	5.48	31.4
Green pod yield (kg/ha)	7871	5745	9446	14.21	18.69	49.3	1493.92	18.98

High heritability coupled with low genetic advance as per cent mean was recorded for days to maturity. These results indicate high environmental effect.

Analysis of phenotypic and genotypic correlations

In the present study, correlations were studied for green pod yield and some of its component traitswhich are presented in the Table 3 and 4. Phenotypic and genotypic correlation for green pod yield was significant and positive with number of branches per plant (0.351, 0.368 respectively), number of pods per plant (0.262, 0.268 respectively), 100 seed weight (0.479, 0.633 respectively), sugar content (0.322, 0.599 respectively) and oil content (0.429, 0588 respectively). Similar findings reported by Shivkumar *et al.* (2011) for number of branches per plant, Shwokat and Tyagi (2010), Aditya *et al*. (2011) for number of pods per plant. Similar findings reported by Shwokat and Tyagi (2010) for 100 seed weight. Parameshwar (2006) reported similar findings for oil content. The characters exhibiting significant correlation should be considered while selecting for improvement in green pod yield provided the character should exhibit high variability, which is the basis for selection.

The traits *viz.,* plant height (0.179), number of pods per plant (0.163), number of branches per plant (0.333), 100 seed weight (0.415) and protein content (0.237) exhibited high positive and direct effect (Table 5). Emphasis should be given on these traits during selection in breeding program in order to increase green pod yield.

The traits *viz.,* days to 50 per cent flowering (-0.303) and days to maturity (-0.199) which exhibited nonsignificant and negative association with green pod yield indicates that these traits are important to some extent for improvement of green pod yield but their importance cannot be over emphasized.

Conclusion

All the traits exhibited highly significant variations among the genotypes. Among traits studied *viz.,* plant height, number

Table 3. Estimate of phenotypic correlation coefficients for green pod yield and its components in vegetable soybean genotypes

Traits	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12
Days to 50 % flowering	1	0.266*	0.274	-0.307*	-0.171	-0.411 **	-0.177	-0.036	-0.340*	-0.115	-0.163	-0.361**
Days to maturity		1	0.268	-0.511**	-0.322*	-0.409 **	-0.091	-0.152	-0.398**	-0.016	-0.202	-0.050
Plant height (cm)			1	-0.165	-0.208	-0.427 **	-0.236	-0.594**	-0.425**	-0.081	-0.017	0.203
No. of branches per plant				1	0.284	0.215	-0.033	0.267	0.443**	0.109	0.168	0.351*
No. of pods per plant					1	0.594 **	-0.103	0.385**	0.367**	0.262	0.202	0.262*
Pod length (cm)						1	0.210	0.488**	0.655**	0.023	0.174	-0.057
Pod width (cm)							1	0.825**	0.421**	0.276*	-0.089	0.182
100 seed weight (g)								1	0.702**	0.258*	-0.198	0.479**
Sugar content (mg/g)									1	0.290*	-0.250	0.322**
Protein content (%)										1	0.287*	0.221
Oil content (%)											1	0.429**
Green pod yield(kg/ha)												1

* - Significant at 5% level
** - Significant at 1% level

X1 = Days to 50% flowering
X2 = Days to maturity
X3= Plant height (cm)
X4= No. of branches per plant
X5= No. of pods per plant
X6= Pod length (cm)
X7= Pod width (cm)
X8= 100 seed weight (g)
X9 = Sugar content (mg/g)
X10 = Protein content (%)
X11 = Oil content (%)
X12 = Green pod yield (kg/ha)

Table 4. Estimates of genotypic correlation coefficients for green pod yield and its components in vegetable soybean genotypes

Traits	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	X12
Days to 50% flowering	1	0.290*	0.291*	-0.400**	-0.180	-0.473**	-0.201	-0.040	-0.352**	-0.117	-0.178	-0.512**
Days to maturity		1	0.279*	-0.666**	-0.337**	-0.442**	-0.103	-0.160	-0.418**	-0.037	-0.223	-0.087
Plant height (cm)			1	-0.184	-0.241	-0.422**	-0.251	-0.699**	-0.508**	-0.103	-0.060	-0.155
No. of branches per plant				1	-0.270*	0.299*	-0.041	0.414**	0.500**	0.207	0.214	0.368**
No. of pods per plant					1	0.625**	-0.113	0.387**	0.369**	0.418**	0.202	0.315**
Pod length (cm)						1	0.240	0.514**	0.695**	0.074	0.186	0.041
Pod width (cm)							1	0.851**	0.436**	0.375**	-0.093	0.189
100 seed weight (g)								1	0.703**	0.214	-0.507**	0.633**
Sugar content (mg/g)									1	0.224	-0.356*	0.599**
Protein content (%)										1	-0.271*	0.215
Oil content (%)											1	0.588**
Green pod yield(kg/ha)												1

* - Significant at 5% level
** - Significant at 1% level

X1 = Days to 50% flowering
X2 = Days to maturity
X3= Plant height (cm)
X4= No. of branches per plant
X5= No. of pods per plant
X6= Pod length (cm)
X7= Pod width (cm)
X8= 100 seed weight (g)
X9 = Sugar content (mg/g)
X10 = Protein content (%)
X11 = Oil content (%)
X12 = Green pod yield (kg/ha)

Table 5. Estimates of phenotypic path coefficients of component traits to green pod yield in vegetable soybean genotypes

Traits	X1	X2	X3	X4	X5	X6	X7	X8	X9	X10	X11	r_p
Days to 50 % flowering	-0.303	-0.083	0.037	-0.084	-0.086	0.207	-0.089	-0.018	0.084	-0.058	0.082	0.361**
Days to maturity	-0.033	-0.199	0.014	0.102	-0.064	0.082	-0.018	0.030	0.079	-0.003	-0.040	-0.050
Plant height (cm)	0.013	0.012	0.179	-0.030	-0.037	-0.077	-0.078	0.106	0.076	-0.014	-0.003	0.203
No. of branches per plant	-0.102	-0.170	0.055	0.333	-0.078	0.072	-0.011	0.122	0.147	0.036	-0.056	0.351*
No. of pods per plant	-0.067	-0.067	0.070	0.035	0.163	0.013	0.051	0.080	0.107	0.004	-0.028	0.262*
Pod length (cm)	-0.004	-0.007	0.004	0.005	-0.097	0.021	0.002	0.008	0.008	-0.006	-0.004	-0.057
Pod width (cm)	0.007	0.004	0.018	-0.001	-0.005	0.013	0.042	0.035	0.018	0.011	-0.021	-0.182
100 seed weight (g)	-0.025	0.108	0.420	0.260	-0.273	-0.345	-0.584	0.415	0.397	-0.098	0.153	0.479**
Sugar content (mg/g)	-0.022	-0.026	-0.027	-0.028	-0.024	0.042	0.027	0.045	0.064	0.009	-0.022	0.322*
Protein content (%)	-0.027	0.004	0.019	0.026	-0.062	0.006	-0.064	0.033	0.033	0.237	0.009	0.221
Oil content (%)	0.019	0.022	0.032	-0.017	0.050	-0.008	0.077	0.061	0.056	-0.014	0.102	0.429**

* - Significant at 5% level
** - Significant at 1% level
Diagonal values represent the direct effects
Residual effect = 0.253
r_p = Phenotypic correlation.

X1 = Days to 50% flowering
X2 = Days to maturity
X3= Plant height (cm)
X4= No. of branches per plant
X5= No. of pods per plant
X6= Pod length (cm)
X7= Pod width (cm)
X8= 100 seed weight (g)
X9 = Sugar content (mg/g)
X10 = Protein content (%)
X11 = Oil content (%)
X12 = Green pod yield (kg/ha)

of pods per plant, number of branches per plant, 100 seed weight, sugar content, oil content and protein content were controlled by additive gene action could be used in crop improvement program. The traits like number of pods and branches per plant, test weight and protein content shown positive correlation and direct effect on green pod yield. Therefore, emphasis should be given on these traits during selection in breeding program in order to increase green pod yield.

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