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Research Note

Study on genetic variability and traits interrelationship among released soybean varieties of India [*Glycine max* (L.) Merrill]

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Abstract:
Information on the economic characters was derived from ninety-two varieties of soybean. Analysis of variance was carried out for the data recorded on plant height, nodes plant^{-1}, branches plant^{-1}, 100-seed weight, days to 50 % flowering, days to maturity, grain yield, oil and protein content. Results revealed highly significant differences among varieties for all the characters. High heritability was recorded for days to maturity, days to 50 % flowering, plant height, nodes, oil and protein content, indicating the additive mode of gene action. Correlation coefficient of yield was significantly negative with days to flowering and maturity. Seed weight was negatively correlated with days to flowering, maturity, plant height, nodes but positively with oil content. Protein content, however, was positively correlated with number of branches and days to 50% flowering but negative with oil content.

Key words: Soybean, yield, oil, protein, correlation, genetic variability, heritability

Soybean (2n = 40), is a very important leguminous seed crop; known for its highly valued protein and oil owing to its use in food, feed, and industrial applications. It enriches the soil by fixing nitrogen in symbiosis with bacteria. In the international world trade markets, soybean is ranked number one in world among the major oil crops such as rapeseed, groundnut, cottonseed, sunflower, linseed, sesame and safflower (Chung and Singh, 2008). Presently, India ranks fifth with respect to acreages and production in the globe. Area under soybean cultivation has steadily increased over the years from 300 ha in 1961 to the present area of 9.67 million ha producing a whopping 10.22 million tons with productivity level of 1.06 ton ha^{-1} (SOPA, 2009). To make soybean assume this prominence, the genetic amelioration work has played a key role. The development of superior varieties is based on the presence and extent of the genetic variability for the desirable characters. Thus, present work aims at studying the soybean varieties for its genetic variability and to evaluate the performance of different varieties. This information may lead to development of desirable plant type in future breeding endeavors.

Ninety-two soybean varieties were grown in a Randomized Block Design with three replications during *kharif* 2009 at experimental farm of the Directorate of Soybean Research, Indore (M.P.) which is situated at 22º 4'37''N latitude, 75º 52'7''E longitude and altitude of 540 meter above the mean sea level. The varieties were sown in six rows in five meter length (spacing 45 cm x 10 cm). The experiments were carried out on deep black cotton soils with pH 7.6 to 8.1, low to medium in organic carbon and available phosphorus and high in potassium (Typical Chromusterts and Lithic Vertic Ustochrepts). Before sowing 20 kg ha^{-1} Nitrogen, 60 kg ha^{-1} Phosphorus and 20 kg ha^{-1} Potassium were applied in the form of commercial fertilizers. Seed yield was recorded on net plot basis (13.5 m^2) and then converted into q ha^{-1}. Data were recorded on plant height (cm), nodes, branches, days to 50% flowering, days to maturity and yield (q ha^{-1}). Freshly harvested seeds were oven dried at 70 ^{0}C till they became moisture free and were used to estimate oil and protein content as per the AOAC method (1990). Analysis of variance, phenotypic variances, genotypic variances and correlations were estimated following Singh and Chaudhary (1985).

The mean sum of squares of various characters (Table 1) indicated that there were significant differences among varieties for all the characters under study. Maximum plant height (93.67 cm) was observed in variety 'Lee', while minimum (19.00 cm) in variety 'LSb-1'. In a similar study on soybean genetic stocks, Karmakar and Bhatnagar (1996) reported a range of 45.2 – 111.9 cm, while Karnwal and Singh (2009) recorded a span of 66.25 -110.75 cm for plants height in their respective studies involving various soybean genotypes. The number of nodes per plant ranged from 5.67 – 21.33. A range of 3.67- 8.67 was observed among varieties for number of branches per plant. Rasaily *et al.* (1986) and Malik *et al*. (2006) reported similar results and recorded considerable genotypic variability for numbers of branches. Data on 100-seed weight among varieties varied from 8.00 g to 15.33 g. These results are in accordance with Srivastava and Jain (1994) who also reported a range of 6.8 – 13.1 g 100^{-1} seeds for seed index.

In the present investigation, 'VLS-47' recorded the most delayed flowering (57.33 days) while it was recorded to be shortest with 'Palam soya' (30.67 days). In contrast to days to flowering, the variety 'LSb-1' recorded earliest maturity (82.66) and 'Co-1' matured late at 107.0 days. Similar trends of variability in phenology were also recorded by Singh *et al*. (1996) who reported a range of 30 to 57 days for 50% flowering and a range of 78.66 to 100.66 days for days to maturity.

A highest yield of 32.8 q ha^{-1} was obtained for 'Co soya-2' and lowest 8.28 q ha^{-1} was recorded for 'Gujarat soya-2'. The other high yielders (>25 q ha^{-1}) were 'JS 93-05', 'JS 335', 'KB -79', 'NRC-37', 'VLS-21', 'JS 95-60', 'VLS-59', 'JS 76-205', 'MAUS 71', 'RKS 18', 'JS 71-05' and 'RAUS 5'. Similar results on yield variability were observed by Rasaily *et al*. (1986); Karmakar and Bhatnagar (1996); Dadson (1976) and Ghatga and Kadu (1993).

The phenotypic variation for protein and oil content within the U.S. Department of Agriculture soybean germplasm collection has been reported to range from 34.1% to 56.8% for protein and 8.1%- 27.9% for oil (Wilson, 2004). The data recorded in the current study showed a range of 15.55% ('MACS 450') to 21.72% (NRC-7) for oil content with average oil content of 18.26 %. Varieties 'VLS 2', 'SL 688', 'Shivalik', 'PS 1042', 'Bragg', 'VLS-63', 'Hara Soya' and 'VL Soya 59' recorded > 20 % oil content. Similar variability for oil content was also reported by Dadson (1976), Maestri *et al.,* (1998) and Malik *et al.,* (2006).

Analysis of variance for protein content revealed that varietal differences were highly significant. Rao *et al.* (1998) evaluated the performance of twelve soybean genotypes and determined their seed protein composition and reported similar trends. Similar results were also chronicled by Dadson (1976) and Maestri *et al.* (1998). In the present investigation, highest protein content was observed in 'ADT-1' (42.74 %) and lowest in 'PK 416' (37.69%) with mean protein content of 40.23 %. Varieties observed with above 42.00 % protein contents were 'MACS 450', 'KHSb-2', 'MAUS 2', 'Guj. Soya 1', 'Punjab - 1', 'Birsa Soya 1' and 'PK 472'. These observations were found consistent with those of Narne *et al*. (2002); who reported the range of protein from 27.31 to 41.35%. Bennett *et al*. (2003) demonstrated that the "microenvironment" (i.e. the location of seeds on the plant) can also impact carbon flux during embryogenesis, with pods positioned at the top of the plant having seeds with a higher percentage of protein and lower oil content than in those positioned at the bottom of the plant.

The partitioning of variance (Table 1) revealed that high heritability was recorded for days to maturity, days to 50% flowering, plant height, oil and protein content, indicating the additive mode of gene action. On the basis of heritability, days to maturity, days to 50% flowering, plant height, nodes, oil and protein contents would respond to any intense selection exercise and would result in improvement in soybean for these characters. However, high heritability and low genetic advance was observed for seed weight, protein and oil content indicating involvement of non-additive genes, hence heterosis breeding involving population improvement exercise may be useful for improvement of these characters.
Moderate heritability (0.57) and high genetic advance was noted for yield, indicating additive gene effects. These results are comparable to the results reported by various workers including Jain and Ramgiry (2000), Jagtap and Mehetre (1994), Ghatge and Kadu (1993), Rasaily *et al.* (1986), Zhu (1992) and Rao *et al.* (1998).

The correlation study (Table 2) showed that yield was negatively associated with both days to flowering and maturity. Similar results were obtained by and Malik *et al.* (2006). Whereas these results are in contradiction to the results of Sharma *et al.* (1983), who reported that days to maturity and days to flowering contributed most to seed yield. The contradiction in results might be due to the influence of environmental factors. Seed weight was negatively correlated with days to flowering, maturity, plant height, number of nodes but positively with oil content.

Present data showed the protein content however, positively correlated with branches and days to flowering but negatively with oil content. Malik *et al*.

(2007) also observed negative correlation between oil and protein content. Schwender *et al*. (2003) studied the relationship between oil and protein content and suggested that 1% reduction in total oil content will lead to a 2% increase in total protein content. Thus, the regulation of carbon flux during embryogenesis will be shifted toward one or the other, which is impacted by both genetics and environment, although strong metabolic links between oil and storage protein synthesis are not apparent. Leffel & Rhodes (1993) also reported that high-protein lines were inferior for seed yield and oil concentration. The inverse relationship between total oil and protein content in soybean is well documented.

From the present investigation it is concluded that the varieties exhibited a wide range of variability for most of the traits. Some varieties possessed desirable genes for more than one character and hence could be utilized directly or included in hybridization programme. The varieties 'JS 93-05', 'JS 335', 'KB -79', 'NRC-37', 'VLS-21', 'JS 95-60', 'VLS-59', 'JS 76-205', 'MAUS 71', 'RKS 18', 'JS 71-05', 'RAUS 5' and 'Co soya-2' proved promising for yield ha^{-1}. It is suggested that these elite genotypes could be utilized in developing physiologically efficient cultivars with higher yield potential.

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Table 1. Means of 9 characters studied in 92 varieties of soybean grown during *kharif* 2009

Statistic	Height (cm)	Nodes/ plant	Branches/ plant	Seed wt (g)	Days to flowering	Days to maturity	Yield (q/ha)	Oil % (db)	Protein % (db)
Range	19.00 - 93.67	5.67 - 21.33	2.67-9.67	8.00-15.33	30.67-57.33	82.67-107.00	8.30-32.80	15.55-21.72	37.70-42.74
Grand Mean	46.975	12.471	4.938	11.761	45.297	98.967	18.879	18.262	40.229
MS(VAR)	771.884**	29.708**	5.941**	6.050**	124.135**	41.905**	87.508**	5.192**	4.346**
ST.ERROR	4.593	1.183	0.985	0.999	1.037	0.504	3.402	0.389	0.407
CD 1%	11.965	3.082	2.566	2.602	2.702	1.312	8.863	1.014	1.061
C V	11.976	11.617	24.431	10.402	2.804	0.623	22.072	2.610	1.240
ECV	11.976	11.617	24.431	10.402	2.804	0.623	22.072	2.610	1.240
PCV	35.519	26.957	34.784	14.763	14.384	3.811	33.811	7.512	3.158
GCV	33.440	24.326	24.760	10.475	14.108	3.759	25.613	7.044	2.905
$h^2{}_{bs}$	0.886	0.814	0.507	0.504	0.962	0.973	0.574	0.879	0.846
G. A.	10.877	8.706	6.159	3.989	7.515	3.912	7.546	4.962	3.097

** Significant at 1% level of significance.

Table 2. Phenotypic correlation coefficients among 9 characters studied in 92 varieties of soybean grown

	Height (cm)	Nodes/plant	Branches/plant	Seed weight (g)	Days to 50% flowering	Days to Maturity	Yield (q/ha)	Oil %
Nodes per plant	0.728**							
Branch per plant	0.093	0.109						
Seed weight (g)	-0.447**	-0.402**	-0.150					
Days to 50% flowering	0.401**	0.386**	0.316**	-0.354**				
Days to maturity	0.563**	0.433**	0.241*	-0.463**	0.519**			
Yield (q/ha)	-0.148	-0.110	-0.110	0.190	-0.390**	-0.246*		
Oil %	-0.133	-0.122	-0.059	0.230*	-0.146	-0.017	-0.119	
Protein%	0.156	0.121	0.242*	-0.124	0.374**	0.164	-0.090	-0.242*