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Study on Genetic Variability, Heritability and Genetic Advance in Soybean

Kuldeep Singh Chandrawat[1*], K. S. Baig[2], Syed Hashmi[3], D. H. Sarang[4], Anil Kumar[1] and Ph. Kiihne Dumai[1]

[1]M.Sc. Students, Department of Agricultural Botany, College of Agriculture

[2]Major Soybean Breeder, Soybean Research Station

[3]Associate Professor, Department of Food Chemistry and Nutrition, College of Food Technology

[4]Assistant Breeder, STRU & BSP Unit, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (MS)

*Corresponding Author E-mail: kchandrawatgpb@gmail.com

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ABSTRACT

An experiment was conducted to evaluation of genetic variability present in the forty one genotypes and five checks (two local + three national checks) and observations were recorded on various yield and yield contributing characters viz., days to 50% flowering, days to maturity, plant height, number of branches per plant, number of pods per plant, 100 seed weight, harvest index and grain yield per plant at field level and oil content, protein content and trypsin inhibitor content in the laboratory. Analysis of variance showed the significant variability for all the studied characters. High values of GCV and PCV were observed for charactersviz., number of pods per plant (35.45, 38.62), plant height (23.49, 25.84), yield per plant (21.35, 24.86) and number of branches per plant (20.58, 24.22) which indicates the presence of high genetic variation. High heritability coupled with high genetic advance observed for the traits viz., Pods per plant, plant height, yield per plant, branches per plant, trypsin inhibitor content and 100 seed weight which indicates presence of additive gene action and demands for population improvement by selection.

Key words: *Genetic variability, Heritability, Genetic advance, Soybean, GCV, PCV*

INTRODUCTION

Taxonomically, soybean belongs to the genus *Glycine* which is divided into two subgenera, *Glycine* and *Soja*.The cultivated soybean, *G. max* (L.) Merril (2n=40) comes under the subgenus *Soja* (Moench). Soybean (*Glycine max* (L.) Merrill.) is aptly called as "Golden Bean" or "Miracle Crop" of the 20th century and is one of the most important oilseed crop in the world[2]. Nutritional value of soybean lies in protein (40-42%) and oil contents (18-22%) and is free from cholesterol making it highly desirable in the human diet[21]. Biodiesel is a synthetic fuel that in the U.S. is produced predominately from the oil extracted from soybeans[1,40]. Inheritance of quantitative characters is often influenced by variation in other characters which may be due to pleiotropy or genetic linkage.

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Knowledge of genetic variability is essential to formulate an effective crop improvement programme. Hence the present investigation carried out for genetic variability for quantitative traits in germplasm lines of soybean.

MATERIALS AND METHODS

The present investigation was undertaken during *kharif* 2013 at the experimental farm of AICRP on Soybean, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. The experimental material comprised of 41 germplasm lines, three national checks *viz.*, Bragg, JS-335 and JS-93-05 and two local checks *viz.*, MAUS-71, and MAUS-158. Observations were recorded on five randomly selected plants per treatment for eleven quantitative characters *viz.*, days to 50% flowering, days to maturity, plant height, number of branches per plant, number of pods per plant, 100 seed weight, harvest index, oil content, protein content, trypsin inhibitor content and grain yield per plant. Oil content was observed according to the soxhlet apparatus, protein content by Micro-kjeldhal method and trypsin inhibitor (TI) activity was determined as suggested by Kakade *et al*[18]., at Department of Food Chemistry and Nutrition, College of Food Technology, VNMKV Parbhani. One unit of trypsin inhibitor activity is defined as the quantity of inhibitor which reduces the activity of trypsin by one unit at 37°C.

The analysis of variance was done as suggested by Panse and Sukhatme[25]. The phenotypic and phenotypic coefficients of variation were worked out according to the method given by Singh and Choudhary[33]. Heritability in broad sense and expected genetic advance on the basis of percent of mean were worked out according to the method given by Allard[4].

RESULTS AND DISCUSSION

The mean sum of squares due to replication was non-significant for all the studied character while, the variation due to genotypes was significant for all the characters under study both at 5 and 1 per cent probability levels (Table-1). The high variability observed might be attributed to their genetic makeup of germplasm lines and the different geographical regions from which they have originated. This result of present investigation is in accordance with Osekita and Omolara *et al*[24]. Mean performance for various characters are observed which showed good range of variability for studied characters (Table-2). The range for yield per plant (2.71-8.46 g), oil content (12.61-22.39), protein content (27.99-43.88), number of pods per plant (13.50-50.88), 100 seed weight (9.57-26.3), harvest index (32.32-67.95), plant height (20.15-53.68), days to 50% flowering (34-46) and for days to maturity (95-111). In the present investigation the range for trypsin inhibitor content ranges from 39.52-86.22 mg/g sample. Different scientists have reported different range of trypsin inhibitor activity[13] 43-84 TIU mg $^{-1}$ sample; Peric *et al*[27]., 15.35 mg/g; Rameshbabu and Subrahmanyam[29],76.52 TIU/mg seed[12]; 11.3-142.5 mg/g seeds). Variation reported in the trypsin enzyme inhibitory activities by different authors might

be because of differences in the methods and units used.

The characters under investigation were analyzed for genotypic variance (σ^2g), phenotypic variance (σ^2p), genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (broad sense) and genetic advance as percent of mean (Table-2). In the present investigation, genotypic variances have low values than phenotypic variances as former is the component of the latter and phenotypic variance expresses by the combined effects of genotypic variances, environmental variances and g x e interactions.

Different traits have different means in different environments so phenotypic variance and genotypic variance are not able to reveal the degree of variability therefore their coefficients were calculated as suggested by Burton[9] and classified (low <10%; Moderate 10-20%; High >20%) as suggested by Sivasubramanian and Madhavamenon[35]. PCV was higher than GCV for all the studied characters[6,20] which indicates the effect of environmental variation but it is also observed the low range between PCV and GCV so it reveals that these traits have low sensitivity to environmental effects and it is reducible. High values of GCV and PCV were observed for characters *viz.*, number of pods per plant, plant height, yield per plant, number of branches per plant and trypsin inhibitor content which indicates the wide spectrum of genotypic variation for these traits. Moderate GCV and PCV were observed for traits *viz.*, 100 seed weight, harvest index, oil content and protein content and the characters *viz.*, days to 50% flowering and days to maturity revealed low GCV and PCV. These results are in agreement with various scientists which are presented in table-3.

GCV measures the amount of variation present in a particular character but it doesn't provide an idea about the proportion of heritable variation present in the total variation therefore, heritability estimates were calculated in the present study. In the present study heritability estimates were high for all the studied character as categorized (Low <30%; Moderate 30-60%; high >60%) by Johnson *et al*[17].

High heritability coupled with high genetic advance observed for the traits *viz.*, Pods per plant[11,15,30], plant height[8,15,16,36], yield per plant[30,36], branches per plant[15,28,30], trypsin inhibitor content and 100 seed weitght[15,30], harvest index[15,30,36] which indicates presence of additive gene action and offers the best possibility for improvement of these traits by various selection methods.

High heritability coupled with moderate genetic advance was observed for characters *viz.*, oil content[30,37], protein content[30,31] and days to 50% flowering indicates the presence of both additive and non-additive gene action for these traits. High heritability coupled with low genetic advance found for only one character days to maturity[6] which clearly states the presence of non-additive gene action and selection is not rewarding for this trait. Recombination breeding and recurrent selection may be used for such type of traits for population improvement.

Table 1: Analysis of Variance for eleven yield and yield contributing characters studied in soybean

S. variation	D.F.	Yield contributing characters										
		Days to 50% Flowering	Days to Maturity	Plant height (cm)	Number of branches per plant	Number of pods per plant	100 seeds (g)	Harvest Index	Oil content (%)	Protein Content (%)	Trypsin inhibitor content (%)	Grain yield per plant (g)
Replication	1	0.391	23	0.999	0.01	2.793	0.815	4.257	0.140	0.495	0.172	0.148
Treatment	45	20.542**	47.864**	117.918**	2.406**	176.101**	13.512**	144.152**	11.497**	34.073**	331.519**	3.035**
Error	45	5.857	21.4	11.203	0.387	15.027	2.355	26.673	2.320	7.161	31.334	0.458

Table 2: Parameters of genetic variability for various yield and yield contributing characters in soybean

Sr. No.	Character	Range	General mean	Genotypic Variance (σ^2g)	Phenotypic Variance (σ^2p)	GCV (%)	PCV (%)	Heritability	Genetic advancement 5%	Genetic adv. as percent of mean
1.	Days to 50% Flowering	34.00-46.00	39.13	7.43	13.20	6.92	9.28	74.56	4.16	10.63
2.	Days to Maturity	95.00-111.50	102.60	13.23	3.54	3.54	5.73	61.78	4.63	4.51
3.	Plant Height	20.15-53.68	31.08	53.35	64.56	23.49	25.84	90.90	13.68	44.00
4.	Number of branches per plant	2.90-8.50	4.88	1.01	1.39	20.58	24.22	84.97	1.76	36.05
5.	Number of pods per plant	13.50-50.88	25.31	80.53	95.56	35.45	38.62	91.79	16.97	67.05
6.	100 seed weight	9.57-26.3	14.02	5.57	7.93	16.83	20.07	83.85	4.08	29.08
7.	Harvest index	32.32-67.95	52.59	57.24	86.91	14.38	17.72	81.15	12.64	24.04
8.	Oil content	12.61-22.39	19.23	4.58	6.90	11.13	13.66	81.47	3.59	18.69
9.	Protein content	27.99-43.88	38.15	13.45	20.61	9.61	11.90	80.75	6.10	16.00
10.	Trypsin Inhibitor content	39.52-86.22	66.15	150.09	181.42	18.52	20.36	90.96	22.95	34.70
11.	Grain yield per plant	2.71-8.46	5.31	1.28	1.74	21.35	24.86	85.88	2.00	37.77

Table 3: Results observed in the present investigation and similar findings by various scientists

Sr. Nu.	Characters	GCV and PCV		Genetic Advance		Heritability	
		Status in present study	Supported by	Status in present study	Supported by	Status in present study	Supported by
1.	Days to 50% Flowering	Low	Srivastava and Shukla[32], Bangar *et al*[5]., Karad *et al*[19].,, Baraskar *et al*[6].	Moderate	Harer and Deshmukh[14], Srivastava and Shukla[32], Bekele *et al*[8].	High	Ramana *et al*[28]., Bangar *et al*[5]., Karad *et al*[19]., Parameshwar[26], Malik *et al*[21].
2.	Days to matirity	Low	Ramana *et al*[28]., Karad *et al*[19]., Ghodrati[10], Reni and Rao[30], Baraskar *et al*[6].	low	Srivastava and Shukla[32], Nehru *et al*[22]., Agarwal *et al.*, Bekele *et al*[8].	High	Ramana*et al*[28]., Karad*et al*[19]., Malik *et al*[21]., Sirohi*et al*[34].
3.	Plant height	High	Parameshwar[26], Bekele *et al*[8]., Baraskar *et al*[6].	High	Basavaraja[7], Bangar*et al*[5]., Hina Kausar[15], Karad *et al*[19]., Parameshwar[26], Sirohi *et al*[34]., Bekele *et al*[8]., Ghodrati[10]	High	Basavaraja[7], Bangar *et al*[5]., Hina Kausar[15], Karad *et al*[19]., Parameshwar[26], Malik *et al*[21]., Sirohi *et al*[34]., Karnwal and Singh[20], Ghodrati[10] (2013)
4.	Number of branches per plant	High	Basavaraja[7], Bangar *et al*[5]., Hina Kousar[15], Reni and Rao[30], Ghodrati[10]	High	Basavaraja[7],Bangar *et al*[5]., Hina Kausar[15], Karad *et al*[19]., Parameshwar[26]	High	Basavaraja[7], Bangar *et al*[5]., Hina Kausar[15], Karad *et al*[19]., Parameshwar[26], Karnwal and Singh[20]
5.	Number of pods per plant	High	Ramana *et al*[28]., Agarwal *et al.*, Basavaraja[7], Karad *et al*[19]., Gohil *et al.*, Sirohi *et al*[34]., Reni and Rao[30], Baraskar *et al*[6].	High	Ramana *et al*[28]., Basavaraja[7], Karad *et al*[19]., Sirohi *et al*[34]., Ghodrati[10]	High	Ramana *et al*[28]., Basavaraja[7], Karad *et al*[19]., Sirohi *et al*[34]., Karnwal and Singh[20], Ghodrati[10]
6.	100 seed weight	Moderate	Bangar *et al*[5]., Hina Kousar[15] Parameshwar[26], Reni and Rao[30].	High	Thorat *et al*[38]., Agarwal *et al.*, Basavaraja[7], Hina Kausar[15].	High	Thorat *et al*[38]., Iqbal *et al*[16]., Hina Kousar[15], Sirohi *et al*[34]., Karnwal and Singh[20]
7.	Harvest index	Moderate	Nirmala Kumari and Balasubramanian[23]	High	Nirmala Kumari and Balasubramanian[23]	High	Nirmala Kumari and Balasubramanian[23], Sirohi *et al*[34].
8.	Oil content	Moderate		Moderate	Parameshwar[26]	High	Harer & Deshmukh[14], Malik *et al*[21].
9.	Protein content	Moderate	Nirmala Kumari and Balasubramanian[23]	Moderate	Nirmala Kumari and Balasubramanian[23]	High	Nirmala Kumari and Balasubramanian[23], Tyagi *et al*[39].
10.	Trypsin inhibitor content	High		High		High	
11.	Yield per plant	High	Hina Kausar[15], Karad *et al*[19]., Parameshwar[26], Sirohi *et al*[34]., Reni and Rao[30], Baraskar *et al*[6].	High	Jain & Ramgiry, Bangar *et al*[5]., Hina Kausar[15], Karad *et al*[19]., Parameshwar[26], Tyagi *et al*[39].	High	Bangar *et al*[5]., Hina Kausar[15], Karad *et al*[19]., Parameshwar[26], Sirohi *et al*[34]., Karnwal and Singh[20], Tyagi *et al*[39].

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