ISSN: 0974 - 0376

The Ecoscan : Special issue, Vol. VII: 209-213: 2015
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES
www.theecoscan.in

ASSESSMENT OF GENETIC DIVERSITY AND PATH COEFFICIENT IN REPRODUCTIVE PHASES AND QUALITY TRAITS AND THEIR CORRELATION WITH SEED YIELD IN SOYBEAN [*GLYCINE MAX* (L.) MERRILL]

Varun Kumar Badaya *et al.*,

KEYWORDS

Soybean
Genetic diversity
Correlation
Path coefficient

Proceedings of National Conference on
Harmony with Nature in Context of
Bioresources and Environmental Health
(HORMONY - 2015)
November 23 - 25, 2015, Aurangabad,
organized by
Department of Zoology,
Dr. Babasaheb Ambedkar Marathwada University
Aurangabad (Maharashtra) 431 004
in association with
National Environmentalists Association, India
www.neaindia.org

The Ecoscan
AN INTERNATIONAL QUARTERLY JOURNAL OF ENVIRONMENTAL SCIENCES

VARUN KUMAR BADAYA*, B. S. GILL, JAGMEET KAUR AND UMESH KUMAR DHAKAD
Department of Plant Breeding and Genetics,
Punjab Agricultural University, Ludhiana - 141 004, Punjab, INDIA
e-mail: varunbadaya67@gmail.com

ABSTRACT

The present study was carried out among sixty soybean breeding lines to assess the genetic diversity and to study correlation among reproductive phases and quality traits and their direct and indirect effect on seed yield. Analysis of variance revealed that all the characters showed significant variation. Genotypic coefficient of variation ranged from 3.40 (protein content) to 25.38 (seed yield per plant). High heritability was observed for the trait days to full flowering (97.93 %) and for protein content and oil content, heritability estimates were 67.30 per cent and 77.78 per cent, respectively. This suggests that selection can be practiced for reproductive phases to improve seed yield in soybean. Correlation analysis revealed that seed yield was significantly and negatively correlated with protein content (-0.16), indicating improvement in this trait will decrease the seed yield. Similarly, oil content had negative and significant correlation with protein content (-0.26). The path coefficient analysis on phenotypic basis revealed that R2-R4 phase (0.142), R2 phase (0.056), R6-R8 phase (0.040) and R4-R6 phase (0.027) had positive direct effect on yield while protein content (-0.012) and oil content (-0.022) had negative effect on yield indicated that duration among reproductive phases directly lead to increase in seed yield.

*Corresponding author

INTRODUCTION

Soybean [*Glycine max* (L.) Merrill] is a legume that grows in tropical, subtropical and temperate climates. Soybean is now cultivated throughout east and South East Asia where people depend on it for food, animal feed and medicine. Soybean has the highest protein content (40 to 42%) of all other food crops and is second in terms of oil content (18 to 22% comprising 85% unsaturated fatty acids and is free from cholesterol) among food legumes, so it is highly desirable in the human diet (Antalina, 1999).

The knowledge of certain genetic parameters is essential for proper understanding and their manipulation in any crop improvement programme (Dong *et al.* 2001). The success of selection is mainly dependent on the amount of genetic variability present in the material. Greater the amount of genetic variability present in the population, greater would be the scope for improvement. Thus, the presence and magnitude of genetic variability in a gene pool is the pre-requisite of any breeding programme.

Correlation analysis is a handy technique, which provides information about the degree of relationship between important plant traits and is also a good index to predict the yield response in relation to the change of a particular character. However, many workers have expressed apprehension about total reliance on yield components analysis (Arshad *et al.* 2006). Path coefficient analysis measures the direct and indirect effect for one variable upon another and permits the separation of the correlation coefficient into components of direct and indirect effect (Dewey & Lu, 1959). In soybean, Board *et al.* (1997), Taware *et al.* (1997), Shukla *et al.* (1998), Board *et al.* (1999) and Iqbal *et al.* (2003) used path analysis for partitions the genotypic correlations into direct and indirect effects of the traits.

So, the objective of this paper is to assess the genetic variability based on reproductive phases and quality traits in soybean and to identify key characters for improvement in seed yield.

MATERIALS AND METHODS

The research work was conducted during *kharif* 2013 at the Pulses Research area of Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana and quality parameters were estimated at Quality Laboratory of Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana. The experimental material (Table 1) was sown in a randomized complete block design with three replications, each having three rows per genotype with row length of 3 meter and spacing of 45 cm between the rows and 5 cm within the rows. The recommended fertilizers and cultural practices were followed to raise the crop. Observations were recorded for days to R2 phase, duration from R2-R4 phase, duration from R4-R6 phase and duration from R6-R8 phase and two quality traits namely protein content and oil content and for seed yield. (R1- Beginning of flowering; R2- Full flowering; R3- Beginning of pod; R4- Full pod; R5- Beginning of seed; R6- Full seed; R7- Beginning of maturity; R8-Full maturity).

Analysis of variance was calculated by Panse and Sukhatme (1985). The genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were estimated by the formula suggested by Burton and Devane (1953). Heritability in broad sense was calculated by the formula given by Lush (1949) and genetic advance (GA) was computed by the formula used by Miller *et al.* (1958). The statistical analyses were carried out on the basis of mean of five competitive plants. The phenotypic and genotypic correlation coefficients and path coefficients were worked out by the formula described by Dewey and Lu (1959). The estimated values were compared with table values of correlation coefficient to test the significance of correlation coefficient prescribed by Fisher and Yates (1963).

RESULTS AND DISCUSSION

The analysis of variances indicated the existence of significant differences among the genotypes studied revealing that sufficient variability is present for the different characters and selection would be effective to develop the varieties with desired forms of crop plants. The result of analysis of variance, GCV, PCV, heritability and expected genetic advance are present in the Table 2.

The development of an effective plant breeding programme depends on the existence of genetic variability. In the present study, the estimates of coefficients of phenotypic variation were higher than their respective genotypic coefficients for all the characters studied indicate the role of environment in expression of characters (Table 2). Among all the characters studied, duration from R6-R8 phase was observed to be having highest phenotypic coefficient of variation (18.17%) closely followed by duration from R4-R6 phase (17.56%). Moderate values of PCV were recorded for duration from R2-R4 phase (16.52%) and days to R2 phase (6.31%). Quality traits like oil content (5.41%) and protein content (4.14%) show low values of PCV. Like phenotypic coefficient of variation, GCV was highest for duration from R6-R8 phase (17.73%) followed by duration from R4-R6 phase (16.54%), while moderate values of GCV were recorded for duration from R2-R4 phase (15.58%) and for days to R2 phases (6.24%). For oil content (4.77%) and protein content (3.40%), low GCV estimates were recorded. Bhat and Basavaraja (2011) reported low GCV and PCV values for days to maturity and oil content. According to Agawane and Parhe (2015), seed priming also influenced the seed yield and yield contributing characters of soybean. They exhibited that seeds primed with GA3 recorded significantly higher germination percentage over the untreated control. Choudhary *et al.* (2014) demonstrated that application of 60 ppm S and 5 ppm Zn should be used for improvement of yield and quality traits of soybean grain. Similarly, Meena and Ghasolia (2013) reported that application of FYM in the field@

Table 1: List of genotypes studied

S. No.	Genotype	S. No.	Genotype	S. No.	Genotype
1	SL1096	21	SL1152	41	SL1172
2	SL1104	22	SL1153	42	SL1173
3	SL1113	23	SL1154	43	SL1174
4	SL1116	24	SL1155	44	SL1175
5	SL1117	25	SL1156	45	SL1176
6	SL1119	26	SL1157	46	SL1177
7	SL1120	27	SL1158	47	SL1178
8	SL1121	28	SL1159	48	SL1179
9	SL1122	29	SL1160	49	SL1180
10	SL1123	30	SL1161	50	SL1181
11	SL1124	31	SL1162	51	SL1182
12	SL1143	32	SL1163	52	DS15-2
13	SL1144	33	SL1164	53	DS12-13
14	SL1145	34	SL1165	54	PS1477
15	SL1146	35	SL1166	55	SL295
16	SL1147	36	SL1167	56	SL525
17	SL1148	37	SL1168	57	SL744
18	SL1149	38	SL1169	58	SL900
19	SL1150	39	SL1170	59	SL955
20	SL1151	40	SL1171	60	SL958

Table 2: Mean of genotypes, range, genotypic coefficient of variance (GCV), phenotypic coefficient of variance (PCV), heritability (h^2) and genetic advance (GA) estimated for different characters

S. No.	Character	Mean of genotypes	Range	GCV	PCV	h^2 (%)	GA (% of mean)
1	R2 phase (days)	75.5	64.3-88.7	6.24	6.31	97.93	12.72
2	R2-R4 phase (days)	15.9	10.0-21.0	15.58	16.52	88.98	30.28
3	R4-R6 phase (days)	18.3	12.7-27.0	16.54	17.56	88.72	32.10
4	R6-R8 phase (days)	23.8	14.0-33.7	17.73	18.17	95.15	35.62
5	Protein content (%)	38.55	35.27-41.86	3.40	4.14	67.30	5.75
6	Oil content (%)	19.59	16.97-21.54	4.77	5.41	77.78	8.67
7	Seed yield (g/plant)	12.45	4.92-20.60	25.38	26.93	88.84	49.28

Table 3: Correlation coefficients for all possible pair of characters

S. No.	Character	R2 phase (days)	R2-R4 phase (days)	R4-R6 phase (days)	R6-R8 phase (days)	Protein content (%)	Oil content (%)	Seed yield (g/plant)
1	R2 phase (days)	-	-0.33	0.11	0.15	0.16	0.44	0.75
2	R2-R4 phase (days)	-0.68**	-	-0.20	0.35	0.06	-0.03	0.36
3	R4-R6 phase (days)	-0.02	0.10	-	-0.01	-0.12	-0.06	-0.10
4	R6-R8 phase (days)	-0.12	-0.04	-0.13	-	0.02	-0.02	0.17
5	Protein content (%)	0.11	-0.10	-0.05	-0.23**	-	0.31	0.18
6	Oil content (%)	-0.16*	0.21**	0.23**	0.18*	-0.26**	-	0.19
7	Seed yield (g/plant)	-0.08	-0.06	-0.07	0.07	-0.16*	0.06	-

Calculated value of 'r' at 5% e" 0.15* and that at 1% e" 0.19**; The values above diagonal are genotypic correlations and below are phenotypic correlation

Table 4a: Path analysis for seed yield based on genotypic correlations among different traits in 60 soybean genotypes

S. No.	Character	R2 phase (days)	R2-R4 phase (days)	R4-R6 phase (days)	R6-R8 phase (days)	Protein content (%)	Oil content (%)	Correlation with seed yield
1	R2 phase (days)	0.099	-0.017	0.075	0.079	-0.001	-0.002	0.75
2	R2-R4 phase (days)	0.085	-0.020	0.096	0.094	-0.001	-0.001	0.36
3	R4-R6 phase (days)	0.060	-0.016	0.124	0.128	0.000	0.001	-0.10
4	R6-R8 phase (days)	0.042	-0.010	0.085	0.186	0.002	0.003	0.17
5	Protein content (%)	0.012	-0.001	0.000	-0.043	-0.008	-0.005	0.18
6	Oil content (%)	-0.018	0.001	0.016	0.050	0.003	0.011	0.19

Table 4b: Path analysis for seed yield based on phenotypic correlations among different traits in 60 soybean genotypes

S. No.	Character	R2 phase (days)	R2-R4 phase (days)	R4-R6 phase (days)	R6-R8 phase (days)	Protein content(%)	Oil content (%)	Correlation with seed yield
1	R2 phase (days)	0.056	0.119	0.016	0.017	-0.001	0.003	-0.08
2	R2-R4 phase (days)	0.047	0.142	0.021	0.020	-0.001	0.001	-0.06
3	R4-R6 phase (days)	0.033	0.107	0.027	0.027	0.000	-0.003	-0.07
4	R6-R8 phase (days)	0.024	0.071	0.019	0.040	0.002	-0.005	0.07
5	Protein content (%)	0.006	0.011	0.001	-0.006	-0.012	0.006	-0.16*
6	Oil content (%)	-0.009	-0.008	0.003	0.009	0.003	-0.022	0.06

5 t/ha are better to increase microbial population as well as yield attributes of soybean in the field.

The coefficient of variation indicates only the extent of variability existing for various characters, but does not give any information about the heritable portion of it. Therefore, it is essential to know about the heritability. In the present study, high heritability was estimated for days to R2 phase (97.93%) followed by duration from R6-R8 phase (95.15%), duration from R2-R4 phase (88.98%) and duration from R4-R6 phase (88.72%). This suggests that selection can be practiced by using these traits to improve seed yield in soybean. The magnitude of heritability was low for quality traits *i.e.* for oil content (77.78%) and for protein content (67.30%). Khan *et al.* (2000) reported high heritability for days to maturity and moderate for oil content. Similarly, Recker (2010) and Ramteke *et al.* (2010) found high heritability estimates for flowering date and maturity date.

Genetic advance as per cent of mean was found to be highest for duration from R6-R8 phase (35.62%) and low for quality traits. High heritability with high genetic advance as per cent of mean was recorded for duration from R6-R8 phase indicating the presence of additive type of genetic variability. High heritability with moderate genetic advance was recorded for days to flowering stage (R2 phase) indicating that this character are governed by both additive and non additive gene action.

The quality characters *viz.*, protein content and oil content showed lower heritability with lower genetic advance, there by indicating that expression of these characters may be due to non additive gene action.

Phenotypic and genotypic correlations among all characters studied were estimated and are shown in table 3. The estimates of genotypic correlation coefficients were higher than the phenotypic correlation coefficients for almost all the character combinations. The oil content had highly significant and positive correlation with duration from R4-R6 phase (0.23) and with duration from R2-R4 phase (0.21) and showed significant and negative correlation with days to R2 phase (-0.16). Swathi (2009) had also reported similar results. Likewise, oil content also showed negatively associated with protein content (-0.26). Similarly, Seed yield was negatively associated with protein content (-0.16) which confirms the findings of Mello *et al.* (2004) and Manggoel *et al.* (2012).

In present investigation, the genotypic as well as phenotypic correlations were partitioned into direct and indirect effects with the help of path analysis (Table 4a and 4b). The path coefficient analysis on phenotypic basis (Table 4b) revealed that duration among reproductive phases exhibited direct positive effect on seed yield but quality traits showed negative direct effects on seed yield. Duration from R2-R4 phase exhibited maximum positive direct effect (0.142) on seed yield followed by days to flowering stage (0.056). Oil content exhibited maximum negative direct effect (-0.022) on seed yield. Duration from R4-R6 phase showed minimal positive direct effect on seed yield (0.027) but showed negative indirect effect through oil content (-0.003). Protein content (-0.012) had negative direct effect on seed yield but had positive indirect effect via duration from R2-R4 phase (0.011). In a similar fashion, oil content showed a negative direct effect (-0.022) but had a positive indirect effect via duration from R6-R8 phase (0.009) on seed yield per plant. Days to full flowering stage had a small positive direct effect (0.056) but showed a high positive indirect effect on seed yield per plant via R2-R4 phase (0.119). The results confirm the findings of Malik *et al.* (2007) who revealed that days to flowering completion had maximum direct contribution to seed yield followed by days to pod initiation.

Based on above results, this study demonstrated that duration among reproductive phases are the important yield component traits and they directly lead to increase in grain yield while, selection for quality traits *i.e.* protein content and oil content may indirectly lead to increase in grain yield.

ACKNOWLEDGEMENT

The first author conveys sincere thanks to Dr. (Mrs.) Sunita Sharma, Senior Analyst (Quality), Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana, for her assistance in analysis of quality parameters.

REFERENCES

Agawane, R. B. and Parhe, S. D. 2015. Effect of seed priming on crop growth and seed yield of soybean [Glycine max (L.)Merill]. *The Bioscan* **10(1):** 265-270.

Antalina. 1999. Recent research and industrial achievement for soybean in Japan. *Proceeding of RIELT-JIRCAS. Workshop on soy research.*

Arshad, M., Ali, N. and Ghafoor, A. 2006. Character correlation and path coefficient in soybean (*Glycine max* (L.) Merrill). *Pak J Bot* **38:** 121-30.

Bhat, S. and Basavaraja, G. T. 2011. Genetic variability and correlation studies in segregating generation of soybean (*Glycine max* (L) Merrill). *Crop Impr* **38:** 77-87.

Board, J. E., Kang, M. S. and Harville, B. G. 1997. Path analyses identify indirect selection criteria for yield of late-planted soybean. *Crop Sci* **37:** 879-84.

Board, J. E., Kang, M. S. and Harville, B. G. 1999. Path analyses of the yield formation process for late-planted soybean. *Agron. J.* **91:** 128-35.

Burton, G. W. and Devane, E. H. 1953. Estimating heritability in tall fescue (*Festuca arundinacea*) from replicated clonal material. *Agron. J.* **45:** 475-81.

Choudhary, P., Jhajharia, A. and Kumar, R. 2014. Influence of sulphur and zinc fertilization on yield, yield components and quality traits of soybean [*Glycine max* (L.) Merrill]. *The Bioscan.* **9(1):** 137-142.

Dewey, J. R. and Lu, K. H. 1959. A correlation and path coefficient analysis of components of crested wheat seed production. *Agron. J.* **51:** 515-18.

Dong, Y. S., Zhuang, B. C., Zhao, L. M., Sun, H. and He, M. Y. 2001. The genetic diversity of annual wild soybeans grown in China. *Theor Appl. Genet.* **103:** 98-103.

Fisher, E. A. and Yates, F. (ed) 1963. Statistical tables for Biological Agricultural and Medical Research. *Oliver and Boyd Ltd, Edinburgh.*

Iqbal, S., Mahmood, T., Tahira, Ali, M., Anwar, M. and Sarwar, M. 2003. Path coefficient analysis in different genotypes of soybean [*Glycine max* (L.) Merrill]. *Pak. J. Biol. Sci.* **6:** 1085-87.

Khan, A., Hatam, M. and Khan, A. 2000. Heritability and interrelationship among yield determining components of soybean varieties. *Pak. J. Agric. Res.* **16:** 5-8.

Lush, J. L. 1949. Animal breeding plans. *The collegiate Press Ames, Iowa.*

Malik, M. F. A., Ashraf, M., Qureshi, A. S. and Ghafoor, A. 2007. Assessment of genetic variability, correlation and path analyses for yield and its components in soybean. *Pak. J. Bot.* **39:** 405-13.

Manggoel, W., Uguru, M. I., Ndam, O. N. and Dasbak, M. A. 2012. Genetic variability, correlation and path coefficient analysis of some yield components of ten cowpea (*Vigna unguiculata* (L.) Walp) accessions. *J. Pl. Breed. Crop. Sci.* **4:** 80-86.

Meena, S. and Ghasolia, R. P. 2013. Effect of phosphate solubilizers and fym on microbial population of soybean field [*Glycine max* (L.) Merrill]. *The Bioscan.* **8(3):** 965-968.

Mello Filho, O. L. de., Sediyama, C. S., Moreira, M. A., Reis, M. S., Massoni, C. A. and Piovesan, N. D. 2004. Grain yield and seed quality of soybean selected for high protein content. *Pesquisa Agropecuaria Brasileira.* **39:** 445-50.

Miller, P. A., Williams, J. C., Robinson, H. F. Jr. and Comstock, R. E. 1958. Estimates of genotypic and environmental variances and covariances in upland cotton and their implication in selection. *Agron. J.* **50:** 126-31.

Panse, V. G. and Sukhatme, P. V. 1985. Statistical Methods for Agricultural Workers. *4th Edition, ICAR,* New Delhi.

Ramteke, R., Kumar, V., Murlidharan, P. and Agarwal, D. K. 2010. Study on genetic variability and traits interrelationship among released soy-bean varieties of India (*Glycine max* (L.) Merrill). *Electron J. Pl. Breeding.* **1:** 1483-87.

Recker, R. J. 2010. Analyzing variances and correlations of quantitative traits in two long term randomly mated soybean populations. *M.Sc. thesis, North Carolina State University.*

Shukla, S., Singh, K. and Pushpendra 1998. Correlation and path coefficient analysis of yield and its components in soybean (*Glycine max* (L) Merrill). *Soybean Genet Newsl.* **25:** 67-70.

Swathi, P. 2009. Breeding investigations in vegetable soybean (*Glycine max* (L.) Merrill). *M.Sc. thesis, University of Agricultural Sciences,* Dharwad.

Taware, S. P., Halvankar, G. B., Raut, V. M. and Patil, V. B. 1997. Variability, correlation and path analysis in soybean hybrids. *Soybean Genet Newsl.* **24:** 96-98.