

Correlation and Path Coefficient Analysis for Various Yield Components and Quality Traits in Soybean (*Glycine max* L.)

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Abstract The present investigation was carried out the experimental material was consisted of one soybean variety i.e. PK 1029. Analysis of variance revealed significance differences between treatments for all the 12 quantitative traits under study. Seed yield exhibited highly significant and positive correlation with total dry matter weight per plant ($gr=0.93^{**}$ and $pr=0.92^{**}$) and number of pods per plant ($gr=0.85^{**}$ and $pr=80^{**}$) at both genotypic and phenotypic levels indicating that selection for these traits improve seed yield in soybean. Path coefficient analysis revealed that total dry matter weight per plant had highest positive direct effect on seed yield (0.9642) followed by harvest index (0.3605) and number of pods per plant (0.0844). The results indicated that total dry matter weight per plant and number of pods per plant is responsible for manipulation of seed yield in soybean.

Keywords Correlation, Mutagens, Quality traits, Soybean, Seed yield.

Introduction

Soybean (*Glycine max* L.) is an important *kharif* pulse crop of India which has significant contribution in Indian agriculture economy. It is fourth important edible oil crop in India after groundnut, rapeseed-mustard and sunflower. Among the mutagens used gamma rays are the most widely and effectively used, resulting in about 70% of the worlds mutant varieties. It is essential to know the effects of mutations on correlation coefficient and path coefficient regarding different quantitative traits. Seed yield is complex character and influenced by many environmental factors therefore it is desirable for plant breeder to know the extent of relationship between yield and various components traits which facilitate selection of desirable traits. Interrelationship of various yield components is important in predicting the correlated response to direct and indirect selection and in the detection of traits with much effect as markers traits. The main objective of the present investigation was to analyze the degree and direction of component traits on seed yield in M_3 generations for genetic improvement of soybean mutants.

Materials and Methods

A study was conducted at the NE Borlaug Crop Research Center of Govind Ballabh Pant University of Agriculture and Technology, Pantnagar. The experimental material was consisted of one soybean variety i.e. PK 1029. 1000 dry seeds with moisture content of 10-12% of the cultivar PK 1029 of soybean were treated with three different doses (20kR, 30kR and

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Table 1. Analysis of variance (ANOVA) for yield and its contributing traits in M_3 generation in soybean. **Significant at 1% level of probability, *Significant at 5% level of probability.

Source of variation	df	Mean squares					
		Days to flowering 1	Days to maturity 2	Plant height 3	Primary branches/plant 4	Total dry matter/plant 5	Pods per plant 6
Replication	2	3.53	8.45	45.23	2.75	38.66	32.24
Treatment	10	28.44**	32.23**	92.25**	2.35*	66.62**	105.15**
Error	20	0.63	1.42	11.11	2.12	9.38	26.22

Table 1. Continued.

Source of variation	df	Mean squares					
		Seed per pod 7	Harvest index 8	100 seed weight 9	Protein content 10	Oil content 11	Seed yield per plant 12
Replication	2	0.43	0.23	0.21	0.15	0.11	2.92
Treatment	10	0.54**	0.27**	1.12*	3.21**	0.26**	10.23**
Error	20	0.15	0.48	0.38	0.27	0.54	1.35

40kR) of gamma rays at Bhaba Atomic Research Center, Tromby in Mumbai, with ^{60}Co gamma rays and three different doses, chemical treatment (0.05%, 0.10% and 0.15% of EMS) of Ethyl Methane Sulfonate ($\text{CH}_3\text{SO}_2\text{C}_2\text{H}_5$) of Sigma Ltd. USA was used at GB Pant University of Agricultural and Technology Pantnagar. The treated seeds along with control (untreated seeds) were sown for each genotype with plot size of row to row spacing 60 cm and seed to seed 10 cm. The experimental material was comprised of 11 treatments along with two controls (Dry seed PK 1029 and Pre-soaked seed PK 1029). The individual seed of M_1 plant progenies were sown to raise M_2 progeny and seeds from 500 M_3 plants were harvested individually in each treatment and M_4 progeny raised in separate rows of 5.0 m length and plant to plant distance was 10-20 cm in randomized complete block design with three replications in *kharif* season of 2012 and finally 50 seeds were sown in each row of 5 m length to raised M_4 generations. Uniform cultivation method and agricultural practices were followed for to raise M_1 , M_2 , M_3 and M_4 generations. Observations were recorded in M_3 and M_4 for various yield components and quality traits namely, days to 50% flowering, days to maturity, plant height (cm), number of primary branches per plant, dry matter weight per plant (g), number of pods per plant, number of seeds per pod, harvest index (g), 100 seed weight (g), oil contain (%), protein contain (%) and seed yield

per plant (g). The data were subjected to analysis of variance, correlation and path analysis were computed by using statistical package WINDOSTAT version 8.6 developed by INDOSTAT Service Hyderabad. Analysis of variance was done by the method suggested by Panse and Sukhatme [1]. The correlation coefficients and path coefficient were worked out by the methods suggested earlier [2, 3] respectively.

Results and Discussion

Analysis of variance revealed significance differences between treatments for all the quantitative traits under study and presented in (Table 1). The differences were highly significant for days to flowering, days to maturity, plant height, total dry matter per plant, number of pods per plant, number of seeds per pod, harvest index, seed yield per plant, oil content and protein content whereas significant for primary branches per plant and 100 seed weight. Similar findings were also reported by Dhaka et al. [4] cowpea and Durai et al. [5] in soybean.

Genotypic and phenotypic correlations between all characters among the mutagenic treatments along with control in soybean are presented in (Table 2). In general, genotypic correlations were higher than the phenotypic correlations. Seed yield per plant exhib-

Table 2. Estimates of genotypic and phenotypic correlation between yield and its contributing traits in M₃ generation in soybean. *, **denotes significance of correlation coefficient at 5% and 1% respectively.

		Days to flower- ing	Days to matu- rity	Plant height	Primary branches per plant	Total dry mater	Pods per plant	Seeds per pod	Harvest index	100 seed weight	Protein content	Oil content	Seed yield per plant
Days to flowering	gr	1	-0.13	0.24	-0.083	0.047	-0.090	-0.047	-0.083	-0.16	-0.015	0.051	0.018
	pr	1	-0.047	0.14	-0.014	-0.023	-0.017	-0.0019	-0.019	-0.11	0.014	-0.090	-0.026
Days to maturity	gr		1	-0.078	0.041	-0.028	-0.073	0.012	-0.0076	-0.071	0.074	0.097	-0.030
	pr		1	-0.055	0.050	-0.035	-0.055	0.0091	-0.0034	-0.623	0.088	0.041	-0.035
Plant height	gr			1	0.21	0.065	-0.077	0.165	-0.164	-0.228	-0.137	0.0099	0.015
	pr			1	0.044	0.045	-0.048	0.17	-0.14	-0.13	-0.088	-0.0030	-0.0006
Primary branches/plant	gr				1	0.35	0.47	0.0021	0.20	0.098	-0.12	0.019	0.44
	pr				1	0.29	0.38	0.022	0.11	0.097	-0.077	-0.010	0.35
Total dry matter/plant	gr					1	0.82**	0.24	-0.27	0.26	0.068	-0.10	0.93**
	pr					1	0.75**	0.19	-0.31	0.23	0.038	0.011	0.92**
Pods per plant	gr						1	0.14	-0.035	0.012	-0.019	0.058	0.85**
	pr						1	0.14	-0.025	0.051	-0.018	0.026	0.80**
Seeds per pod	gr							1	-0.086	0.047	-0.070	-0.042	0.24
	pr							1	-0.11	0.015	-0.084	0.070	0.16
Harvest index	gr								1	0.18	-0.049	0.10	0.068
	pr								1	0.12	-0.019	0.0024	0.061
100-seed weight	gr									1	0.0070	-0.0008	0.34
	pr									1	0.053	-0.099	0.28
Protein content	gr										1	-0.64*	-0.038
	pr										1	-0.60*	-0.028
Oil content	gr											1	0.046
	pr											1	0.012

ited highly significant and positive correlation with total dry matter weight per plant ($rg=0.93$ and $rp=0.92$) and number of pods per plant ($rg=0.85$ and $rp=0.80$), while number of primary branches ($rg=0.44$ and $rp=0.35$), 100 seed weight ($rg=0.34$ and $rp=0.28$), number of seeds per pod ($rg=0.24$ and $rp=0.16$), harvest index ($rg=0.068$ and $rp=0.061$), oil content ($rg=0.046$ and $rp=0.011$), were non-significant and positively correlated with yield at both genotypic and phenotypic levels, respectively. The plant height ($rg=-0.0006$) was negatively correlated with yield at phenotypic level. The significant and positive correlation between seed yield and number of pods per plant were reported by a number of workers viz. Mehetre et al. [6] and Jain et al. [7] who reported that number of pods per plant is a reliable trait for improving the grain yield in soybean. The number of pod per plant was highly significant and positively correlated with total dry matter ($rg=0.81$ and $rp=0.75$) and seed yield per plant ($rg=0.85$ and $rp=0.80$). The number of pods per plant had positive correlation with number of primary branches per plant ($rg=0.47$ and $rp=0.38$), number of seeds per plant

($rg=0.14$ and $rp=0.13$), 100 seed weight ($rg=0.012$ and $rp=0.051$) and oil content ($rg=0.059$ and $rp=0.26$). The results obtained were similar to the earlier findings [8]. Total dry matter weight per plant showed highly significant and positive correlation with number of pods per plant ($rg=0.81$ and $rp=0.75$) and seed yield per plant ($rg=0.93$ and $rp=0.92$), 100 seed weight had positive correlation with total dry matter ($rg=0.20$ and $rp=0.22$), protein content ($rg=0.0070$ and $rp=0.053$) and seed yield per plant ($rg=0.33$ and $rp=0.28$), whereas protein content showed significant negative correlation with oil content ($rg=-0.64$ and $rp=-0.60$) and non-significant correlation with seed yield per plant ($rg=-0.038$ and $rp=-0.028$) at genotypic and phenotypic levels, respectively. Similar findings were also reported earlier [7, 8] for different yield components.

The path coefficient analysis was used to partition the correlation coefficients of all the component characters studied with seed yield into direct and indirect effects. The result of various causes influencing seed yield (direct and indirect effects) are shown

Table 3. Path coefficient showed direct and indirect effect of 11 traits on seed yield at phenotypic and genotypic level in M₃ generation. Residual factor 0.1058.

Characters	Yield	Days to flowering	Days to maturity	Plant height	Primary branches/plant	Total dry matter
Days to 50% flowering	-0.026	0.0047	-0.0002	0.0007	-0.0001	-0.0001
Days to maturity	-0.035	-0.0003	0.0064	-0.0004	0.0003	-0.0002
Plant height	-0.0006	0.0015	-0.0006	0.0106	0.0005	0.0005
Primary branches/plant	0.35	0.0001	-0.0003	-0.0003	-0.0062	-0.0018
Total dry matter/plant	0.92**	-0.0220	-0.0338	0.0439	0.2813	0.9642
Pods per plant	0.80**	-0.0015	-0.0046	-0.0041	0.0322	0.0637
Seeds per pod	0.16	0.0000	0.0001	0.0013	0.0002	0.0015
Harvest index	0.061	-0.0068	-0.0012	-0.0498	0.0397	-0.1107
100-seed weight	0.28	-0.0022	-0.0004	-0.0026	0.0019	0.0044
Protein content	-0.028	0.0000	-0.0002	0.0002	0.0001	-0.0001
Oil content	0.012	0.0001	-0.0001	0.0000	0.0000	0.0000
Character	Yield					
Days to 50% flowering	0.018	0.0224	-0.0028	0.0054	-0.0019	0.0011
Days to maturity	-0.030	-0.0022	0.0172	-0.0013	0.0007	-0.0005
Plant height	0.015	0.0073	-0.0024	0.0303	0.0063	0.0020
Primary branches/plant	0.44	0.0007	-0.0003	-0.0017	-0.0081	-0.0028
Total dry matter plant	0.93**	0.0412	-0.0241	0.0566	0.3021	0.8670
Pods per plant	0.85**	-0.0141	-0.0114	-0.0120	0.0731	0.1281
Seeds per pod	0.24	-0.0012	0.0003	0.0042	0.0001	0.0061
Harvest index	0.068	-0.0256	-0.0023	-0.0508	0.0624	-0.0843
100-seed weight	0.34	-0.0108	-0.0047	-0.0151	0.0065	0.0171
Protein content	-0.038	0.0000	0.0001	-0.0002	-0.0002	0.0001
Oil content	0.046	0.0001	0.0002	0.0000	0.0000	-0.0002

Table 3. Continued.

Characters	Indirect effects					
	Pods per plant	Seeds per pod	Harvest index	100 seed weight	Protein content	Oil Content
Days to 50% flowering	-0.0001	0.0000	-0.0001	-0.0005	0.0001	-0.0004
Days to maturity	-0.0004	0.0001	0.0000	-0.0001	0.0006	0.0003
Plant height	-0.0005	0.0018	-0.0015	-0.0014	-0.0009	0.0000
Primary branches/plant	-0.0024	-0.0001	-0.0007	-0.0006	0.0005	0.0001
Total dry matter/plant	0.7281	0.1842	-0.2961	0.2183	0.0367	0.0107
Pods per plant	0.0844	0.0115	-0.0021	0.0043	-0.0015	0.0022
Seeds per pod	0.0011	0.0078	-0.0009	0.0001	-0.0007	0.0005
Harvest index	-0.0089	-0.0411	0.3605	0.0420	-0.0068	0.0009
100-seed weight	0.0010	0.0003	0.0023	0.0196	0.0010	-0.0019
Protein content	0.0000	0.0002	0.0000	-0.0001	-0.0018	0.0011
Oil content	0.0000	-0.0001	0.0000	0.0002	0.0009	-0.0016
Character	Indirect effects					
Days to 50% flowering	-0.0020	-0.0011	-0.0019	-0.0037	-0.0003	0.0011
Days to maturity	-0.0013	0.0002	-0.0001	-0.0012	0.0013	0.0017
Plant height	-0.0023	0.0050	-0.0050	-0.0069	-0.0042	0.0003
Primary branches/plant	-0.0038	0.0000	-0.0016	-0.0008	0.0010	-0.0002
Total dry matter plant	0.7108	0.2120	-0.2367	0.2249	0.0594	-0.0898
Pods per plant	0.1563	0.0217	-0.0054	0.0019	-0.0030	0.0092
Seeds per pod	0.0035	0.0251	-0.0022	0.0012	-0.0018	-0.0011
Harvest index	-0.0107	-0.0267	0.3089	0.0559	-0.0152	0.0316
100-seed weight	0.0008	0.0031	0.0120	0.0661	0.0005	-0.0001
Protein content	0.0000	-0.0001	-0.0001	0.0000	0.0014	-0.0009
Oil content	0.0001	-0.0001	0.0002	0.0000	-0.0011	0.0017

in (Table 3) at the phenotypic as well as genotypic levels, respectively. A critical perusal of phenotypic path coefficient analysis revealed that total dry matter weight per plant had the highest direct effect on seed yield per plant (0.9642) followed by harvest index (0.3605), number of pods per plant (0.0844). The largest negative direct effect was that of number of primary branches per plant (-0.0062) followed by protein content (-0.0018) and oil content (-0.0016). The residual effect at the phenotypic level was 0.0470 and at the genotypic level was 0.0176.

Path coefficient analysis showed that total dry matter weight per plant had highest direct effect on seed yield at both genotypic and phenotypic levels followed by number of pods per plant, harvest index, number of seeds per plant, number of primary branches per plant and 100 seed weight. These results are similar to the earlier findings [6, 7] in soybean Kharkwal [8] reported that harvest index and number of pods per plant had the highest positive direct effect on seed yield whereas Chandra et al. [9] reported positive direct effect of harvest index on seed yield in chickpea. These results are suggested that selection for the traits showing positive direct effect on seed yield may be advantageous in terms of bringing improvement in yield in soybean.

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