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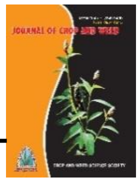

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Evaluation of growth and developmental behaviour of soybean [*Glycine max* (L.) Merrill] and their multicollinearity under the influence of detopping and mepiquat chloride application

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ABSTRACT

The present investigation was conducted to evaluate the growth rate, and path analysis for sixteen characters of soybean cv. SL 744 during 2014 and 2015. The experiment was laid out in randomized complete block design having 8 treatments including control, detopping and foliar spray of mepiquat chloride (MC) in three doses and at two different intervals which were replicated four times. During 2014, two sprays of MC @ 200 and 250 ppm registered 46.0 and 37.7 per cent higher NAR as compared to control (0.50 mg cm^{-2} day^{-1} respectively. Furthermore, in 2015, maximum NAR was reported by two sprays of MC @ 250 ppm and found statistically at par with detopping, but significantly higher (36.7%) than control (0.49 mg cm^{-2} day^{-1}). Seed yield showed a positive and significant correlation with accumulation of dry matter (80, 110 DAS and at harvest), specific leaf weight (80 and 110 DAS) and pods per plant in both 2014 and 2015. In 2014, pod setting percentage followed by number of flowers plant^{-1}, LAI (110 DAS) and accumulation of dry matter at harvest showed highest positive direct relation with seed yield. But in 2015, highest positive direct effect on seed yield was exhibited by flowers plant^{-1} followed by accumulation of dry matter at harvest, accumulation of dry matter at 110 DAS and specific leaf weight at 110 DAS. Results of the investigation clearly demonstrated that to enhance the growth rate of soybean, farmers can either go for detopping at 50-55 DAS or sequential application of MC @ 200 or 250 ppm at two growth stages.

Keywords: Correlation coefficient, detopping, growth indices, mepiquat chloride, path analysis, soybean

Soybean (*Glycine max* L.) is not only known as an important protein source but also for edible oil (Kaur *et al.*, 2006). Its seed consists of good quality protein and oil to the extent of 40 and 20% respectively. In pulse crops, major evolutionary aspect includes indeterminate growth behaviour as a positive manipulation under concurrent drought periods. Recurrent droughts in these regions suppress growth of pulse crops. At the same time, growth habit (indeterminate type) proves to be a beneficial process to cope up the drought and less water availability. On revival of optimum soil moisture, regained vegetative and reproductive growth becomes major supplier of assimilates to growing pods. On the contrary, cultivation of soybean under irrigated conditions faces various complications due to indeterminate behaviour in respect of growth and development including excessive vegetative growth, and enhanced level of competition between vegetative and reproductive parts. Disturbance of source-sink relationship results in shedding of flowers and pods as flower and pod setting are regulated by the movement of prepared food towards developing flowers and pods, therefore, a balance of assimilate supply needs to be managed to maintain the integrity of the whole process which can prove worth in combating internal disorders in soybean. Mepiquat chloride (MC) application registered significant effect on dry matter per plant, pod weight, number of pods per plant and seed yield of summer greengram (Sandhu *et al.*, 2015). Nipping of field pea at 30 days after sowing resulted in significant increase in branches plant^{-1}, pods plant^{-1}, and seed yield (Singh and Devi, 2006). Jaidka *et al*. (2018) reported significant improvement in crop growth indices in response to detopping and foliar application of mepiquat chloride.

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Two of the statistical methods to indicate interaction between different parameters are correlation coefficient and study of direct and indirect effects (Haghi *et al.* 2012). Rodrigues *et al.* (2010) emphasized that the correlation coefficient does not explains the actual cause and effect relation of attributes, which can be misinterpreting when the better correlation between the attributes is as a result of indirect effect by other characters. The path analysis permits logical understanding about the relation among various attributes by segregation of correlation coefficients into direct and indirect effects. In soybean, Bizeti and co-workers (2004), Arshad and co-workers (2006), and Chavan *et al.* (2016) emphasized use of path analysis for assessment of character association under multicollinearity. Malik *et al.* (2006) reported a highly positive and statistically significant correlation coefficient between grain yield of soybean and pods plant^{-1}. Present research was planned and conducted to study the role of detopping and MC on crop growth and segregation of correlations between various attributes and grain yield into direct and indirect effects through path coefficient analysis.

MATERIALS AND METHODS

An experiment was conducted in instructional farm of Punjab Agricultural University, Ludhiana, in 2014 and 2015 (*kharif*). The experiment was designed in Randomised Complete Block Design with eight treatments i.e., control, detopping (cutting 5 cm top portion) at 50-55 days after sowing (DAS), mepiquat chloride (MC) @ 200 ppm (50-55 DAS), MC @ 200 ppm (50-55 + 65-70 DAS), MC 250 ppm (50-55 DAS), MC @ 250 ppm (50-55 + 65-70 DAS), MC @ 300 ppm (50-55 DAS) and MC @ 300 ppm (50-55 + 65-70 DAS). Each treatment was replicated four times. Soybean cv. SL 744 was sown on 13-06-2014 in 2014 and 08-06-2015 in 2015 practising *pora* method with seed @ 75 kg ha^{-1} and 45 cm (R-R) ×5 cm (P-P) crop geometry. Nitrogen and phosphorus were supplied through urea and single super phosphate @ 70 and 500 kg ha^{-1} respectively. Soil of the experimental area has pH value 7.8, EC 0.20 dS m^{-1}, medium in organic carbon content, and high in phosphorus and potassium availability. The weather parameters noted in meteorological observatory of the university during both the years is presented in Fig.- 1.

Data were recorded on days taken to 50% seedling emergence, days to first floral initiation, days to first pod initiation and days to seed development from five randomly selected pods.

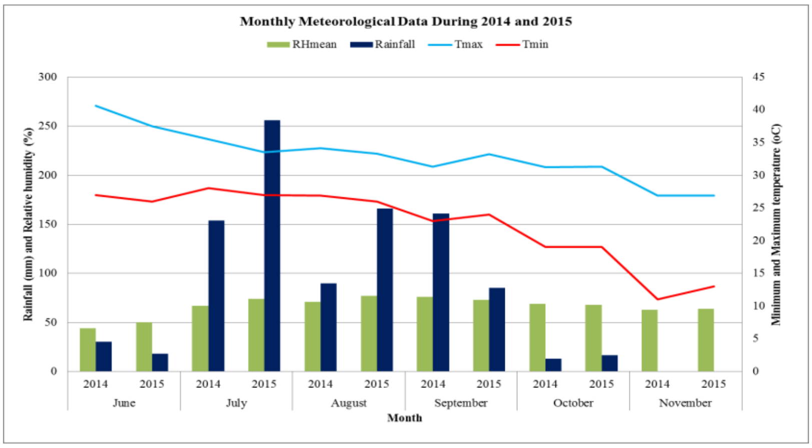

Fig. 1: Weather data of two growing seasons

The data on days taken to complete the seed development was noted on the basis of proportion of the pod cavity filled by developing seeds. Growth indices were calculated with the methods as follow:

$$\text{Crop growth rate (CGR)} = \frac{(W_2 - W_1)}{(T_2 - T_1)\,P}$$

Where,

W_1 – Dry matter (g) at time T_1 (days)
W_2 – Dry matter (g) at time T_2 (days)
P – Ground area (m^2)

$$\text{Relative growth rate (RGR)} = \frac{\log_e W_2 - \log_e W_1}{T_2 - T_1}$$

Where,

W_1 - Dry matter (g) at time T_1 (days)
W_2 – Dry matter (g) at time T_2 (days)

$$\text{Net assimilation rate (NAR)} = \frac{(W_2 - W_1)\,(\log_e L_2 - \log_e L_1)}{(T_2 - T_1)\,(L_2 - L_1)}$$

Where,

W_1 - Dry matter (g) at time T_1 (days)
W_2 – Dry matter (g) at time T_2 (days)
L_1 – Leaf area (cm^2) at time T_1 (days)
L_2 – Leaf area (cm^2) at time T_2 (days)

Statistical analysis

The statistical analysis was performed through general linear model procedure (SAS Software 9.2) by application of DMRT and least significant difference. Multicollinearity analysis was done according to Dewey and Lu (1959) following the 'Do Little' methods as:

$$Py_1 + Py_2.r_{12} + Py_3.r_{13} + ……. + Pyn.r_1n = ry_1$$
$$Py_1.r_{12} + Py_2 + Py_3.r_{23} + ……. + Pyn.r_2n = ry_2$$
$$Py_1.r_{13} + Py_2.r_{23} + Py_3 + ……. + Pyn.r_3n = ry_3$$
$$Py_1.rn_{12} + Py_2 + Py_3.rn_3 + ……. + Pyn = ry_n$$

where Py_1, Py_2, Py_3…. Py_n are the direct path effects of 1, 2, 3… n variables on the dependent variable 'y'. r_{12}, r_{13} …. r_1n ….. r(n-1)n are the possible coefficients of correlation between various independent variables, and ry_1, ry_2, …. ry_n are the coefficients of correlation between independent variables and dependent variable 'y'.

RESULTS AND DISCUSSION

Growth indices

In 2014, CGR of control was significantly lower than all other treatments. Both detopping and two sprays of MC @ 250 ppm resulted in higher crop growth rate (21.4 %) over control (0.14 g m^{-2} day^{-1}). Similarly in 2015, application of mepiquat chloride as well as detopping resulted in significantly higher CGR than control. Two sprays of MC @ 250 ppm as well as detopping resulted in significantly higher (28.6 % each) CGR in comparison with control (0.14 g m^{-2} day^{-1}) (Table 1). During 2014, the highest value of RGR was recorded by detopping, which was statistically equal with two sprays of MC @ 200 and 250 ppm. Increase in RGR by detopping and two sprays of MC @ 250 ppm (0.078 g g^{-1} day^{-1}) was 14.1 and 11.5 per cent in comparison with control, respectively. In 2015, detopping and two sprays of MC @ 250 ppm led to 8.1 and 10.5 % increase in RGR than control (0.086 g g^{-1} day^{-1}), respectively. During 2014, two sprays of MC @ 200 and 250 ppm registered 46.0 and 37.7 per cent higher NAR as compared to control (0.50 mg cm^{-2} day^{-1}), respectively. Detopping also significantly increased the NAR by 40.0% as compared to control. Furthermore, in 2015, highest NAR was resulted by two sprays of MC @ 250 ppm, which was found statistically equal to detopping but significantly higher (36.7 %) as compared to control (0.49 mg cm^{-2} day^{-1}). Increase in growth rate due to detopping may be the result of stimulation of suppressed side primordia by arresting the terminal growth. MC regulated enhanced accumulation of photosynthates in response to increased SPAD value, SLW, decreased LAI resulting in increased rate of growth. These changes in the plant system and morphology lead to efficient canopy photosynthesis, lesser parasitism among leaves, more availability of assimilates, and more dry matter accumulation over the course of time.

Crop phenology

Detopping and spray of MC did not have any significant effect on all the phenological stages during both the crop years (Table 2). The results pertaining to change in crop phenology under the influence of detopping and MC are accordance with Sandhu *et al.* (2015), who concluded that detopping and MC could not significantly affect the phenology of summer greengram.

Correlation coefficient

Seed yield of soybean reported positive and significant phenotypic correlation (Table 3 and 4) with accumulation of dry matter (80, 110 DAS and at harvest), SLW at 80 and 110 DAS, and number of pods $plant^{-1}$ during both the years. Kumar and co-workers (2014) also recorded significant and positive phenotypic correlation coefficient between grain yield and total biomass production. Grain yield showed negative correlation with leaf area index (80 and 110 DAS) and abscission of reproductive parts. Grain yield and 100-seed weight showed a non-significant phenotypic correlation coefficient during 2014, which is in line with Iqbal *et al.* (2003). But grain yield exhibited positive and significant phenotypic correlation coefficient with 100-seed weight during 2015, which is in accordance with El-Badawy *et al.* (2012) and Nagarajan *et al.* (2015). Pods $plant^{-1}$ had positive and significant correlation with accumulation of dry matter (80, 110 DAS and at harvest), SLW (80 and 110 DAS), flowers per plant which is consonance with the observations of Kumar *et al.* (2014). Significant and positive correlation coefficient between grain yield and pods $plant^{-1}$ is in line with Nagarajan *et al.* (2015) and Silva *et al.* (2015). Negative correlation coefficient depicted between grain yield and leaf area index can be attributed to anti-gibberellin properties of mepiquat chloride that inhibit the synthesis of gibberellins by refraining the cyclization process of geranyl pyrophosphate to copalyl pyrophosphate (Halmann, 1990). Accumulation of dry matter at all growth stages, SLW (80 and 110 DAS), pods $plant^{-1}$, 100-seed weight and LAI were important characters which affected the seed yield to a large extent.

Path coefficient analysis

In 2014 (Table 5), setting percentage followed by flowers $plant^{-1}$, LAI at 110 DAS, dry matter accumulation at harvest, dry matter accumulation at 110 DAS, SPAD value at 80 DAS, accumulation of dry matter (80 DAS), abscission of reproductive parts, SLW at 110 DAS and 100-grain weight depicted maximum positive direct effect on grain yield.

Table 1: Effect of detopping and foliar spray of mepiquat chloride on growth rate

Treatment	CGR ($g\ m^{-2}\ day^{-1}$)		RGR ($g\ g^{-1} day^{-1}$)		NAR ($mg\ cm^{-2}\ day^{-1}$)	
	2014	**2015**	**2014**	**2015**	**2014**	**2015**
Control	0.14 d	0.14 d	0.078 d	0.086 d	0.50 b	0.49 b
Detopping	0.17 a	0.18 a	0.089 a	0.093 b	0.70 a	0.67 a
Mepiquat Chloride @ 200 ppm at 50-55 DAS	0.15 c	0.16 c	0.082 c	0.090 c	0.53 b	0.61 a
Mepiquat Chloride @ 200 ppm at 50-55+65-70 DAS	0.16 b	0.17 b	0.087 ab	0.095 ab	0.73 a	0.64 a
Mepiquat Chloride @ 250 ppm at 50-55 DAS	0.16 b	0.16 c	0.083 c	0.092 bc	0.69 a	0.61 a
Mepiquat Chloride @ 250 ppm at 50-55+65-70 DAS	0.17 a	0.18 a	0.088 a	0.096 a	0.73 a	0.67 a
Mepiquat Chloride @ 300 ppm at 50-55 DAS	0.16 b	0.16 c	0.083 c	0.090 c	0.71 a	0.66 a
Mepiquat Chloride @ 300 ppm at 50-55+65-70 DAS	0.16 b	0.16 c	0.084 bc	0.092 bc	0.76 a	0.63 a
SE_m (±)	**0.002**	**0.002**	**0.0008**	**0.0006**	**0.01**	**0.01**
P(F)	**0.02**	**<0.0001**	**0.004**	**<0.0001**	**<0.0001**	**0.006**

But direct effect i.e., maximum negative, on grain yield was shown by pods plant^{-1} followed by LAI (80 DAS), specific leaf weight at 80 DAS, SPAD value at 110 DAS and specific leaf weight at maturity. Although pods/plant exhibited maximized negative direct effect on productivity, at the same time it showed strong positive indirect effect through accumulation of dry matter (at harvest), flowers plant^{-1} and setting percentage. During 2015 (Table 6), highest positive direct effect on productivity was depicted by flowers plant^{-1} followed by accumulation of dry matter (at harvest), specific leaf weight at 110 DAS, LAI (110 DAS), 100-seed weight and SPAD value at 80 DAS. But highest negative direct effect was observed in case of pods per plant followed by abscission of reproductive parts, specific leaf weight at maturity, pod setting percentage, SPAD value at 110 DAS, LAI (80 DAS), accumulation of dry matter accumulation (80 DAS) and specific leaf weight at 80 DAS. Similar to 2014, pods plant^{-1} showed strong positive indirect effect via accumulation of dry matter (at harvest) and flowers/plant. As per Singh and Choudhary (1985), if correlation coefficient is positive but direct effect is negative, then indirect effect might be causal factor of correlation e.g., pods plant^{-1} and SLW (80 DAS), positive correlation with grain yield but negative direct effect which means that selection for pods plant^{-1} and SLW at 80 DAS can be made through indirect routes like flowers plant^{-1} and accumulation of dry matter, respectively. Iqbal *et al.* (2003), El-Badawy *et al.* (2012), Silva *et al.* (2015), Pawar *et al.* (2020) and Lodhi *et al.* (2023) reported positive direct effect of 100-grain weight on grain yield of soybean. Positive direct effect of accumulation of dry matter and negative direct effect of pods plant^{-1} on grain yield remain in corroboration with the findings of Kumar *et al.* (2014), Mathivanthana *et al.* (2015) and Naveed *et al.* (2012).

Table 2: Effect of detopping and foliar spray of mepiquat chloride (MC) on crop phenology

Treatment	Days to Emergence		Days to floral initiation		Days to pod initiation		Days to seed development initiation		Days to full seed development		Days to physiological maturity	
	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Control	7.1^{ns}	7.2^{ns}	52.2^{ns}	51.6^{ns}	62.8^{ns}	62.6^{ns}	89.7^{ns}	90.6^{ns}	112.2^{ns}	110.1^{ns}	138.5^{ns}	138.6^{ns}
Detopping	7.1	7.3	51.8	52.1	62.7	62.9	90.4	91.5	111.6	112.5	138.8	139.0
MC @ 200 ppm at 50-55 DAS	7.2	7.1	51.7	52.0	61.9	62.9	89.3	90.0	110.8	111.7	138.8	137.9
MC @ 200 ppm at 50-55+65-70 DAS	7.1	7.3	52.6	51.9	62.6	62.6	92.2	92.2	111.3	112.0	138.3	138.3
MC @ 250 ppm at 50-55 DAS	7.2	7.3	51.8	52.1	62.7	62.9	89.6	90.5	112.3	111.9	138.3	138.0
MC @ 250 ppm at 50-55+65-70 DAS	7.2	7.2	51.9	52.0	62.8	62.9	90.8	89.9	110.9	110.3	138.4	138.8
MC @ 300 ppm at 50-55 DAS	7.1	7.4	52.1	52.2	62.5	63.0	90.8	91.1	112.5	111.7	138.6	139.2
MC @ 300 ppm at 50-55+65-70 DAS	7.1	7.3	52.1	51.9	62.8	62.8	92.6	90.4	111.6	111.2	138.5	137.9
SE_m (±)	**0.13**	**0.11**	**0.12**	**0.12**	**0.13**	**0.16**	**0.86**	**1.02**	**0.67**	**0.84**	**0.14**	**0.18**
P(F)	**0.99**	**0.99**	**0.71**	**0.99**	**0.81**	**0.45**	**0.98**	**0.99**	**0.99**	**0.99**	**0.97**	**0.47**

Table 3: Phenotypic correlation coefficient of different attributes and grain yield during 2014

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0.9299**	0.2478	0.2958	0.2339	-0.4520	-0.5668	0.6930**	-0.7642	-0.7521	0.3647*	0.7159**	-0.1519	-0.5415	-0.9117	-0.1186
2	-	0.1659	0.2318	0.1484	-0.5013	-0.7034	0.6526**	-0.8006	-0.7955	0.3543	0.7314**	-0.1771	-0.5698	-0.9304	-0.1103
3		-	0.8465**	0.8282**	0.5035**	0.4362*	0.6017**	-0.0279	0.1012	0.6780**	0.2942	0.5705**	0.2444	-0.0294	0.6254**
4			-	0.9112**	0.5907**	0.4288*	0.6727**	-0.0790	0.0398	0.7240**	0.2683	0.6469**	0.3051	-0.1187	0.6539**
5				-	0.5816**	0.4739**	0.6289**	-0.0458	0.0872	0.6665**	0.2143	0.6225	0.3298	-0.0841	0.7323**
6					-	0.7780**	0.0759	0.5003**	0.5459**	0.1880	-0.3653	0.5259**	0.6020**	0.5836**	0.5396**
7						-	-0.0945	0.6340**	0.7295**	0.1037	-0.5053	0.5400**	0.6893**	0.7003**	0.5471**
8							-	-0.5576	-0.4548	0.5768**	0.5588**	0.2315	-0.1680	-0.6503	0.2612
9								-	0.8187**	-0.1385	-0.5379	0.2766	0.5031**	0.8577**	0.1307
10									-	-0.0960	-0.6103	0.3870*	0.6441**	0.8598**	0.2794
11										-	0.5645**	0.7340**	0.1862	-0.2496	0.2873
12											-	-0.1462	-0.7014	-0.7042	-0.1868
13												-	0.8003**	0.2801	0.4980**
14													-	0.6248**	0.5021**
15														-	0.1972

Table 4: Phenotypic correlation coefficient of different attributes and grain yield during 2015

	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	0.9121**	0.1665	0.0887	0.2779	-0.5219	-0.6489	0.6711**	-0.4547	-0.6555	0.2288	0.6755**	-0.3139	-0.6099	-0.8800	-0.3162
2	-	0.1993	0.0460	0.2631	-0.4687	-0.7851	0.7165**	-0.5019	-0.7310	0.2680	0.6955**	-0.2853	-0.6070	-0.9276	-0.3725
3		-	0.8257**	0.8172**	0.5598**	0.2875	0.5410**	0.1176	-0.0209	0.5609**	0.0609	0.6036**	0.3661*	-0.0008	0.5143**
4			-	0.9097**	0.6063**	0.4683**	0.6071**	0.0670	0.0961	0.5905**	0.0074	0.6842**	0.4585*	0.1123	0.6533**
5				-	0.4770**	0.2211	0.7768**	-0.0947	-0.0379	0.5645**	0.01500	0.5311**	0.2696	-0.1463	0.5459**
6					-	0.6924**	-0.0566	0.3367	0.5057**	0.3120	-0.3601	0.6750**	0.6546**	0.6220	0.6408**
7						-	-0.3012	0.5331**	0.6489**	0.1144	-0.5159	0.5780**	0.6872**	0.8329	0.6488**
8							-	-0.4259	-0.4695	0.4686**	0.4827**	0.1675	-0.1713	-0.6661	0.0651
9								-	0.5234**	-0.0898	-0.4257	0.2614	0.4276*	0.5887	0.3019
10									-	-0.0706	-0.4938	0.3426	0.5218**	0.7579	0.2212
11										-	0.5507**	0.6954**	0.1136	-0.0854	0.3001
12											-	-0.2169	-0.7627	-0.6060	-0.1846
13												-	0.7895**	0.4218	0.5100**
14													-	0.6398	0.4451*
15														-	0.4855**

*Note: Critical value of 'r' at 0.05= 0.3609 and at 0.01= 0.4629; * and ** significant at 0.05 and 0.01, respectively*

1-leaf area index (80 DAS), 2-leaf area index (110 DAS), 3-accumulation of dry matter (80 DAS), 4- accumulation of dry matter (110 DAS), 5- accumulation of dry matter (at maturity), 6- SLW (80 DAS), 7- SLW (110 DAS), 8- SLW (at maturity), 9- SPAD at 80 DAS, 10- SPAD at 110 DAS, 11- flowers per plant, 12- shedding of reproductive parts, 13- pods/plant, 14- fruiting percentage, 15- 100-grain weight, 16- grain yield

Table 5: Segregation of correlation coefficient of different growth parameters on grain yield during 2014

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	**-0.9624**	0.7794	0.0586	0.1991	0.1702	0.3016	-0.1083	-0.0696	-0.1938	0.1794	0.4615	0.1403	0.5164	-1.5217	-0.0695	-0.1186
2	-0.8949	**0.8381**	0.0392	0.1560	0.1080	0.3345	-0.1343	-0.0656	-0.2030	0.1898	0.4483	0.1433	0.6022	-1.6011	-0.0709	-0.1103
3	-0.2385	0.1390	**0.2365**	0.5698	0.6027	-0.3360	0.0833	-0.0604	-0.0071	-0.0241	0.8579	0.0576	-1.9399	0.6868	-0.0022	0.6254
4	-0.2847	0.1943	0.2002	**0.6731**	0.6632	-.3941	0.0819	-0.0676	-0.0200	-0.0095	0.9161	0.0526	-2.1997	0.8572	-0.0090	0.6539
5	-0.2251	0.1244	0.1959	0.6133	**0.7278**	-0.3881	0.0905	-0.0632	-0.0116	-0.0208	0.8434	0.0420	-2.1165	0.9267	-0.0064	0.7323
6	0.4350	-0.4201	0.1191	0.3976	0.4233	**-0.6673**	0.1486	-0.0076	0.1268	-0.1302	0.2379	-0.0716	-1.7881	1.6917	0.0445	0.5396
7	0.5455	-0.5895	0.1032	0.2886	0.3449	-0.5191	**0.1910**	0.0095	0.1607	-0.1740	0.1312	-0.0990	-1.8360	1.9368	0.0534	0.5471
8	-0.6669	0.5469	0.1423	0.4527	0.4577	-0.0506	-0.0181	**-0.1005**	-0.1414	0.1085	0.7299	0.1095	-0.7872	-0.4721	-0.0495	0.2612
9	0.7355	-0.6710	-0.0066	-0.0532	-0.0333	-0.3338	0.1211	0.0560	**0.2535**	-0.1953	-0.1752	-0.1054	-0.9405	1.4135	0.0653	0.1307
10	0.7239	-0.6667	0.0239	0.268	0.0635	-0.3642	0.1393	0.0457	0.2076	**-0.2385**	-0.1215	-0.1196	-1.3160	1.8099	0.0655	0.2794
11	-0.3510	0.2969	0.1604	0.4873	0.4851	-0.1255	0.0198	-0.0579	-0.0351	0.0229	**1.2654**	0.1106	-2.4958	0.5233	-0.0190	0.2873
12	-0.6889	0.6130	0.0696	0.1806	0.1560	0.2437	-0.0965	-0.0561	-0.1364	0.1456	0.7143	**0.1960**	0.4971	-1.9710	-0.0537	-0.1868
13	0.1462	-0.1485	0.1349	0.4354	0.4530	-0.3509	0.1031	-0.0233	0.0701	-0.0923	0.9288	-0.0286	**-3.4001**	2.2487	0.0213	0.4980
14	0.5212	-0.4776	0.0578	0.2053	0.2400	-0.4017	0.1316	0.0169	0.1275	-0.1536	0.2357	-0.1374	-2.7211	**2.8099**	0.0476	0.5021
15	0.8774	-0.7798	-0.0070	-0.0799	-0.0612	-0.3894	0.1337	0.0653	0.2175	-0.2051	-0.3159	-0.1380	-0.9524	1.7558	**0.0762**	0.1972

Note: Unexplained (residual) variation= 0.1129

Table 6: Segregation of correlation coefficient of different growth parameters on grain yield during 2015

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1	**-0.4172**	0.5130	-0.0408	0.0445	0.3669	0.1079	-0.1201	-0.7240	-0.0529	0.3092	1.1059	-2.5343	1.2095	0.3855	-0.1092	-0.3162
2	-0.3806	**0.1677**	-0.0489	0.0231	0.3473	0.0969	-0.1453	-0.7731	-0.0584	0.3448	1.2955	-2.6093	1.0991	0.3837	-0.1151	-0.3725
3	-0.0695	0.0334	**-0.2453**	0.4140	1.0788	-0.1158	0.0532	-0.5837	0.0137	0.0099	2.7110	-0.2285	-2.3254	-0.2314	-0.0001	0.5143
4	-0.0370	0.0077	-0.2025	**0.5014**	1.2009	-0.1254	0.0867	-0.6550	0.0078	-0.0453	2.8538	-0.0279	-2.6359	-0.2898	0.0139	0.6533
5	-0.1160	0.0441	-0.2004	0.4561	**1.3201**	-0.987	0.0409	-0.8391	-0.0110	0.0179	2.7283	-0.5626	-2.0462	-0.1704	-0.0181	0.5459
6	0.2177	-0.0786	-0.1373	0.3040	0.6297	**-0.2068**	0.1282	0.0611	0.0392	-0.2385	1.5079	1.3512	-2.6004	-0.4137	0.0772	0.6408
7	0.2707	-0.1316	-0.0705	0.2348	0.2919	-0.1432	**0.1851**	0.3249	0.0620	-0.3061	0.5529	1.9356	-2.2267	-0.4343	0.1033	0.6488
8	-0.2800	0.1201	-0.1327	0.3044	1.0254	0.0117	-0.0558	**-1.0789**	-0.0495	0.2215	2.4095	-1.8111	-0.6452	0.1083	-0.0826	0.0651
9	0.1897	-0.0842	-0.0288	0.0336	-0.1249	-0.0696	0.0987	0.4595	**0.1163**	-0.2469	-0.4341	1.5971	-1.0072	-0.2702	0.0730	0.3019
10	0.2735	-0.1226	0.0051	0.0482	-0.0501	-0.1046	0.1201	0.5065	0.0609	**-0.4717**	-0.3413	1.8526	-1.3197	-0.3298	0.0940	0.2212
11	-0.0955	0.0449	-0.1376	0.2960	0.7452	-0.0645	0.0212	-0.5379	-0.0104	0.0333	**4.8330**	-2.0664	-2.6789	-0.0718	-0.0106	0.3001
12	-0.2818	0.1166	-0.0149	0.0037	0.1980	0.0745	-0.0955	-0.5208	-0.0495	0.2329	2.6617	**-3.7520**	0.8356	0.4821	-0.0752	-0.1846
13	0.1310	-0.0478	-0.1480	0.3430	0.7011	-0.1396	0.1070	-0.1807	0.0304	-0.1616	3.3606	0.8138	**-3.8525**	-0.4990	0.0523	0.5100
14	0.2545	-0.1018	-0.0898	0.2299	0.3559	-0.1354	0.1272	0.1848	0.0497	-0.2462	0.5489	2.8617	-3.0417	**-0.6320**	0.0794	0.4451
15	0.3671	-0.1555	0.0002	0.0563	-0.1931	-0.1286	0.1542	0.7187	0.0685	-0.3575	-0.4127	2.2736	-1.6251	-0.4043	**0.1241**	0.4855

Note: Unexplained (residual) variation= 0.2029

1-leaf area index (80 DAS), 2-leaf area index (110 DAS), 3-accumulation of dry matter (80 DAS), 4- accumulation of dry matter (110 DAS), 5- accumulation of dry matter (at maturity), 6- SLW (80 DAS), 7- SLW (110 DAS), 8- SLW (at maturity), 9- SPAD at 80 DAS, 10- SPAD at 110 DAS, 11- flowers per plant, 12- shedding of reproductive parts, 13- pods/plant, 14- fruiting percentage, 15- 100-grain weight, 16- grain yield

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REFERENCES

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

Bizeti, H.S., Portela de Carvalho, C.G., de Souza, J.R.P. and Destro, D. 2004. Path analysis under multicollinearity in soybean. *Brazilian Archives boi. Tech.,* **47**: 669-76.

Chavan, B.H., Dahat, D.V., Rajput, H.J., Deshmukh, M.P. and Diwane, S.L. 2016. Correlation and path analysis in soybean. *Int. Res. J. Multidiscip. Stud.,* **2**: 1-5.

El-Badawy, M.El.M. and Mehasen, S.A.S. 2012. Correlation and path coefficient analysis for yield and yield components of soybean genotypes under different planting density. *Asian J. Crop Sci.,* **4**: 150-58.

Haghi, Y., Boroomandan, P., Moradin, M., Hassankhali, M., Farhadi, P., Farsaei, F. and Dabiri, S. 2012. Correlation and path analysis for yield, oil and protein content of soybean [*Glycine max* (L) Merrill] genotypes under different levels of nitrogen starter and plant density. *Biharean Biologist.,* **6**: 32-37.

Halmann, M. 1990. Synthetic plant growth regulators. *Adv. in Agron.,* **43**: 47-105.

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

Jaidka, M., Deol, J. S. and Brar, A. S. 2018. Development of optimized source-sink relationship, favourable morpho-physiological behaviour and profitability of soybean through detopping and mepiquat chloride application**.** *J. Crop and Weed,* **14**(1): 82-89.

Kaur, J., Singh, P. and Parmar, U. 2006. Response of mungbean (*Vigna radiata* L.) to exogenous application of sodium nitroprusside (SNP-NO releasing compound). *Environ. Eco.,* **24**: 187-89.

Kumar, G.V., Vanaja, M., Sathish, P., Vagheera, P., Shishodia, S.S. and Razak, A. 2014. Correlation and path analysis of seed yield and yield contributing components of blackgram (*Vigna mungo* L. Hepper) under rainfed conditions from Andhra Pradesh, India. *Int. J. App. Biol. Pharma. Tech.,* **5**: 137-140.

Lodhi, B.S., Holkar, S., Dhakad, A., Jha, A., Chouhan, M. and Kumar, P. 2023. Dissecting yield determinants in soybean cultivation: A path coefficient analysis of morpho-physiological traits and their impacts. *Pharma Inn. J.,* **12**(11): 987-91.

Malik, M.F.A., Qureshi, A.S., Ashraf, M. and Ghafoor, M. 2006. Genetic variability of the main yield related characters in soybean. *Int. J. Agric. Biol.,* **8**: 815-19.

Mathivanthana, M.K., Shunmugavalli, N., Muthuswamy, A. and Harris, C.V. 2015. Correlation and path analysis in blackgram. *Agric. Sci. Digest,* **35**: 158-60.

Nagarajan, D., Kalaimagal, T. and Murugan, E. 2015. Correlation and path coefficient analysis for yield and yield attributes in soybean (*Glycine max* (L) Merrill). *Int. J. Farm Sci.,* **5**: 28-34.

Naveed, M.T., Ali, Q., Ahsan, M. and Hussain, B. 2012. Correlation and path coefficient analysis for various quantitative traits in chickpea (*Cicer arietinum* L.). *Int. J. Agro Vet. Med. Sci.,* **6**: 97-106.

Pawar, M.G., Chaudhary, S.B., Pawar, V.S. and Chavan, S.B. 2020. Correlation coefficient and path analysis study in different soybean genotypes based on yield and yield contributing traits. *Int. J. Curr. Microbiol. App. Sci.* **9**(9): 434-44.

Rodrigues, G.B., Marim, B.G., Silva, D.J.H., Mattedi, A.P., Oliveira, E.P., Lima, M. and Torres, F.E. 2010. Analise de trilha de components de producao primarios e secundarios em tomateiro do grupo Salada. *Pesquisa Agropecuaria Brasileira,* **45**: 155-62.

Sandhu, M.S., Deol, J.S. and Brar, A.S. 2015. Effect of growth regulation on growth and yield attributes of summer mungbean [*Vigna radiata* (L.) Wilczek]. *Crop Res.,* **49**: 18-22.

Silva, A.F., Sediyama, T., Silva, F.C.S., Bezerra, A.R.G. and Ferreira, L.V. 2015. Correlation and path analysis of soybean yield components. *Int. J. Plant Animal Environ. Sci.,* **5**: 177-79.

Singh, R.K. and Choudhary, B.D. 1985. *Biometrical Methods in Quantitative Analysis*. Kalyani Publishers, New Delhi, India.

Singh, M.S. and Devi, K.S. 2006. Profitability of nipping in cultivation of pea (*Pisum sativum*) - an indigenous agro-technique in Manipur. *Ind. J. Agron.,* **51**: 206-08.