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Sanjay Kumar
Department of Vegetable Science, College of Agriculture Raipur, Indira Gandhi Agriculture University, Raipur, Chhattisgarh, India

Bhupendra Kumar
Department of Vegetable Science, College of Agriculture Raipur, Indira Gandhi Agriculture University, Raipur, Chhattisgarh, India

Manish Kumar
Department of Vegetable Science, College of Agriculture Raipur, Indira Gandhi Agriculture University, Raipur, Chhattisgarh, India

Dhananjay Sharama
Department of Vegetable Science, College of Agriculture Raipur, Indira Gandhi Agriculture University, Raipur, Chhattisgarh, India

Corresponding Author:
Sanjay Kumar
Department of Vegetable Science, College of Agriculture Raipur, Indira Gandhi Agriculture University, Raipur, Chhattisgarh, India

To find out association correlation and path coefficient analysis for fruit yield and its component characters in brinjal (*Solanum melongena* L.)

Sanjay Kumar, Bhupendra Kumar, Manish Kumar and Dhananjay Sharama

Abstract
A field experiment was conducted at the Horticultural Research cum Instructional Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during the rabi season in the year 2016-17. Path coefficient analysis revealed that average fruit weight, expressed highest positive direct effect on fruit yield per plant followed by yield per hectare, number of fruits per plant, days to 50% flowering, plant height, days to maturity, fruit stalk length. For genetic improvement in brinjal average fruit weight, fruit yield per plant, yield per hectare, number of fruits per plant, days to 50% flowering, plant height, days to maturity, fruit stalk length are important. The association analysis revealed that the fruit yield per plant showed significant positive correlation with number of fruit per plant, yield per hectare at genotypic and phenotypic levels and days to first flowering, average fruit weight at genotypic level only.

Keywords: Genotypes and phenotypic, genetic variability, path analysis, heritability, traits

Introduction
Brinjal (*Solanum melongena* L.) also known as eggplant or aubergine is an important solanaceous crop of sub-tropics and tropics. According to De Candolle (1883) [2], eggplant was known in India in ancient times and probably a native of India (Vavilov, 1928) [15]. It is believed that eggplant may have originated in Indo-Burma and China may be the secondary centre of origin. The first record of eggplant in Europe was in the fifteenth century, the name was probably derived from the white egg like fruits. It is one of the most popular and important vegetable grown extensively in a wide range of climatic conditions from north to south and east to west, whereas, in hilly regions it is grown only in summer.
Brinjal is major vegetable crop of our country and since ancient time the human society has social and economic relationship with this crop. Many local cultivars are popular in different locations for their qualitative traits though they are poor yielders and susceptible to various pest and diseases. A great genetic variation is available in brinjal throughout the country with regard to fruit size, shape, colour, growth habit, canopy bearing habit, yield, diseases & insect-pests resistance, as well as quality and adaptability for different localities and for different growing seasons. Due to the burgeoning population of the country, it is estimated that by 2020, the country's vegetable demand would be around 135 million tonnes. So, brinjal as an important vegetable deserves a deep contemplation for improvement of locally preferred cultivars for high yield and adaptation or development of new hybrid combinations. It should be highly pragmatic by the fact that India being the centre of origin and diversity of brinjal, it should pave the way to bring about a kind of plant architecture, which could enhance its quality and productivity without losing the consumer's requirements. There are specific genotypes suited for specific preparations apart from the large genetic variation observed with regard to colour, shape and size of fruits. In addition, variation is also noticed for traits like vegetative growth, maturity and presence or absence of spines on leaves, stem and fruit calyx, among the indigenous material.

Material and method
The present investigation entitled "Studies on correlation and path coefficient analysis for fruit yield and its component characters in brinjal (*Solanum melongena* L.)." was conducted at All India Coordinated Research Project on Vegetable Crop at Horticultural Research cum Instructional Farm, Department of vegetable Science, Indira Gandhi Krishi Vishwavidyalaya,

Raipur (C.G.) during the *rabi* season of 2016-17. The place of investigation is situated in the central part of Chhattisgarh at 21°16' N latitude, 81°36' E longitude and at an altitude of 289.56 m from mean sea level. The climate of Raipur is characterized as dry sub-humid with normal rainfall of 1200-1400 mm per annum, mostly concentrated during the monsoon months *i.e.*, 15 June to September. It comes under the seventh agro-climatic zone of country, which is eastern plateau and hills. The soil of experimental field was clay-loam in texture with average fertility which is locally known as *Dorsa* in the region. The experimental field was cropped with crop like cabbage, chilli, tomato, pea etc. during last five years.

The experiment was laid out in Randomized Block Design (RBD) with three replications with above 17 treatments with plot size of 3.75 m. x 3.0 m and plant spacing are 75 x 60 cm. five plants are randomly selected in each plot to representative sample for studying growth performance, *viz.*, by recording observations on Yield per hectare (q), Yield per plant (g), Plant height (cm), Number of primary branches per plant, Days to first flowering, Days to 50% flowering, Number of flower per cluster, Number of fruits per cluster, Average fruits per cluster, Days to maturity, Number of fruits per plant.

Table 1: Details of experimental material (Treatments)

S. No.	Genotype	Source
1.	2014 / BRLVAR -1	AICRP on Vegetable Crops
2.	2014 / BRLVAR -2	AICRP on Vegetable Crops
3.	2014 / BRLVAR -4	AICRP on Vegetable Crops
4.	2015 / BRLVAR -1	AICRP on Vegetable Crops
5.	2015 / BRLVAR -2	AICRP on Vegetable Crops
6.	2015 / BRLVAR -3	AICRP on Vegetable Crops
7.	2015 / BRLVAR -4	AICRP on Vegetable Crops
8.	2015 / BRLVAR -5	AICRP on Vegetable Crops
9.	2016 / BRLVAR -1	AICRP on Vegetable Crops
10.	2016 / BRLVAR -2	AICRP on Vegetable Crops
11.	2016 / BRLVAR -3	AICRP on Vegetable Crops
12.	2016 / BRLVAR -4	AICRP on Vegetable Crops
13.	2016 / BRLVAR -7	AICRP on Vegetable Crops
14.	2016 / BRLVAR -8	AICRP on Vegetable Crops
15.	2016 / BRLVAR -9	AICRP on Vegetable Crops
16	Kashi Taru	IIVR, Varanasi
17.	Punjab Sadabahar	PAU, Ludhiana

Results and Discussion

Correlation coefficient of analysis

Association analysis is an important approach in a breeding programme. It gives an idea about relationship among the various characters and determines the component characters, on which selection can be used for genetic improvement in the fruit yield. The degree of association also affects the effectiveness of selection process. The degree of association between independent and dependent variables was first suggested by Galton (1888) [4], its theory was developed by Pearson (1904) [10] and their mathematical utilization at phenotypic, genotypic and environmental levels was described by Searle (1961) [12].

The genotypic and phenotypic correlation coefficient for fruit yield and its component character in Cherry tomato are presented in Table 2. and only significant correlations are discussed here.

The fruit yield per plant showed significant positive correlation with number of fruit per plant (0.887 and 0.856), yield per hectare (0.978 and 0.961) at both genotypic and phenotypic levels and days to first flowering (0.274), at genotypic level and average fruit weight (0.291) at phenotypic level only.

Days to first flowering expressed significant positive correlation with days to 50% flowering (0.963 and 0.893) and plant height (0.404 and 0.300) and number of fruit per plant (0.377 and 0.325) at genotypic and phenotypic levels. whereas, number of primary branch per plant (-0.657 and -0.452), number of flower per cluster (-0.782 and -0.407), number of fruit per cluster (-0.587 and -0.346). fruit length (-0.532 and -0.419), fruit stalk length (-0.551 and -0.477), days to maturity (-0.542 and -0.427) expressed significant negative correlation at both genotypic and phenotypic levels. and average fruit per cluster (-0.314), average fruit weight (-0.319) expressed significant negative correlation at genotypic level only.

Days to 50% flowering showed positive significant correlation with Plant height (0.317), number of fruit per plant (0.302) at genotypic level only whereas, number of primary branch per plant (-0.652 and -0.473), number of flower per cluster (-0.670 and -0.403), number of fruit per cluster (-0.560 and -0.276), fruit length (-0.639 and -0.548), average fruit weight (-0.419 and -0.336), fruit stalk length (-0.537 and -0.465), days to maturity (-0.549 and -0.454) expressed significant negative correlation at both genotypic and phenotypic levels and average fruit per cluster (-0.291) at genotypic level only.

Plant height showed positive and significant correlation with fruit length (0.447 and 0.333) at both genotypic and phenotypic levels and average fruit weight (0.470) only at genotypic level and number of primary branch per plant (0.364) at phenotypic level. Whereas, fruit stalk length (-0.697 and -0.522) expressed significant negative correlation at both genotypic and phenotypic levels. and number of flower per cluster (-0.437), number of fruit per cluster (-0.381) at genotypic level only.

Number of primary branches had positive and highly significant correlation with number of flower per cluster (0.882 and 0.457), number of fruit per cluster (0.617 and 0.349), average fruit per cluster (0.342 and 0.305), fruit length (0.661 and 0.435) at both genotypic and phenotypic levels and average fruit weight (0.370), fruit stalk length (0.340), days to maturity (0.424) only at genotypic level. Whereas, number of fruit per plant (-0.367) expressed significant negative correlation at genotypic level only.

Number of flower per cluster had positive and highly significant correlation with average fruit per cluster (0.797 and 0.529), fruit stalk length (0.633 and 0.285) at both genotypic and phenotypic levels and number of fruit per cluster (0.870) at genotypic level only. Whereas, fruit girth (-0.611 and -0.373) expressed significant negative correlation at both genotypic and phenotypic level.

Number of fruit per cluster had positive and highly significant correlation with fruit length (0.882 and 0.446) at both genotypic and phenotypic levels and average fruit per cluster (0.385), average fruit weight (0.384), fruit stalk length (0.870), days to maturity (0.488) at genotypic level only. Whereas, fruit girth (-0.747) expressed significant negative correlation at genotypic level only.

Average fruit per cluster had positive and highly significant correlation with fruit length (0.381) number of fruit per plant (0.393), yield per hectare (0.318) at genotypic level only. Fruit girth (-0.599 and -0.372) expressed significant negative correlation at genotypic and phenotypic level and average fruit weight (-0.269) at genotypic level only.

Fruit length had positive and highly significant correlation

with average fruit weight (0.549 and 0.542), days to maturity (0.421 and 0.369) at both genotypic and phenotypic levels and fruit girth (-0.276) expressed significant negative correlation at genotypic level only.

Fruit girth had positive and highly significant correlation with average fruit weight (0.569 and 0.606), days to maturity (0.511 and 0.399) at both genotypic and phenotypic levels. Whereas, fruit stalk length (-0.413 and -0.313), number of fruit per plant (-0.490 and -0.394) expressed significant negative correlation at genotypic and phenotypic level and yield per hectare (-0.272) at genotypic levels only.

Average fruit weight had positive and highly significant correlation with average fruit days to maturity (0.710 and 0.523) at both genotypic and phenotypic level and fruit stalk length (-0.335), number of fruit per plant (-0.273) expressed significant negative correlation at genotypic level only.

Table 2: Genotypic and phenotypic correlation coefficient between fruit yield and its components in brinjal.

S.N	Characters		2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Days to first flower	G	0.963**	0.404**	-0.657**	-0.782**	-0.587**	-0.314*	-0.532**	0.056	-0.319*	-0.551**	-0.542**	0.377**	0.234	0.274*
		p	0.893**	0.300*	-0.452**	-0.407**	-0.346*	-0.094	-0.419**	0.032	-0.252	-0.477**	-0.427**	0.325*	0.191	0.204
2	Days to 50% flowering	G		0.317*	-0.652**	-0.670**	-0.560**	-0.291*	-0.639**	0.098	-0.419**	-0.537**	-0.549**	0.302*	0.114	0.144
		P		0.204	-0.473**	-0.403**	-0.276*	-0.165	-0.548**	0.081	-0.336*	-0.465**	-0.454**	0.252	0.078	0.088
3	Plant height (cm.)	G			0.234	-0.437**	-0.381**	-0.016	0.447**	0.137	0.470**	-0.697**	0.124	0.049	0.248	0.251
		P			0.364**	-0.061	-0.032	0.005	0.333*	0.036	0.251	-0.522**	0.080	-0.010	0.093	0.116
4	No. of primary branch / plant	G				0.882**	0.617**	0.342*	0.661**	-0.176	0.370**	0.340*	0.424**	-0.367*	-0.227	0.233
		P				0.457**	0.349*	0.305*	0.435**	-0.168	0.202	0.177	0.226	-0.276	-0.216	-0.208
5	No. of flower / cluster	G					0.870**	0.797**	0.580**	-0.611**	-0.062	0.633**	0.057	0.075	0.050	-0.063
		P					0.202	0.529**	0.233	-0.373**	-0.098	0.285*	0.081	-0.023	-0.084	-0.087
6	No. of fruit / cluster	G						0.385**	0.882**	-0.747**	0.384**	0.870**	0.488**	-0.226	0.033	-0.053
		P						0.194	0.446**	-0.262	0.112	0.196	0.170	-0.062	-0.011	-0.041
7	Average fruits / cluster	G							0.381**	-0.599**	-0.269*	0.072	0.204	0.393**	0.318*	0.194
		P							0.258	-0.372**	-0.128	0.007	0.102	0.284	0.227	0.146
8	Fruit length (cm.)	G								-0.276*	0.549**	0.029	0.421**	0.003	0.268	0.209
		P								-0.209	0.542**	0.053	0.369**	-0.011	0.264	0.223
9	Fruit girth (cm.)	G									0.569**	-0.413**	0.511**	-0.490**	-0.272*	0.199
		P									0.606**	-0.313*	0.399**	-0.394**	0.130	-0.092
10	Average fruits weight	G										-0.335*	0.710**	-0.273*	0.120	0.208
		P										-0.174	0.523**	-0.200	0.211	0.291*
11	Fruit stalk length (cm.)	G											-0.021	-0.092	-0.197	-0.238
		P											-0.024	-0.087	-0.139	0.148
12	Days to maturity	G												0.485**	-0.198	-0.189
		P												-0.465**	-0.217	-0.202
13	No. of fruit per plant	G													0.915**	0.887**
		P													0.900**	0.856**
14	Yield per hectare (q)	G														0.978**
		P														0.961**
		G														1.00
		P														1.00

*Significant at 5% level, ** significant at 1% level

Days to maturity had positive and highly significant correlation with number of fruit per plant (0.485 and 0.465) at both genotypic and phenotypic levels.

Number of fruit per plant had positive and highly significant correlation with yield per hectare (0.915 and 0.900) at both genotypic and phenotypic levels.

Path coefficient analysis

Direct and indirect effect of different character on total fruit yield is presented in Table 3. The genotypic correlation coefficient of total fruit yield and along with its components was partitioned into direct and indirect effect taking total fruit yield as depended variable.

The concept of path analysis was developed by Wright (1921) [16] and this technique was first used by Dewey and Lu (1959) [3] that helps in determining yield contributing characters thus, useful in indirect selection. Correlation coefficients along with path coefficients provide more reliable information, which can be effectively utilized in crop improvement program me. If the correlation between yield and a character is due to direct effect of a character, it reveals true relationship between them and direct selection for the trait will be rewarding for yield improvement. However, if the correlation coefficient is mainly due to indirect effect of the character through another component trait, indirect selection through such trait will be effective in yield improvement.

The genotypic correlation coefficient of fruit yield and its components were broken down in to direct and indirect effect and taking fruit yield per plant as dependent variable and rest of the characters were taken as independent variables. Direct and indirect effects of fruit yield contributing characters in brinjal.

Average fruit weight (0.692) expressed highest positive direct effect on fruit yield per plant followed by yield per hectare (0.626), number of fruit per plant (0.350), days to 50% flowering (0.280), plant height (0.168), days to maturity (0.080), fruit stalk length (0.037). Whereas, negative direct effect on fruit yield per plant was observed for fruit girth (-0.546), fruit length (-0.517), days to first flowering (-0.429), average fruit per cluster (-0.103), number of primary branch per plant (-0.098), number of flower per cluster (-0.016), number of fruit per cluster (-0.013).

Days to of first flowering had positive indirect effect through fruit length (0.275), days to 50% flowering (0.270), yield per hectare (0.146), number of fruit per plant (0.131), plant height (0.067), number of primary branch per plant (0.064), average fruit per cluster (0.032), fruit girth (0.030), number of fruit per cluster (0.016), number of flower per cluster (0.013) while rest of characters exhibited indirect negative values.

Days to 50% flowering had positive indirect effect through number of fruit per plant (0.105), yield per hectare (0.071), number of primary branch per plant (0.064), plant height (0.053), average fruit per cluster (0.030), fruit length (0.030), number of fruit per cluster (0.018), number of flower per

cluster (0.011) while rest of characters exhibited indirect negative values.

Plant height had positive indirect effect through average fruit weight (0.325), yield per hectare (0.155), days to 50% flowering (0.089), number of fruit per plant (0.017), days to maturity (0.009), number of flower per cluster (0.007), number of fruit per cluster (0.005), average fruit per cluster (0.001) while rest of characters exhibited indirect negative values.

Number of primary branch per plant had positive indirect effect through days to first flowering (0.282), average fruit weight (0.255), fruit girth (0.096), Plant height (0.039), days to maturity (0.034), fruit stalk length (0.012) while rest of characters exhibited indirect negative values.

Number of flower per cluster had positive indirect effect through days to first flowering (0.336), fruit girth (0.333), yield per hectare (0.031), number of fruit per plant (0.026), fruit stalk length (0.023) while rest of characters exhibited indirect negative values.

Number of fruit per cluster had positive indirect effect through days to first flowering (0.518), fruit girth (0.407), average fruit weight (0.265), fruit stalk length (0.041), days to maturity (0.039), yield per hectare (0.020) while rest of characters exhibited indirect negative values.

Average fruit per cluster had positive indirect effect through fruit girth (0.326), yield per hectare (0.199), number of fruit per plant (0.137), days to first flowering (0.134), days to maturity (0.016), fruit stalk length (0.002) while rest of characters exhibited indirect negative values.

Fruit length had positive indirect effect through average fruit weight (0.380), days to first flowering (0.228), yield per hectare (0.168), fruit girth (0.150), Plant height (0.075), days to maturity (0.033), fruit stalk length (0.001), number of fruit per plant (0.001), while rest of characters exhibited indirect negative values.

fruit girth had positive indirect effect through Average fruit weight (0.393), fruit length (0.142), yield per hectare (0.075), average fruit per cluster (0.062), days to maturity (0.057), days to 50% flowering (0.027), Plant height (0.022), number of primary branch per plant (0.017), number of flower per cluster (0.010), number of fruit per cluster (0.010), while rest of characters exhibited indirect negative values.

Average fruit weight had positive indirect effect through days to first flowering (0.137), Plant height (0.079), and yield per hectare (0.075), days to maturity (0.057), and average fruit per cluster (0.027), number of flower per cluster (0.001) while rest of characters exhibited indirect negative values.

Fruit stalk length had positive indirect effect through days to first flowering (0.236), fruit girth (0.225) while rest of characters exhibited indirect negative values.

Days to maturity had positive indirect effect through average fruit weight (0.491), day to first flowering (0.232), Plant height (0.020) while rest of characters exhibited indirect negative values.

Number of fruit per plant had positive indirect effect through yield per hectare (0.573), fruit girth (0.267), days to 50% flowering (0.084), and number of primary branch per plant (0.036), Plant height (0.008), and number of fruit per cluster (0.003) while rest of characters exhibited indirect negative values.

Yield per hectare had positive indirect effect through number of fruit per plant (0.320), fruit girth (0.148), average fruit weight (0.083), plant height (0.041), days to 50% flowering (0.031), number of primary branch per plant (0.022) while rest of characters exhibited indirect negative values.

Similar findings were observed by Singh and Singh (2001) [13], Mohanty (2001) [7], Naik (2006) [8], Lohakare (2008) [6] and Bansal and Mehta (2008) [1], Singh and Singh (2001) [13], Singh *et al.* (2001) [13], Singh *et al.* (2003) [14], Singh *et al.* (2003) [14], Patel and Sarnaik (2004) [9], Katoch *et al.* (2005) [5] and Praneetha (2006) [11].

Table 3: Genotypic path coefficient analysis for fruit yield and its component character in brinjal.

S. N	Characters	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	Days to first flower	-0.429	0.270	0.067	0.064	0.013	0.016	0.032	0.275	0.030	-0.221	-0.020	-0.043	0.131	0.146	0.274*
2	Days to 50% flowering	-0.413	0.280	0.053	0.064	0.011	0.018	0.030	0.030	-0.053	-0.289	-0.020	-0.044	0.105	0.071	0.144
3	Plant height (cm.)	-0.173	0.089	0.168	-0.023	0.007	0.005	0.001	-0.231	-0.074	0.325	-0.026	0.009	0.017	0.155	0.251
4	No. of branch / plant	0.282	-0.183	0.039	-0.098	-0.014	-0.008	-0.035	-0.342	0.096	0.255	0.012	0.034	-0.128	-0.142	0.233
5	No. of flower / cluster	0.336	-0.188	-0.073	-0.086	-0.016	-0.019	-0.082	-0.300	0.333	-0.042	0.023	-0.004	0.026	0.031	-0.063
6	No. of fruit / cluster	0.518	-0.367	-0.064	-0.060	-0.023	-0.013	-0.039	-0.697	0.407	0.265	0.041	0.039	-0.079	0.020	-0.053
7	Average fruit / cluster	0.134	-0.081	-0.002	-0.033	-0.013	-0.005	-0.103	-0.197	0.326	-0.186	0.002	0.016	0.137	0.199	0.194
8	Fruit length (cm.)	0.228	-0.179	0.075	-0.064	-0.009	-0.018	-0.039	-0.517	0.150	0.380	0.001	0.033	0.001	0.168	0.209
9	Fruit girth (cm.)	-0.023	0.027	0.022	0.017	0.010	0.010	0.0620	0.142	-0.546	0.393	-0.015	0.057	-0.095	0.075	0.199
10	Average fruit weight	0.137	-0.117	0.079	-0.036	0.001	-0.005	0.027	-0.284	-0.310	0.692	-0.012	0.057	-0.095	0.075	0.208
11	Fruit stalk length (cm.)	0.236	-0.150	-0.117	-0.033	-0.010	-0.015	-0.007	-0.014	0.225	-0.231	0.037	-0.001	-0.023	-0.123	-0.238
12	Days to maturity	0.232	-0.154	0.020	-0.041	0.000	-0.006	-0.021	-0.218	-0.279	0.491	-0.000	0.080	-0.169	-0.124	-0.189
13	No. of fruit per plant	-0.161	0.084	0.008	0.036	-0.001	0.003	-0.040	-0.001	0.267	-0.188	-0.003	-0.038	0.350	0.573	0.887**
14	Yield per hectare (q)	-0.100	0.031	0.041	0.022	-0.000	-0.000	-0.032	-0.138	0.148	0.083	-0.007	-0.015	0.320	0.626	0.978**
15	Yield per plant (kg)															

Residual Effect = 0.01382, Figures in bold direct effects

Conclusion

The correlation coefficient of fruit yield per plant was found to positive and significant with number of fruit per plant, yield per hectare at genotypic and phenotypic levels and days to first flowering, average fruit weight at genotypic level only. The path coefficient analysis revealed that direct selection for average fruit weight, yield per hectare, number of fruit per plant, days to 50% flowering, plant height, days to maturity, fruit stalk length had positive direct effect on total fruit yield will be effective and would help to select the genotypes having highest fruit yield per plant.

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