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Ashish Kumar
Department of Horticulture, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

B Singh
Department of Horticulture, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Manoj K Singh
Department of Horticulture, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Vaishali
Department of Agricultural Biotechnology, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Pooran Chand
Department of Genetics and Plant Breeding, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Correspondence
Ashish Kumar
Department of Horticulture, Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India

Characters association and path cofficient analysis studies in brinjal (*Solanum melongena* L.)

Ashish Kumar, B Singh, Manoj K Singh, Vaishali and Pooran Chand

Abstract
Economic yield attributing characters were studied in Brinjal for crop improvement through selecting high yielding characters. Significant variations were recorded among the genotypes for various yield traits studied. Fruit yield per plant observed positive and significant correlation with fruit index, number of fruits per plant, diameter of fruits, average fruit weight plant spread, primary branches per plant, plant height. Fruit yield per plant observed negative and significant correlation with, Days to first flowering, days to first fruit set, days to first fruit picking at both genotypic and phenotypic level had exhibited true association with direct effect on fruit yield per plant. The direct selection for these traits would be rewarding for crop improvement in the total fruit yield per plant.

Keywords: yield, character association and path coefficient analysis

Introduction
Brinjal (*Solanum melongena* L.) is an third most important vegetable crop in India. It's belong to the family Solanaceae and having 2n = 24 chromosome number. The family contains more than 2000 species distributed in 75 genera. In the genus "*Solanum*" there are three main species viz; *escullantum* (large round), *serpentium* (long slender) and *depressum* (dwarf brinjal) (Chaudhry, 1976). It originated in India, as Subcontinent people are used to grow brinjal since last 4000 years (Dunlop, 2006) [5]. Brinjal (*Solanum melongena),* or aubergine, is a species of nightshade, grown for its edible fruit. Brinjal is the common name in North America, Australia and New Zealand, but British English uses the French word aubergine. It is known in South Asia and South Africa as brinjal. Brinjal is a vegetable commonly grown by the farmers throughout the tropical and sub-tropical regions of the world. Brinjal have to much importance in the warm areas of Far East, being grown extensively in India, Bangladesh, Pakistan, China and Philippines. It is also popular in Egypt, France, Italy and United States. In India, it is one of the most common, popular and principal vegetable crops grown throughout the country except higher altitudes. It is a versatile crop adapted to different agro-climatic regions and can be grown throughout the year. It is a perennial but grown commercially as an annual crop. A large number of cultivars are grown in India, consumer preference being dependent upon fruit color, size and shape. The fruit is widely used in cooking. The wonderful nutritional value and health benefits of brinjal are primarily derived from its vitamin, mineral, and nutrient content. Brinjal are a rich source of vitamin C, vitamin K, vitamin B6, thiamin, niacin, magnesium, phosphorous, copper, dietary fiber, folic acid, potassium, and manganese. Brinjal is a non-starchy vegetable, which is low in calories and carbohydrates. Foods that have a low glycemic index don't raise blood sugars as quickly as other foods that contain carbohydrate. The nutritional value per 100 g of brinjal fruit contains 92.70 per cent moisture, 0.1 g fat, 5.7 g carbohydrate and 1.0 g protein. In addition, numerous vitamins and minerals, such as B_1, B_6, folic acid, copper, manganese (0.25 mg), magnesium (14 mg), potassium (230 mg) and about 10 per cent of the daily value of fiber are also present (USDA Nutrient Database, 2005) [12]. It's contains a higher content of free reducing sugars, anthocyanin, phenols, glycol alkaloids (Solasodine) and amide proteins. Bitterness in brinjal fruit is due to the presence of saponins and glycol alkaloids (Mariola *et al.*, 2013) [8].

Materials and Methods
Experimental material of the present investigation comprising of 28 F_1s along with 8 parents were evaluated in a completely randomized block design with three replications during *kharif* 2017 at Sardar Vallabhbhai Patel University, Horticulture Research Centre, Meerut U.P. Nursery was prepared in portrays of 98 holes and each of 28 F_1s was transplanted on ridges after 30 days.

The length of rows was three meter long and the parents were planted in two rows. The rows were spaced 120 cm apart and plant to plant distance was maintained 60 cm. Observations were recorded on five competitive plants for Plant height (cm), Primary branches per plant, Plant spread (cm), Days to first flowering, Days to first fruit set, Days to first fruit harvest, Average fruit weight (g), Length of fruit (cm), Dia. of fruit (cm), Fruit index, Fruits per plant and Yield per plant (g). Data on quantitative character were also recorded. Correlation coefficients among all important character combination at phenotypic and genotypic level were calculated as per the methods suggested by Robinson *et al.* (1951) [11], Al-Jibourie *et al.* (1958) and Fisher and Yates (1938) and path coefficient were worked out as per the method of Dewey and Lu (1959) [3].

Results and Discussion

Genotypic and Phenotypic correlation coefficient were worked out by utilizing data from eight genotypes of brinjal, sown in three replications and studied over 12 fruit yield and its contributing metric traits are presented in Table-1.

Genotypic correlation coefficient among growth and yield contributing traits are presented in Table 1. Fruit yield per plant showed positive and significant genotypic correlation with, plant height (0.385), primary branches per plant (0.350), plant spread (0.357), average fruit weight (0.658), diameter of fruits, (0.474) and fruit index (0.465) whereas, negative significant correlation was observed for days to first flowering (0.586), days to first fruit set (0.594) and days to first fruit picking (0.587). Phenotypic correlation coefficients among growth and yield contributing attributes are presented in Table 1. Fruit yield per plant showed positive and significant phenotypic correlation with, plant height (0.381), primary branches per plant (0.340), plant spread (0.354), average fruit weight (0.654), diameter of fruits, (0.465) and fruit index (0.450). Whereas, negative and significant correlation with days to first flowering (0.577), days to first fruit set (0.594), days to first fruit picking (0.579) phenotypic level. The result indicated that by improving these characters yield may be enhanced in this crop. These result are in general agreement with the finding of Patel *et al*., (2015) [10] and Pandey *et al*., (2016) [9]. Though correlation analysis indicates the association pattern of component traits with yield, it simply represent the overall association of a particular traits with yield rather than providing cause and effect relationship developed by Wright (1921) [13] and demonstrated by Dewey and Lu (1957) [4].

There are twelve important growth, earliness and yield parameters subjected to genotypic and phenotypic path coefficient analysis by considering fruit yield per plant as dependent variable on eleven other independent variable are presented in Table 2. This discussed only at genotypic level. High direct positive and negative contribution on fruit yield per plant *viz.*, plant height (0.385), Primary branches per plant (0.350), Plant spread (0.357), Days to first flowering (-0.586), Days to first fruit set(-0.594), Days to first fruit picking (-0.587), average fruit weight (0.658), Dia. of fruit (0.474), Fruit index (0.465). The genotypic correlation coefficient between these two characters was negative significant Number of fruits per plant (-0.194) via. length of fruit, days to first flowering, plant spread, fruit index, number of fruits per plant and significant negative effect Plant height, primary branches per plant, days to first fruit set, days to first fruit picking, fruit weight, dia. of fruit (Pandey *et al*., 2016 and Mangi *et al*., 2017) [9, 7] had positive and negative direct effect indicating there true positive and significant association with fruit yield per plant.

Table 1: Genotypic and Phenotypic correlations coefficient in F_1 among for twelve characters in brinjal (*Solanum melongena* L.)

Characters		Plant height (cm)	Primary branch per plant	Plant spread (cm)	Days to first flowering	Days to first fruit set	Days to first fruit picking	Average per fruit wt. (g)	Length of fruit (cm.)	Dia. of fruit (cm)	Fruit index	No of fruit /plant	Yield of fruit / plant (g)
Plant height (cm)	G	1.000	0.138	0.187	-0.220*	-0.234*	-0.240*	0.380**	-0.127	0.159	0.070	-0.237*	0.385**
	P	1.000	0.127	0.186	-0.217*	-0.231*	-0.238*	0.378**	-0.126	0.159	0.069	-0.234*	0.381**
Primary branch per plant	G			0.552**	-0.106	-0.104	-0.120	0.215*	0.082	0.206*	0.298**	-0.031	0.350**
	P			0.526**	-0.098	-0.098	-0.114	0.206*	0.068	0.194*	0.275**	-0.029	0.340**
Plant spread (cm)	G				-0.283**	-0.297**	-0.308**	0.542**	0.154	0.446**	0.577**	-0.521**	0.357**
	P				-0.277**	-0.291**	-0.304**	0.540**	0.149	0.441**	0.566**	-0.515**	0.354**
Days to first flowering	G					1.002**	0.997**	-0.492**	0.172	-0.147	-0.088	0.172	-0.586**
	P					0.987**	0.980**	-0.486**	0.166	-0.142	-0.081	0.168	-0.577**
Days to first fruit set	G						0.995**	-0.510**	0.174	-0.168	-0.107	0.187	-0.594**
	P						0.979**	-0.501**	0.173	-0.160	-0.095	0.188	-0.582**
Days to first fruit picking	G							-0.514**	0.166	-0.183	-0.130	0.216*	-0.587**
	P							-0.509**	0.166	-0.182	-0.125	0.216*	-0.579**
Average per fruit wt. (g)	G								-0.234*	0.761**	0.689**	-0.789**	0.658**
	P								-0.227*	0.754**	0.675**	-0.781**	0.654**
Length of fruit (cm.)	G									-0.378**	0.091	0.171	-0.093
	P									-0.369**	0.117	0.171	-0.092
Dia. of fruit (cm)	G										0.875**	-0.689**	0.474**
	P										0.866**	-0.679**	0.465**
Fruit index	G											-0.635**	0.465**
	P											-0.616**	0.450**
No of fruit /plant	G												-0.194*
	P												-0.191*
Yield of fruit /plant (g)	G												1.000
	P												1.000

*, ** significant at 5% and 1% level respectively

Table 2: Direct and indirect effect at genotypic and phenotypic level of different quantitative characters in brinjal (*Solanum melongena* L.)

Characters		Plant height (cm)	Primary branch per plant	Plant spread (cm)	Days to first flowering	Days to first fruit set	Days to first fruit picking	Average per fruit wt. (g)	Length of fruit (cm.)	Dia. of fruit (cm)	Fruit index	No of fruit /plant	correlation with yield of fruit /plant (g)
Plant height (cm)	G	0.125	0.009	-0.004	-0.148	0.055	0.159	0.351	-0.019	0.048	0.000	-0.192	0.385**
	P	0.140	0.012	-0.007	0.007	0.026	0.024	0.315	-0.017	0.045	0.002	-0.166	0.381**
Primary branch per plant	G	0.017	0.065	-0.010	-0.072	0.025	0.079	0.199	0.012	0.063	-0.002	-0.025	0.350**
	P	0.018	0.095	-0.020	0.003	0.011	0.012	0.172	0.009	0.055	0.006	-0.021	0.340**
Plant spread (cm)	G	0.023	0.036	-0.019	-0.190	0.070	0.203	0.501	0.023	0.136	-0.004	-0.422	0.357**
	P	0.026	0.050	-0.038	0.009	0.032	0.031	0.450	0.020	0.124	0.013	-0.364	0.354**
Days to first flowering	G	-0.028	-0.007	0.005	0.673	-0.237	-0.659	-0.455	0.026	-0.045	0.001	0.139	-0.586**
	P	-0.030	-0.009	0.011	-0.034	-0.109	-0.100	-0.405	0.022	-0.040	-0.002	0.119	-0.577**
Days to first fruit set	G	-0.029	-0.007	0.006	0.675	-0.236	-0.658	-0.472	0.026	-0.051	0.001	0.151	-0.594**
	P	-0.032	-0.009	0.011	-0.033	-0.111	-0.100	-0.417	0.023	-0.045	-0.002	0.133	-0.582**
Days to first fruit picking	G	-0.030	-0.008	0.006	0.671	-0.235	-0.661	-0.476	0.025	-0.056	0.001	0.175	-0.587**
	P	-0.033	-0.011	0.012	-0.033	-0.108	-0.102	-0.424	0.022	-0.051	-0.003	0.153	-0.579**
Average per fruit wt. (g)	G	0.048	0.014	-0.010	-0.331	0.120	0.340	0.925	-0.035	0.232	-0.004	-0.639	0.658**
	P	0.053	0.020	-0.021	0.016	0.055	0.052	0.833	-0.031	0.212	0.016	-0.552	0.654**
Length of fruit (cm.)	G	-0.016	0.005	-0.003	0.116	-0.041	-0.110	-0.216	0.150	-0.115	-0.001	0.138	-0.093
	P	-0.018	0.006	-0.006	-0.006	-0.019	-0.017	-0.189	0.135	-0.104	0.003	0.121	-0.092
Dia. of fruit (cm)	G	0.020	0.013	-0.008	-0.099	0.040	0.121	0.704	-0.057	0.304	-0.006	-0.558	0.474**
	P	0.022	0.019	-0.017	0.005	0.018	0.019	0.629	-0.050	0.281	0.020	-0.480	0.465**
Fruit index	G	0.009	0.019	-0.011	-0.059	0.025	0.086	0.637	0.014	0.266	-0.006	-0.514	0.465**
	P	0.010	0.026	-0.022	0.003	0.010	0.013	0.562	0.016	0.244	0.023	-0.435	0.450**
No of fruit /plant	G	-0.030	-0.002	0.010	0.115	-0.044	-0.143	-0.730	0.026	-0.210	0.004	0.810	-0.194*
	P	-0.033	-0.003	0.020	-0.006	-0.021	-0.022	-0.651	0.023	-0.191	-0.014	0.707	-0.191*

*, ** significant at 5% and 1% level respectively

Conclusion

The correlation studies revealed that the total fruit yield per plant had significantly and positive correlated with number of fruits per plant, plant spread, fruit weight and length of fruit were correlated to each other and will have great influence in increasing the fruit yield of the brinjal crop. The path coefficient analysis studies revealed that characters *viz*., fruit yield per plant, number of fruits, length of length of fruits, days to flowering, days to fruit harvesting, days to first fruit set and plant height had highest significant positive direct effect on fruit yield per plant at genotypic level. Thus, selection of these traits can be considered as guidelines for further breeding work on brinjal.

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