

Original Research Article

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Correlation Studies in Segregating Population of Brinjal (*Solanum melongena* L.) Developed Through Bi-Parental Mating Using Bacterial Wilt Resistant Varieties

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ABSTRACT

Keywords

Correlation coefficient (r), Character association, Path analysis, Bi-parental mating, Plant height, pH, Fruit diameter, FD, Marketable yield per plant, MYPP.

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The present study was undertaken with the objective to determine the nature and magnitude of association between yield and its component characters and their direct, indirect effects on marketable fruit yield per plant in brinjal (*Solanum melongena* L.). Forty eight bi-parental and 60 F₃ progenies were evaluated for identifying their efficiency with respect to 16 yield and quality traits. The correlation studies revealed strong positive association of marketable fruit yield with fruits per plant, plant height and fruit weight. Genotypic correlations in general were high as compared to their phenotypic correlations indicated strong inherent association between the characters. The result of path analysis indicated that the fruit weight had maximum direct effect on marketable fruit yield followed by number of fruits per plant and fruit length.

Introduction

Brinjal (*Solanum melongena* L.) is a popular vegetable of India. It belongs to family Solanaceae and have chromosome number $2n=2x=24$ (Hazra *et al.*, 2011). Being rich in fiber, potassium, vitamin B-6 and phytonutrients like flavonoids, this vegetable lowers the risk of heart disease. As brinjals are low in carbohydrates and high in fibre content, they are known to be good for people suffering from diabetes. Brinjal contains potassium, an important mineral, which plays a key role in maintaining electrolyte balance in the body.

It also helps in neutralizing the effects of sodium on the body thereby aiding in blood pressure control. Brinjals is rich in chlorogenic acid that acts as a powerful antioxidant agent, lowering cholesterol levels in the body, several varieties of aubergines grown all around the world. They vary widely in size, shape, and color depending upon the cultivar type. Aubergines fall into two broad categories, either oval shaped, or thin and elongated. It is grown commercially as fresh market crop especially in low and mid hill areas of Himachal Pradesh.

The correlation between different characters is an important tool in the hands of plant breeder for making the crop improvement, whereas the path coefficient analysis partitions the correlation coefficients into direct and indirect effects. The description of the technique of path coefficient analysis for partitioning the correlation coefficient into direct and indirect effects was first published by Wright (1921). This method was further illustrated as a means of analyzing correlation coefficients by Dewey and Lu (1959). Johanson *et al.*, (1955) stated that the estimates of genotypic and phenotypic correlation among the characters are useful in planning and evaluating breeding programme. The genetic improvement of a dependent trait can be achieved by applying strong selection to characters which are genetically correlated with dependent character. Sometime a character has low heritability. Under such situation, another character having high heritability and high correlation with former traits chosen to make selection more effective. Thus genetic improvement is achieved using indirect selection through component characters with high heritability.

A positive correlation between desirable characters is favourable to the plant breeder because it helps in simultaneous improvement of both the characters. In plant breeding, phenotypic and genotypic paths are commonly estimated to determine yield contributing characters. Knowledge of yield components is useful for plant breeders in selection of elite genotype from diverse genetic populations. It is quite possible that a trait showing positive direct effect on yield may have a negative indirect effect via other component traits. Path analysis permits the examination of direct effects of various characters on yield as well as their indirect effects via other component characters. Thus through the estimates of direct and indirect effects, it determines the yield components.

Adams and Grafius (1971) have mentioned that yield should be considered as end product of a number of traits and breeder should not ignore the principle of balance among these traits. So, it is beneficial to know the association of various economically important traits. This consideration becomes more useful when one visualizes yield as a complex trait and product of the interaction of several traits. Correlation studies between characters also play an important role in the determination of the most efficient breeding procedures. Stronger the association of a trait with yield, the more will be the success of a selection programme. Therefore this investigation was undertaken with the objective to determine the nature and magnitude of association among different traits and their association with fruit yield in segregating populations of brinjal.

Materials and Methods

Present studies were conducted at the Vegetable Research Farm of Department of Vegetable Science and Floriculture, CSKHPKV, Palampur (H.P) during *Kharif* season 2012 and 2013. The experimental material was developed by using contrasting parents *viz*; Arka Keshav x Bhola Nath. The varieties possess resistance to bacterial wilt. While selecting the parents' emphasis was given upon the growth habit, fruit shape, fruit colour, fruit maturity, average fruit yield and reaction to bacterial wilt disease.

Mating design

Experimental material comprising of parents (P₁, P₂), F₁, F₂, BIP's and F₃ generations. Biparental progenies has been developed in F₂ generations of an intervarietal crosses using North Carolina Design I as suggested by Comstock and Robinson (1948 and 1952). The biparental progenies (BIP's) and F₃ progenies were raised in Randomized Block

Design (RBD) with three replications. Each experimental plot consisted of two rows of 2.70m length for biparental and F₃ progenies with inter and intra plant distance of 60 cm and 45 cm, respectively. In addition, six rows of each F₂, two rows each of the original parents and F₁'s were also included in each replication for making comparisons. The F₂ seeds obtained from crosses attempted during *Kharif* 2011 were grown during March, 2012. This material was used to produce seeds of biparental and F₃ progenies. The seeds of F₁ were also obtained by making fresh crosses. The final experiment was conducted during *Kharif* 2013.

The observations were recorded on randomly taken five competitive plants in each entry for most of the traits. The characters studied were as follows: days to 50% flowering, days to first picking, number of marketable fruits per plant, fruit length, fruit diameter, average fruit diameter, plant height, number of branches per plant, fruit weight, pedicel length, total soluble solid, bacterial wilt incidence, dry matter content, iron content, phenol content, marketable yield per plant

The mean over three replications has been subjected to statistical analysis. The method of analysis of variance followed was as proposed by Comstock and Robinson (1948 and 1952). Estimates of correlation coefficient were determined by path analysis given by Dewey and Lu.

Results and Discussion

Perusal of data in tables 1 and 2 indicated that genotypic correlations in general were higher as compared to their phenotypic correlations indicated strong inherent association between the characters. In case of BIP's, marketable fruit yield per plant showed significant and positive correlation with number of marketable fruits per plant, plant height and fruit weight whereas it was negatively and

significantly associated with bacterial wilt incidence. Chattopadhyay *et al.*, (2011), Karak *et al.*, (2012), Nayak and Nagre (2013) and Lakshmi *et al.*, (2014) have also recorded similar results in brinjal. Among the component characters, days to 50% flowering had positive and significant association days to first picking, fruits per plant, whereas it was negatively correlated with bacterial wilt incidence. Number of marketable fruits per plant had a positive and significant association with plant height and number of branches per plant and non-significantly negative correlation with bacterial wilt incidence. Fruit length showed no significant correlation with any other character in cross AK × BN. The fruit diameter was positively correlated with fruit weight and manifested negative and significant association with total soluble solids. The average fruit diameter was positively correlated with fruit weight and negatively and significantly correlated with dry matter content. Plant height was positively and significantly correlated with fruit weight, while it manifested negative correlation with branches per plant.

The fruit weight was positively and significantly correlated with total soluble solids, while it manifested positive correlation with dry matter content in cross AK × BN. The fruit weight also exhibited non-significant and negative correlations with bacterial wilt incidence.

In F₃ progenies, marketable fruit yield per plant was significantly and positively correlated with number of marketable fruits per plant and fruit weight, whereas it was negatively and significantly associated with days to 50% flowering and bacterial wilt incidence. Among the component characters, days to 50% flowering manifested positive association with days to first picking, number of marketable fruits per plant, whereas, it was negatively correlated with bacterial wilt incidence.

Table.1 Estimate of phenotypic correlation coefficient (r) between different pairs of characters in eggplant

		DTFF	DTFP	NFPP	FL	FD	AFD	PH	BPP	FW	PL	TSS	BWI	DM	IC	PC	MYPP
DTFF	BIP's	1	0.775*	0.696*	-0.058	-0.118	-0.024	0.089	0.069	0.165	0.026	-0.024	-0.335*	0.015	-0.028	-0.089	-0.132
	F3's	1	0.336*	0.435*	-0.081	-0.204	0.011	0.066	0.114	0.036	0.155	0.061	-0.237	-0.012	0.054	-0.020	-0.419*
DTFP	BIP's		1	0.088	0.059	-0.098	-0.104	-0.052	-0.070	0.059	-0.109	-0.047	-0.699*	0.106	0.107	-0.038	0.094
	F3's		1	0.411*	-0.123	0.004	-0.031	-0.234	0.026	-0.038	0.019	0.011	-0.232	0.103	0.106	0.022	-0.152
NFPP	BIP's			1	-0.026	0.091	0.135	0.163	0.044	0.798*	0.142	0.099	-0.389*	-0.016	-0.069	-0.029	0.794*
	F3's			1	-0.092	-0.078	0.033	0.572*	0.058	0.279	0.022	0.063	-0.694*	-0.045	0.035	-0.004	0.658
FL	BIP's				1	-0.069	0.032	0.291	0.008	0.133	0.099	0.146	-0.147	0.136	0.056	-0.009	0.199
	F3's				1	0.125	0.014	0.483*	-0.045	0.563*	0.042	0.115	-0.128	0.087	0.045	0.035	0.146
FD	BIP's					1	0.794*	0.047	0.155	0.475*	0.110	-0.314*	-0.170	-0.138	-0.127	0.149	0.256
	F3's					1	0.982*	0.075	0.117	0.737*	0.152	-0.049	-0.059	-0.150	-0.131	0.083	0.123
AFD	BIP's						1	-0.114	0.107	0.533*	0.032	-0.674*	-0.224	-0.190	0.162	0.211	0.157
	F3's						1	0.066	0.122	0.142	0.116	-0.335*	-0.048	-0.160	0.095	0.158	0.122
PH	BIP's							1	-0.564*	0.659*	0.079	-0.150	-0.107	0.023	0.115	0.156	0.662*
	F3's							1	-0.107	0.372*	-0.149	0.011	-0.091	0.025	0.049	0.040	0.629*
BPP	BIP's								1	0.054	0.030	0.159	-0.131	0.166	0.132	0.146	0.094
	F3's								1	0.122	0.068	0.029	-0.225	0.110	0.043	0.079	0.253
FW	BIP's									1	0.027	0.455*	-0.120	0.383*	0.007	0.121	0.881*
	F3's									1	0.072	0.346*	-0.014	0.445*	0.092	0.020	0.725*
PL	BIP's										1	-0.054	-0.127	-0.063	-0.028	-0.019	-0.007
	F3's										1	0.171	-0.172	0.163	0.155	0.086	0.216
TSS	BIP's											1	0.123	-0.009	0.069	-0.046	-0.088
	F3's											1	-0.100	0.193	0.159	-0.065	0.107
BWI	BIP's												1	-0.090	-0.066	-0.204	-0.495*
	F3's												1	-0.083	-0.048	-0.165	-0.503*
DM	BIP's													1	0.153	-0.113	0.201
	F3's													1	0.204	-0.199	0.178
IC	BIP's														1	0.045	0.209
	F3's														1	0.153	-0.133
PC	BIP's															1	-0.031
	F3's															1	-0.196

DTFF = Days to 50% flowering, DTFP = Days to first picking, NFPP = Number of marketable fruits per plant, FL= Fruit length, FD = Fruit diameter, AFD = Average fruit diameter, PH = Plant height, NBPP = Number of branches per plant, FW = Fruit weight, PL = Pedicel length, TSS = Total soluble solid, BWI= Bacterial wilt incidence, DMC = Dry matter content, IC = Iron content, PC = Phenol content, MYPP = Marketable yield per plant

Table.2 Estimate of genotypic correlation coefficient (r) between different pairs of characters in eggplant

		DFFF	DTFP	NFPP	FL	FD	AFD	PH	BPP	FW	PL	TSS	BWI	DM	IC	PC	MYPP
DFFF	BIP's	1	0.812*	0.711*	-0.111	-0.181	-0.011	0.067	0.039	0.291	0.079	-0.049	-0.451*	0.077	-0.059	-0.076	-0.232
	F ₃ 's	1	0.621*	0.502*	-0.093	-0.346	0.037	0.092	0.099	0.104	0.111	0.055	-0.332	-0.052	0.112	-0.032	-0.355*
DTFP	BIP's		1	0.078	0.087	-0.165	-0.161	-0.085	-0.065	0.072	-0.094	-0.053	-0.568*	0.211	0.187	-0.065	-0.452
	F ₃ 's		1	0.452*	-0.135	0.105	-0.066	-0.312	0.056	-0.045	0.032	0.018	-0.243	0.301	0.138	0.054	-0.122
NFPP	BIP's			1	-0.077	0.104	0.143	0.217	0.076	0.786*	0.189	0.108	-0.422*	-0.032	-0.071	-0.038	0.855*
	F ₃ 's			1	-0.113	-0.115	0.089	0.602*	0.061	0.456	0.035	0.075	-0.702*	-0.057	0.054	-0.014	0.764*
FL	BIP's				1	-0.084	0.045	0.322	0.019	0.185	0.087	0.176	-0.206	0.186	0.091	-0.048	0.284
	F ₃ 's				1	0.134	0.024	0.503*	-0.052	0.542*	0.034	0.133	-0.144	0.092	0.082	0.055	0.413
FD	BIP's					1	0.812*	0.092	0.162	0.533*	0.122	-0.452*	-0.154	-0.129	-0.131	0.153	0.532
	F ₃ 's					1	0.879*	0.075	0.159	0.795*	0.174	-0.083	-0.035	-0.165	-0.154	0.093	0.611
AFD	BIP's						1	-0.132	0.128	0.621*	0.094	-0.712*	-0.325	-0.217	0.187	0.273	0.515
	F ₃ 's						1	0.053	0.135	0.182	0.123	-0.451*	-0.079	-0.233	0.105	0.193	0.646
PH	BIP's							1	-0.628*	0.643*	0.104	-0.213	-0.142	0.073	0.171	0.182	0.753*
	F ₃ 's							1	-0.118	0.442*	-0.185	0.078	-0.111	0.049	0.059	0.104	0.686*
BPP	BIP's								1	0.089	0.067	0.174	-0.145	0.210	0.162	0.189	0.254
	F ₃ 's								1	0.213	0.106	0.045	-0.284	0.095	0.113	0.049	0.182
FW	BIP's									1	0.086	0.524*	-0.167	0.427*	0.018	0.234	0.982*
	F ₃ 's									1	0.092	0.483*	-0.045	0.496*	0.045	0.187	0.802*
PL	BIP's										1	-0.056	-0.189	-0.063	-0.053	-0.044	-0.312
	F ₃ 's										1	0.086	-0.173	0.163	0.176	0.102	0.298
TSS	BIP's											1	0.132	-0.031	0.056	-0.082	0.422
	F ₃ 's											1	-0.064	0.045	0.174	-0.078	0.346
BWI	BIP's												1	-0.103	-0.015	-0.155	-0.433*
	F ₃ 's												1	-0.068	-0.054	-0.099	-0.335*
DM	BIP's													1	0.167	-0.156	0.412
	F ₃ 's													1	0.134	-0.165	0.257
IC	BIP's														1	0.078	0.165
	F ₃ 's														1	0.217	0.234
PC	BIP's															1	-0.412
	F ₃ 's															1	-0.288

DFFF = Days to 50% flowering, DTFP = Days to first picking, NFPP = Number of marketable fruits per plant, FL= Fruit length, FD = Fruit diameter, AFD = Average fruit diameter, PH = Plant height, NBPP = Number of branches per plant, FW = Fruit weight, PL = Pedicel length, TSS = Total soluble solid, BWI= Bacterial wilt incidence, DMC = Dry matter content, IC = Iron content, PC = Phenol content, MYPP = Marketable yield per plant

Table.3 Estimates of direct and indirect effects at the phenotypic level in biparental progenies of cross Arka Keshav X Bhola Nath (AK x BN)

	DFFF	DTFP	NFPP	FL	FD	AFD	PH	BPP	FW	PL	TSS	BWI	DM	IC	PC
DFFF	-0.051	0.041	-0.030	0.009	0.015	0.012	-0.030	0.019	0.034	0.001	0.001	-0.017	0.011	0.006	0.009
DTFP	-0.042	0.053	-0.029	-0.028	0.011	-0.009	0.028	0.019	-0.031	0.006	-0.003	0.016	-0.005	-0.065	-0.012
NFPP	-0.175	0.097	0.330	-0.022	0.012	0.013	0.121	0.013	0.249	-0.034	0.003	0.011	-0.006	-0.048	-0.009
FL	0.078	0.073	0.182	0.290	0.066	0.075	0.083	0.057	0.075	0.001	0.020	-0.035	0.033	0.036	0.013
FD	0.071	-0.049	0.076	0.015	0.245	0.095	0.109	0.018	0.052	0.012	0.042	-0.028	0.058	0.031	0.017
AFD	0.003	-0.060	0.012	-0.073	-0.179	0.126	0.015	-0.067	0.075	0.006	-0.137	0.073	-0.092	-0.052	-0.018
PH	0.053	0.048	0.097	0.103	0.116	0.107	0.309	0.094	0.192	0.002	0.013	-0.105	0.084	0.056	0.005
BPP	0.023	0.023	0.027	0.026	0.009	0.013	-0.013	0.063	0.022	0.002	0.010	-0.008	-0.016	0.008	0.009
FW	-0.114	0.092	0.148	0.112	0.036	0.039	0.103	0.060	0.471	0.005	0.009	-0.054	0.031	0.035	0.014
PL	0.001	-0.044	-0.004	0.003	0.006	-0.007	-0.002	-0.001	-0.001	-0.029	0.002	0.004	-0.002	0.001	-0.001
TSS	-0.003	-0.025	-0.010	-0.015	-0.003	-0.002	0.005	0.007	0.006	0.006	0.075	-0.000	-0.021	-0.007	-0.005
BWI	0.000	0.058	0.002	-0.001	-0.002	-0.004	-0.001	0.005	0.002	0.002	-0.001	-0.194	-0.017	-0.013	-0.007
DM	0.000	0.015	0.000	0.003	0.003	0.007	0.003	0.003	0.006	0.008	0.001	-0.013	0.140	0.022	-0.016
IC	0.005	-0.013	0.001	0.002	0.002	0.000	0.001	0.001	0.006	0.003	0.009	-0.008	0.019	0.126	0.006
PC	0.002	0.002	0.003	-0.003	-0.003	-0.003	0.004	0.001	-0.003	0.000	-0.001	-0.005	0.201	0.209	-0.019
Coeff. of corr. with MYPP	-0.132	0.094	0.794*	0.199	0.256	0.157	0.662*	0.094	0.881*	-0.007	-0.088	-0.495*	0.201	0.209	-0.031

Residual effect: 0.0053 (Underlined values denotes direct effects and the remaining indirect effects)

Number of marketable fruits per plant was positively and significantly associated with plant height, fruit weight, whereas it was negatively correlated with bacterial wilt incidence. Fruit length was significantly and positively correlated with plant height and fruit weight and negative and non-significant association was observed with number of branches per plant. The fruit diameter was positively correlated with average fruit diameter and fruit weight. The average fruit diameter was positively correlated with fruit weight and negatively and significantly correlated with dry matter content. Positive and significant correlation of plant height with fruit weight was observed. The fruit weight was positively and significantly correlated with total soluble solids and dry matter content in cross AK × BN. The fruit weight also exhibited non-significant and negative correlations with bacterial wilt incidence

Total association between a pair of characters is measured by the correlation coefficients. But the association between the two characters comprises of a complicated pathway involving various other attributes, which may have direct or indirect effects on the dependent characters. Direct contribution of the component characters to fruit weight and the indirect effects, which there may have through their relationship with each other been isolated out through path analysis (Table 3).

While comparing the BIP's and F3 families with respect to the direct effects of the component characters, it was observed that best expression of the effect in respect of fruit weight was obtained in BIP's and F3 progenies of both the crosses. A perusal of the indirect effect of various component characters on marketable fruit yield indicated that fruit weight via number of marketable fruits per plant, fruit length and plant height contributed the maximum in biparental and F3 progenies. Fruit weight had the highest direct effects in the BIP's and F3 progenies. Number of marketable fruits per plant, as well as plant height also contributed substantially indirectly through fruit

weight for BIP's and F3 progenies. From the above results, it appeared that inter-mating influenced both direct and indirect effects of various characters on fruit yield. Similar observations have also been recorded by Nair and Mehta (2008), Tripathi *et al.*, (2009) and Kumar *et al.*, (2013) in brinjal.

Nayak and Nagre (2013) revealed that fruit length, diameter and weight influenced the fruit yield with high direct effect and significant positive correlation. Therefore, fruit length, diameter and weight are important characters which may be included in selection criteria for improvement in fruit yield per plant. Lakshmi *et al.*, (2014) revealed positive and highly significant association of number of flowers per cluster, number of fruits per cluster, average fruit length and number of fruits per plant with fruit yield in brinjal. Path coefficient analysis revealed that the characters viz., fruit set percentage, fruit weight, number of fruits per plant, relative style length, number of flowers per cluster and number of fruits per cluster had high direct effect and correlation values. Thus, the fruit yield per plant can be improved by making selection of these characters during yield improvement programme.

In conclusion, the association studies revealed that marketable fruit yield was positively and significantly correlated with fruits per plant, plant height and fruit weight in BIP's and F₃ progenies. The four quality attributes viz., dry matter, total soluble solids, iron content and phenol content appeared to be independent of each other as correlation among them were found to be non-significant. Path analysis indicated that fruit weight had a maximum direct effect with marketable fruit yield. Indirect effects of fruit weight on marketable fruit yield via other characters viz., number of marketable fruits per plant, plant height and fruit length were also of higher magnitude. Thus, predicting the true relationship of fruit weight with marketable fruit yield. As such, selection based on fruit weight would prove fruitful and rewarding for obtaining high fruit yield.

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