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Correlation and path analysis studies in brinjal (*Solanum melongena* L.)

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Abstract

Correlation studies were carried out in brinjal to find out the association between yield and its contributing characters. Certain characters might indirectly influence yield, but their correlation with yield may not be statistically significant. In such cases, path coefficient analysis is an efficient technique, which permits the separation of coefficients into components of direct and indirect effects. Hence the study was carried out to know interrelations of twelve characters and to understand the nature of direct and indirect effects of these characters on yield. Correlation and path analysis in 24 genotypes of brinjal indicated that Marketable fruit yield per plant manifested significant and positive correlation with number of marketable fruits per plant, fruit weight, fruit diameter, fruit length, plant height and number of branches per plant, whereas it had significant and negative association with days to 50 per cent flowering and days to first picking at both phenotypic and genotypic levels. Path analysis indicated that number of marketable fruits per plant, fruit weight, fruit diameter, fruit length and number of branches per plant had the maximum positive direct effect on marketable fruit yield per plant at both phenotypic and genotypic level. Hence, these characters may be given consideration while making selection for the improvement of brinjal.

Keywords: Brinjal, Correlation coefficient, Path analysis, Yield related characters

Introduction

Eggplant, *Solanum melongena* L. is a common vegetable crop grown in the subtropics and tropics. It is called brinjal in India, and *aubergine* in Europe. Knowledge of association between traits serves two main purposes for the breeders. Firstly, these are highly useful in selecting characters which are not easily observed or genotypic values of which are modified by environmental effects. There is ample evidence to show that direct selection for yield in plants is not easy. Thus, any morphological characters that is associated with higher yield or which makes significant contribution to yielding ability, would be useful in improvement of yield. Secondly, correlation between characters provides information regarding the nature and direction of selection pressure among different traits. Adams and Graficus (1971) and Adams (1975) 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. Significantly higher the association of a trait with yield, the more will be the success of a selection programme.

Studies on this aspect were made earlier by several workers. The correlation between traits is important when simultaneous selection of traits is required, or when the trait of interest presents a low heritability, or measuring and identification problems. In this case, by selecting for another trait with high variability and easy identification and measuring, and with a high correlation to the desired trait, the breeder may obtain more rapid progress compared with direct selection. Kumar et al. (2013) reported strong correlations between fruit yield and numbers of branches per plant, average fruit weight and number of fruit per plant. High positive effects of fruit diameter on fruit yield reported by Karak et al. (2012). A simple measure of correlation of characters does not quantify the relative contribution of causal factors to the ultimate yield. Since the component traits themselves are inter-dependant, they often affect their direct relationship with yield and consequently restrict the reliability of selection indices based upon correlation coefficients. Selection for yield is more effective when it is based on component characters which are highly heritable and positively correlated. When more number of variables is considered in correlation the association becomes more complex and less obvious. The path analysis is useful under such circumstances. This gives clear picture of the direct and indirect effects of various

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traits on yield. Hence, the present study was undertaken to estimate the genotypic correlations and direct and to determine the indirect effects of component characters on yield in brinjal. Based upon these considerations, the present studies was undertaken in twenty four bacterial wilt resistant genotypes with the objectives to estimate the extent of association between marketable fruit yield and other horticultural traits.

Materials and Methods

The field experiments with twenty-four genotypes and experiment was laid out in a randomized block design with three replications during kharif 2014 at experimental research farm of Vegetable Science at CSKHPKV, Palampur. It is situated at 32°6'N latitude and 76°3'E longitude at an elevation of 1290.8 meters above mean sea level representing mid hill zone of Himachal Pradesh. The soil of this zone is of podzolic type with pH ranging from 5.0-5.8. The total rainfall for the crop season was 1626.73 mm. Maximum temperature ranged from 15.6^{0}C to 34.4^{0}C and minimum temperature varied from 6.72 to 21.8°C, while the relative humidity ranged from 31.2 per cent to 93.6 per cent during the growth period of crop. Thirty days old seedlings were transplanted on the ridges adopting a spacing of 60 × 45 cm. Standard horticultural practices and plant protection measures recommended for hybrid eggplant were adopted uniformly. Observations were recorded on different horticultural traits *viz*. marketable fruit yield per plant, days to 50 per cent flowering, days to first picking, marketable fruit per plant, fruit length, fruit diameter, plant height, number of branches per plant, fruit weight, pedicel length, total soluble solids and dry matter percentage. For computing phenotypic, genotypic and environmental correlation coefficients, analysis of co-variance were carried out in all possible pairs of combinations of the characters. The phenotypic, genotypic and environmental coefficients of correlation were computed as suggested by Al-Jibouri et al. (1958). The path-coefficient analysis of important horticultural traits as well as quality traits with yield was done following Dewey and Lu (1959) was used to partition the genotypic correlation into components of direct and indirect effects.

Results and Discussion

In the present study, in general, correlation studies revealed that though there is strong inherent association between various traits, the phenotypic expression of the correlation gets reduced under the influence of environment. Marketable fruit yield per plant manifested significant and positive correlation with number of marketable fruits per plant, fruit weight, fruit diameter, fruit length, plant height and number of branches per plant. It had significant and negative association with days to 50% flowering and days to first picking. The quality attributes *viz.,* total soluble solids and dry matter content had no association with marketable fruit yield per plant. These results suggest that selection for more vigorous plants along with number of marketable fruits per plant, fruit weight, fruit diameter and fruit length, plant height and number of branches per plant will be rewarding for contributing towards higher yield. These results corroborate with the findings of Patel and Sarnaik (2005), Nayak and Nagre (2013) and Lakshmi et al. (2014).

Correlation studies among the other traits revealed that days to 50% flowering is positively and significantly associated with the days to first picking and have negative association with marketable fruit yield. Likewise, days to first picking has been found to be negatively associated with the marketable fruit yield per plant and plant height meaning thereby that dwarf plant produced early fruit yield. Association of fruit length with dry matter and marketable fruit yield per plant has been found positive and significant. These results are in consonance with the findings of Lakshmi et al. (2014) who have reported positive association of fruit length with marketable fruit yield. Association of fruit length with fruit diameter has been found to be negative and significant. This trend is expected as the long fruited genotypes, in general, have lesser fruit diameter as compared to round fruited ones. These results are in conformity with the findings of Dhankar and Singh (1983) who have also reported negative association of fruit length with fruit diameter. However, fruit diameter has been found to be significantly and positively associated with fruit weight. This trend expect as round fruited varieties Hisar Shyamal possessed higher fruit weight than the long fruited types. The negative association of number of marketable fruits per plant with fruit weight and fruit diameter were observed revealing a balanced selection pressure for each trait. The study indicated that the improvement in fruit yield could be affected by increasing the number of marketable fruits per plant and making a compromise for size and weight, depending upon the fruit shape since the association of fruit weight was significantly positive with fruit diameter. The plants producing higher number of marketable fruits per plant, in general, recorded lower fruit weight. The negative association of these two traits has also been reported by Patel et al. (2004). This may be due to limited supply of nutrients between large number of fruits. If the number of fruit is less it will get the nutrients in the desired amount and therefore size of

fruits will be more. Quality trait appears to be independent of these association and marketable fruit yield per plant. From the present investigations, it is concluded that characters like number of marketable fruits per plant, fruit weight, fruit diameter and fruit length are to be given due consideration in selection schemes aimed at the improvement of fruit yield in brinjal.

Marketable fruit yield per plant was taken as a dependent variable and all other traits used for correlation were considered as casual variables. Maximum positive direct effect on marketable yield/plant at phenotypic and genotypic levels (Table 1) were observed for number of marketable fruits per plant (0.544, 0.547), fruit weight (0.504, 0.525), fruit diameter (0.377, 0.380), fruit length (0.320, 0.322) and number of branches per plant (0.274, 0.285). Further, it was observed that beside fruit diameter the number of marketable fruits per plant had the maximum direct contribution on the total association of fruit length, plant height and number of branches per plant at both phenotypic and genotypic level with marketable fruit yield per plant. These results are in accordance with the findings Ahmed et al. (2013) and Shende et al. (2014) also advocated that number of fruits per plant, length of fruit, fruit weight and plant height would be selection criteria for yield improvement in brinjal. The low magnitude of residual effect at phenotypic and genotypic level indicated that the traits included in present investigation accounted for most of the variations present in the dependent variable *viz.,* marketable fruit yield per plant. However, direct effect of fruit weight on yield was positive and high and its correlation was also positive and high. This revealed that indirect effect of fruit weight via number of branches per plant, fruit diameter, fruit length were positive resulting in a positive but significant association of this trait with marketable yield.

Number of marketable fruits per plant exhibited highest direct effect on marketable yield per plant and its association with yield was positive and significant which may be attributed high positive indirect effects via number of branches per plant, fruit length, and plant height. These results corroborate with the findings of Nair and Mehta (2007), Thangamani and Jansirani (2012). Like fruit weight, fruit diameter exhibited high direct effect on marketable yield per plant. However its association with yield was positive and significant which may be attributed to high positive indirect effects via fruit weight and number of branches per plant. With

Table 1: Estimates of phenotypic (P) and genotypic (g) correlation coefficient for different pairs of marketable fruit yield and other horticultural traits in brinjal

Traits		Days to first picking	Number of marketable fruits per plant	Fruit length (cm)	Fruit diameter (cm)	Plant height (cm)	Number of branches per plant	Fruit weight (g)	Pedicel length (cm)	TSS (%)	Dry matter percentage	Marketable fruit yield per plant (kg)
Days to 50% flowering	P	0.986**	0.0240	0.215	0.136	0 .177	0.089	0.111	0.201	0.113	0.063	--0.219*
	G	0.989**	0.0247	0.217	-0.139	-0.180	-0.090	-0.118	0.207	0.116	0.064	-0.221*
Days to first picking	P		-0.001	0.203	0.152	0.217	-0.031	0.139	0.167	0.143	0.132	-0.228*
	G		0.001	0.206	0.154	-0.285*	0.027	0.135	0.169	0.146	0.138	-0.232**
Number of marketable fruits per plant	P			-0.223*	0.121	0.542**	0.158	-0.228*	0.190	0.170	0.136	0.544**
	G			-0.227*	0.125	0.543**	0.159	-0.231*	0.196	0.191	0.148	0.547**
Fruit length	P				-0.285*	0.168	0.226	0.053	0.230*	0.112	0.168	0.320**
	G				-0.288*	0.187	0.229	0.059	0.280*	0.133	0.187	0.322**
Fruit diameter	P					0.1643	0.186	0.918*	-0.093	0.225*	0.277*	0.377**
	G					0.1651	0.195	0.924*	-0.151	0.232*	0.282*	0.380**
Plant height	P						0.217	0.191	0.133	0.121	0.206	0.243**
	G						0.220	0.199	0.164	0.123	0.208	0.245*
Number of branches per plant	P							0.173	0.094	0.200	0.119	0.274*
	G							0.177	0.098	0.212	0.123	0.285*
Fruit weight	P								0.126	0.177	0.115	0.504**
	G								0.129	0.194	0.119	0.525**
Pedicel length	P									0.139	0.187	0.126
	G									0.142	0.195	0.129
TSS	P										0.134	0.133
	G										0.133	0.135
Dry matter percentage	P											0.151
	G											0.155

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

respect to number of branches per plant exhibited high direct effect on marketable yield per plant as well as its association with yield was positive and significant which may be attributed to high positive indirect effects via fruit length, fruit diameter and number of marketable fruits per plant. High positive effect of number of branches per plant on yield has also been reported by Nair and Mehta (2007), Thangamani and Jansirani (2012) and Ahmed et al. (2013). Plant height, besides having high and positive correlation with marketable yield, also exhibited high positive contribution towards yield at both phenotypic and genotypic level. The trait also manifested positive direct influence on marketable yield via number of marketable fruits per plant, fruit weight and number of branches per plant. High positive effect of plant height on fruit yield has also been reported by Ahmed et al. (2013). Keeping in view, the direct and indirect contributions of component traits, purposeful and balanced selection on the basis of horticultural traits, *viz.,* number of marketable fruits per plant fruit weight, fruit diameter, fruit length and number of branches per plant would be more effective and rewarding for the improvement of brinjal.

The association studies revealed that marketable fruit yield per plant possesses positive and significant correlation with number of marketable fruits per plant and fruit weight. Path coefficient analysis indicated that number of marketable fruits per plant, fruit weight, fruit diameter, fruit length, and number of branches per plant had maximum direct effects on marketable fruit yield per plant. Indirect effects of number of marketable fruits per plant on marketable fruit yield per plant via other characters were also of high magnitude. Therefore, selection based on marketable fruit yield per plant, number of marketable fruits per plant, fruit weight, fruit diameter, fruit length and number of branches per plant would be fruitful and rewarding for the improvement of brinjal.

Table 2: Estimates of direct and indirect effects of different traits on marketable yield and horticultural traits at phenotypic (P) and genotypic (G) levels in brinjal

Traits		Days to 50 % flowering	Days to first picking	Number of marketable fruits per plant	Fruit length (cm)	Fruit diameter (cm)	Plant height (cm)	Number of branches per plant	Fruit weight (g)	Pedicel length (cm)	TSS (°Brix)	Dry matter percen-tage	Correlation with marketable fruit yield per plant
Days to 50 % flowering	P	**-0.315**	0.103	-0.214	0.082	-0.081	-0.044	0.035	-0.074	0.073	0.068	0.071	--0.219*
	G	**-0.317**	0.106	-0.218	0.083	-0.091	-0.046	0.043	-0.076	0.075	0.069	0.074	-0.221*
Days to first picking	P	-0.145	**0.220**	0.208	0.166	0.157	-0.079	-0.222	-0.219	-0.077	-0.062	0.054	-0.228*
	G	-0.147	**0.232**	-0.212	0.169	0.163	-0.082	0.225	-0.223	-0.079	-0.063	0.068	-0.232*
Number of marketable fruits per plant	P	-0.092	0.048	**0.635**	0.124	-0.142	0.065	0.160	-0.160	-0.054	0.042	0.070	0.544**
	G	-0.098	0.051	**0.740**	0.126	-0.168	0.068	0.167	-0.168	-0.058	0.048	0.024	0.547**
Fruit length	P	-0.163	0.084	0.127	**0.399**	-0.154	0.094	0.103	-0.174	0.060	0.076	0.064	0.320**
	G	-0.165	0.092	0.132	**0.530**	-0.220	0.098	0.108	-0.178	0.061	0.079	0.067	0.322**
Fruit diameter	P	-0.078	0.078	-0.245	-0.212	**0.498**	-0.077	0.130	0.142	-0.032	0.084	0.095	0.377**
	G	-0.086	0.080	-0.202	-0.215	**0.526**	-0.079	0.134	0.149	-0.038	0.088	0.096	0.380**
Plant height	P	-0.103	-0.163	0.116	-0.094	0.061	**0.199**	0.062	0.088	-0.048	-0.036	0.022	0.243*
	G	-0.107	-0.168	0.124	-0.097	0.065	**0.220**	0.064	0.092	-0.049	-0.038	0.024	0.245*
Number of branches per plant	P	0.052	-0.108	0.098	0.134	0.117	-0.105	**0.322**	-0.202	-0.022	0.038	0.068	0.274*
	G	0.057	-0.110	0.103	0.158	0.123	-0.107	**0.328**	-0.212	-0.024	-0.041	0.069	0.285*
Fruit weight	P	-0.074	-0.066	-0.130	-0.125	0.135	-0.063	0.127	**0.568**	-0.032	-0.064	0.038	0.504**
	G	-0.077	-0.069	-0.138	-0.128	0.138	-0.066	0.132	**0.572**	-0.034	0.067	0.045	0.525**
Pedicel length	P	-0.034	0.026	0.037	0.152	-0.050	-0.047	-0.065	-0.031	**0.141**	-0.023	-0.048	0.126
	G	-0.035	0.028	0.039	0.164	-0.053	-0.049	-0.067	-0.033	**0.143**	-0.024	-0.049	0.129
TSS	P	0.033	-0.029	0.075	0.105	0.092	-0.054	-0.061	0.043	-0.023	**0.023**	0.021	0.133
	G	0.038	-0.031	0.076	0.107	0.098	-0.057	-0.063	0.046	-0.026	**0.027**	0.023	0.135
Dry matter percentage	P	0.017	-0.043	0.048	0.072	0.114	-0.052	-0.039	0.063	-0.058	-0.036	**0.028**	0.151
	G	0.019	-0.045	0.057	0.074	0.119	-0.054	-0.041	0.068	-0.059	-0.038	**0.029**	0.155

Residual effects (P) = 0.171; (G) = -0.223 Bold values indicates direct effects ***Significant at 5% level, ** Significant at 1% level**

सारांश

बैंगन में उपज एवं उपज घटकों के मध्य सहसम्बन्ध ज्ञात करने के लिये अध्ययन किया गया। कुछ गुण परोक्ष तौर पर उपज को प्रभावित कर सकते हैं लेकिन उपज के साथ सहसम्बन्ध सांख्यिकी तौर पर सार्थक नही हो सकता। ऐसी स्थिति में पथ गुणांक विश्लेषण जो एक प्रभावी तकनीकी है, के माध्यम से प्रत्यक्ष व अप्रत्यक्ष प्रभाव को अलग किया जा सकता है। अतः 12 गुणों में अन्तःसम्बन्ध को ज्ञात करने के लिए अध्ययन किया गया एवं जिससे इन गुणों के प्रत्यक्ष व अप्रत्यक्ष प्रभाव की प्रवृति को समझा जा सके। बैंगन के कुल 24 प्रभेदों के सहसम्बन्ध व पथ विश्लेषण से बाजार योग्य फल उपज प्रति पौध ने सार्थक व धनात्मक सहसम्बन्ध बाजार योग्य फलों की संख्या/पौध फल भार, फल व्यास, फल की लम्बाई, पौध ऊँचाई तथा शाखाओं की संख्या/पौध से रहा जबकि इसका सार्थक व ऋणात्मक सम्बन्ध 50 प्रतिशत पुष्पन तथा प्रथम तुड़ाई के दिन का दोनों लक्ष्य प्रारूप व अनुवांशिक प्ररूप स्तर पर स्पष्ट पाया गया। पथ विश्लेषण से स्पष्ट हुआ कि बाजारयोग्य फलों की संख्या/पौध, फल भार, फल व्यास, फल की लम्बाई तथा प्रति पौध शाखाओं की संख्या अधिक धनात्मक प्रयोग सीधे तौर पर बाजार योग्य फलों की संख्या/पौध के प्रति लक्षण प्ररूप व अनुवांशिक प्ररूप दोनों स्तर पर पाया गया। अतः बैंगन के उन्नयन प्रक्रिया में उपरोक्त गुणों पर बल देना चाहिए।

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