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Analysis of direct and indirect effects of various components on tomato (*Lycopersicon esculentum* Mill.) fruit yield by correlation and path co-efficient analysis

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ABSTRACT

Genetic studies were conducted for yield and physiological traits in F_2 generation involving six crosses. The parameters statistically analyzed were correlation and path analysis to study direct and indirect effects of various components on fruit yield. From the correlation studies, it was revealed that the trait plant height followed by dry matter accumulation and number of fruits per plant showed the highest positive and significant relationship with fruit yield. The path analysis in F_2 cross combination concluded that plant height, number of fruits per plant and flowering duration had the highest direct contribution than other component of yield in all the six crosses. If emphasis would be given for selection of these traits in breeding programme, it will automatically increase fruit yield per plant.

Key words : Correlation, Path analysis, F_2 generation, Direct and indirect effects, Tomato

Tomato occupies the largest area among the vegetable crops in the world, next to potato. It is considered as "poor man's apple" because of its attractive appearance and high nutritive value. In the recent past, tomato improvement is being attempted with wider breeding objectives, including development of heat tolerant lines, processing tomatoes and resistant genotypes for various biotic and abiotic stresses etc.

Unfortunately, the minimum temperature of Tamil Nadu also, never falls below 20^0C during summer months. Hence attempts have been made in recent past to evolve a variety with potentiality of high yield and also tolerance for heat. Based on these objectives parents of heat tolerants were selected in this study.

Further, in any crop improvement programme, it is obvious to have simultaneous improvement of more than one character. Involvement of more than one component in the expression of complex characters like yield complicates the progress of selection. Hence, before attempting for selection, information on magnitude of association existing between these characters and their components should be made available. Estimate of simple correlation coefficient is important to facilitate selection programme. Hence, selection based on the magnitude and direction of association between yield and its components would be more useful for a successful breeding programme.

MATERIALS AND METHODS

The study was undertaken at Agricultural College and Research Institute, Madurai utilizing the intervarietal crosses of tomato (*Lycopersicon esculentum* Mill.) with an aim to select superior crosses and promising segregants in F_2 generation

The experimental materials included were six crosses of F_2 *viz*., P_3 x P_4 (CO 3 X Arka Meghali), P_3 x P_6 (CO 3 x CLN 1462 AG), P_4 x P_6 (Arka Meghali x CLN 1462 AG), P_4 x P_5 (Arka Meghali x Paiyur 1), P_4 x P_8 (Arka Meghali x H 24), P_5 x P_8 (Paiyur 1 x H 24) involving five parents *viz.,* P_3 (CO 3), P_4 (Arka Meghali), P_5 (Paiyur 1), P_6 (CLN 1462 AG) and P_8 (H 24). The selfed seeds of F_1 generation from the previous study conducted by Rahul Marik (2005) were used for raising the F_2 progenies.

Study of F_2 generation:

The F_2 generation was raised during June-October, 2005. A total of two hundred and fifty plants of each cross were maintained in all the six crosses. Forty plants in each of five parents involved in the above crosses were also maintained. The progenies were evaluated for eleven characters on single plant basis for yield and physiological contributions.

Selfing:

The selected F_2 progenies were selfed with an idea of forwarding them to the next generation. The unopened, matured flower buds of the crosses and parents that are likely to open on the next day were covered with butter paper covers and the same were removed after 4 or 5 days following the confirmation of self pollination with

fruit development.

Care was taken to maintain a healthy crop by adopting all the recommended cultural practices. Observations were recorded on single plant basis in F_2 populations on plant height, number of primary branches per plant, number of fruits per plant, single fruit weight, fruit yield per plant, flowering duration and physiological characters *viz*., style length, chlorophyll stability index, root length, dry matter accumulation, root/shoot ratio.

The magnitude and the strength of association between yield and related characters were estimated through the phenotypic and genotypic correlation coefficients according to Miller *et al*. (1958) and their significance was tested. The association among the characters was measured by the correlation coefficient (r) in F_2 generation following the method suggested by Goulden (1952).

The relative influences of ten components on yield by themselves (direct effects) and through other traits (indirect effects) were evaluated by the method of path coefficient analysis as suggested by Dewey and Lu (1959). The simple correlation coefficients estimated previously at genotypic level were utilized for this purpose.The direct and indirect effects were classified based on the scale given by Lenka and Misra (1973).

RESULTS AND DISCUSSION

The observation made on individual plants of F_2 generation of six crosses along with their five parents for eleven characters *viz*., plant height, flowering duration, number of fruits per plant, number of primary branches per plant, single fruit weight, style length, chlorophyll stability index, root length, root/shoot ratio, dry matter accumulation and fruit yield per plant were stastically analysed. The results revealed that significant differences existed between the crosses due to wide variability. Hence, the experimental material offers excellent scope for further improvement through selection.

The segregating progenies of six crosses were evaluated for their yield potential. In each cross combination direct and indirect pathway of fruit yield were also estimated. The results are discussed here in.

Correlation:

Studies on the inter relationship of characters on fruit yield was provided by correlation and simultaneous improvement of desirable characters are possible under selection. The efficiency of selection depends on the utilization of information on the direction and magnitude of association between yield and its components. Therefore, in the present study, the inter relationship of

Table 1 : Genotypic correlation coefficients between fruit yield per plant and yield components in the cross P_3 x P_4

Sr. No.	Characters	Plant height	Flowering duration	Number of fruits plant	Number of primary branches per plant	Single fruit weight	Style elongation	Chlorophyll stability index	Root length	Root / shoot ratio	Dry matter accumulation	Fruit yield per plant
1.	Plant height	1.00	0.052	0.843*	0.827*	0.733*	-0.032	-0.590	0.011	-0.776*	0.669*	0.787*
2.	Flowering duration		1.00	0.033	0.069	0.020	-0.027	-0.027	0.009	-0.034	0.010	0.020
3.	Number of fruits per plant			1.00	0.815*	0.748*	-0.110	-0.654*	0.015	-0.844*	0.896*	0.878*
4.	Number of primary branches per plant				1.00	0.668*	-0.092	-0.591	0.032	-0.694*	0.673*	0.753*
5.	Single fruit weight					1.00	-0.088	-0.579	-0.030	-0.669*	0.771*	0.735*
6.	Style elongation						1.00	0.065	-0.011	0.072	-0.154	-0.127
7.	Chlorophyll stability index							1.00	0.009	0.563	-0.586	-0.604*
8.	Root length								1.00	-0.002	0.003	-0.007
9.	Root / shoot ratio									1.00	-0.768*	-0.751*
10.	Dry matter accumulation										1.00	0.871*
11.	Fruit yield per plant											1.00

* indicates significance of value at P=0.05

Table 2 : Genotypic correlation coefficients between fruit yield per plant and yield components in the cross P_3 x P_6

Sr. No.	Characters	Plant height	Flowering duration	Number of fruits plant	Number of primary branches per plant	Single fruit weight	Style elongation	Chlorophyll stability index	Root length	Root / shoot ratio	Dry matter accumulation	Fruit yield per plant
1.	Plant height	1.00	0.920*	0.950*	-0.049	0.046	-0.055	-0.959*	-0.676*	-0.720*	0.469	0.860*
2.	Flowering duration		1.00	0.800*	-0.076	0.046	-0.021	-0.899*	-0.706*	-0.537	0.285	0.672*
3.	Number of fruits per plant			1.00	-0.042	0.046	-0.083	-0.897*	-0.659*	-0.762*	0.597	0.927*
4.	Number of primary branches per plant				1.00	-0.006	-0.123	0.051	0.071	-0.085	-0.062	-0.054
5.	Single fruit weight					1.00	0.012	-0.056	-0.032	-0.076	-0.079	0.076
6.	Style elongation						1.00	0.055	0.013	0.081	-0.074	-0.098
7.	Chlorophyll stability index							1.00	0.616*	0.673*	-0.410	-0.850*
8.	Root length								1.00	0.411	-0.306	-0.544
9.	Root / shoot ratio									1.00	-0.262	-0.788*
10.	Dry matter accumulation										1.00	0.512
11.	Fruit yield per plant											1.00

* indicates significance of value at P=0.05

Table 3 : Genotypic correlation coefficients between fruit yield per plant and yield components in the cross P_4 x P_6

Sr. No.	Characters	Plant height	Flowering duration	Number of fruits plant	Number of primary branches per plant	Single fruit weight	Style elongation	Chlorophyll stability index	Root length	Root / shoot ratio	Dry matter accumulation	Fruit yield per plant
1.	Plant height	1.00	0.803*	0.868*	0.815*	0.625*	-0.731*	-0.832*	-0.833*	-0.836*	0.843*	0.785*
2.	Flowering duration		1.00	0.902*	0.864*	0.761*	-0.869*	-0.883*	-0.824*	-0.914*	0.894*	0.910*
3.	Number of fruits per plant			1.00	0.955*	0.669*	-0.807*	-0.925*	-0.965*	-0.965*	0.948*	0.883*
4.	Number of primary branches per plant				1.00	0.581	-0.749*	-0.863*	-0.894*	-0.907*	0.862*	0.838*
5.	Single fruit weight					1.00	-0.877*	-0.717*	-0.635*	-0.718*	0.724*	0.870*
6.	Style elongation						1.00	0.843*	0.756*	0.823*	-0.835*	-0.904*
7.	Chlorophyll stability index							1.00	0.870*	0.943*	-0.958*	-0.857*
8.	Root length								1.00	0.923*	-0.923*	-0.839*
9.	Root / shoot ratio									1.00	-0.955*	-0.878*
10.	Dry matter accumulation										1.00	0.850*
11.	Fruit yield per plant											1.00

* Significant at 5 per cent level

eleven traits including yield per plant was estimated in the F_2 generation to identify characters or combination of characters which may be useful as an indicator of high yield.

In the present study, in cross I dry matter accumulation, number of fruits per plant, plant height, number of primary branches per plant and single fruit weight showed significant and positive correlation with fruit yield; In cross II number of fruits per plant, plant height and flowering duration exhibited positive and significant association with fruit yield; In cross III flowering duration, number of fruits per plant, dry matter accumulation, single fruit weight, number of primary branches per plant and plant height registered highly significant and positive correlation with fruit yield; In cross IV number of primary branches per plant, dry matter accumulation, single fruit weight, flowering duration, plant height and number of fruits per plant recorded highly positive and significant correlation with fruit yield; In cross V flowering duration, number of primary branches per plant, single fruit weight, plant height and dry matter accumulation showed positive and significant correlation with fruit yield; In cross VI single fruit weight, plant height, dry matter accumulation, number of primary branches per plant, number of fruits per plant and flowering duration registered highly significant and positive association with fruit yield. This offered the opportunity of getting recombinant with high fruit yield. From this correlation study, it may be concluded that intensive selection on positive side for plant height, number of fruits per plant, dry matter accumulation, flowering duration, number of primary branches per plant and single fruit weight will increase the fruit yield. Since these characters showed significantly positive relationship with fruit yield. However, among this positive side responsed by different characters, the traits such as plant height followed by dry matter accumulation and number of fruits per plant showed very close association in all the six crosses towards fruit yield. When going for future selection in breeding programme of these characters is likely to increase fruit yield also. This kind of observation was observed in tomato by Singh and Mital (1976),Bangaru *et al.*(1983), Parthasarathy *et al.* (1982) and Chandran (1987). Style lengthwas negatively correlated with fruit yield which supported the selection for short styled flowers to improve the yield. Chlorophyll stability index, root length, root/shoot ratio had negative correlation with fruit yield. Hence, intensive selection for these characters will, however, reduce the yield and compromise towards selection is required for these characters.

Table 4 : Genotypic correlation coefficients between fruit yield per plant and yield components in the cross P_4 x P_5

Sr. No.	Characters	Plant height	Flowering duration	Number of fruits plant	Number of primary branches per plant	Single fruit weight	Style elongation	Chlorophyll stability index	Root length	Root / shoot ratio	Dry matter accumulation	Fruit yield per plant
1.	Plant height	1.00	0.833*	0.739*	0.879*	0.846*	-0.759*	-0.873*	-0.837*	-0.866*	0.860*	0.838*
2.	Flowering duration		1.00	0.708*	0.926*	0.822*	-0.773*	-0.916*	-0.826*	-0.860*	0.847*	0.869*
3.	Number of fruits per plant			1.00	0.812*	0.889*	-0.660*	-0.855*	-0.955*	-0.855*	0.843*	0.689*
4.	Number of primary branches per plant				1.00	0.918*	-0.830*	-0.981*	-0.910*	-0.945*	0.919*	0.917*
5.	Single fruit weight					1.00	-0.796*	-0.937*	-0.967*	-0.989*	0.934*	0.883*
6.	Style elongation						1.00	0.863*	0.806*	0.839*	-0.875*	-0.806*
7.	Chlorophyll stability index							1.00	0.942*	0.955*	-0.939*	-0.913*
8.	Root length								1.00	0.956*	-0.940*	-0.838*
9.	Root / shoot ratio									1.00	-0.953*	-0.914*
10.	Dry matter accumulation										1.00	0.890*
11.	Fruit yield per plant											1.00

* indicates significance of value at P=0.05

Table 5 : Genotypic correlation coefficients between fruit yield per plant and yield components in the cross P_4 x P_8

Sr. No.	Characters	Plant height	Flowering duration	Number of fruits plant	Number of primary branches per plant	Single fruit weight	Style elongation	Chlorophyll stability index	Root length	Root / shoot ratio	Dry matter accumulation	Fruit yield per plant
1.	Plant height	1.00	0.944*	0.092	0.946*	0.955*	-0.113	-0.889*	-0.913*	-0.097	0.874*	0.847*
2.	Flowering duration		1.00	0.088	0.970*	0.956*	-0.131	-0.928*	-0.935*	-0.136	0.892*	0.933*
3.	Number of fruits per plant			1.00	0.089	0.075	-0.012	-0.061	-0.048	-0.016	0.023	0.073
4.	Number of primary branches per plant				1.00	0.957*	-0.148	-0.927*	-0.916*	-0.113	0.872*	0.924*
5.	Single fruit weight					1.00	-0.142	-0.922*	-0.926*	-0.110	0.923*	0.876*
6.	Style elongation						1.00	0.151	0.147	0.011	-0.156	-0.147
7.	Chlorophyll stability index							1.00	0.860*	0.122	-0.886*	-0.905*
8.	Root length								1.00	0.139	-0.883*	-0.866*
9.	Root / shoot ratio									1.00	-0.101	-0.145
10.	Dry matter accumulation										1.00	0.789*
11.	Fruit yield per plant											1.00

* indicates significance of value at P=0.05

Table 6 : Genotypic correlation coefficients between fruit yield per plant and yield components in the cross P_5 x P_8

Sr. No.	Characters	Plant height	Flowering duration	Number of fruits plant	Number of primary branches per plant	Single fruit weight	Style elongation	Chlorophyll stability index	Root length	Root / shoot ratio	Dry matter accumulation	Fruit yield per plant
1.	Plant height	1.00	0.988*	0.965*	0.976*	0.989*	-0.889*	-0.977*	-0.972*	-0.882*	0.988*	0.935*
2.	Flowering duration		1.00	0.947*	0.955*	0.970*	-0.845*	-0.980*	-0.946*	-0.871*	0.964*	0.904*
3.	Number of fruits per plant			1.00	0.952*	0.972*	-0.879*	-0.927*	-0.949*	-0.828*	0.946*	0.909*
4.	Number of primary branches per plant				1.00	0.978*	-0.899*	-0.945*	-0.983*	-0.909*	0.964*	0.923*
5.	Single fruit weight					1.00	-0.905*	-0.948*	-0.976*	-0.862*	0.975*	0.936*
6.	Style elongation						1.00	0.866*	0.893*	0.852*	-0.898*	-0.929*
7.	Chlorophyll stability index							1.00	0.934*	0.902*	-0.961*	-0.911*
8.	Root length								1.00	0.885*	-0.957*	-0.927*
9.	Root / shoot ratio									1.00	-0.882*	-0.861*
10.	Dry matter accumulation										1.00	0.932*
11.	Fruit yield per plant											1.00

* indicates significance of value at P=0.05

Table 7 : Direct and indirect effects on fruit yield as partitioned by path analysis in the cross P_3 X P_4

Characters	Plant height	Flowering duration	Number of fruits per plant	Number of primary branches per plant	Single fruit weight	Style elongation	Chlorophyll stability index	Root length	Root / shoot ratio	Dry matter accumulation	Correlation coefficient with fruit yield
Plant height	0.2275	-0.0004	0.1253	0.0893	-0.0113	0.0005	0.0171	-0.0002	-0.0306	0.3703	0.787*
Flowering duration	0.0119	-0.0084	0.0049	0.0075	-0.0003	0.0004	0.0008	-0.0002	-0.0014	0.0056	0.020
Number of fruits per plant	0.1918	-0.0003	0.1486	0.0881	-0.0115	0.0016	0.0189	-0.0003	-0.0333	0.4746	0.878*
Number of primary branches per plant	0.1882	-0.0006	0.1212	0.1080	-0.0103	0.0014	0.0171	-0.0006	-0.0274	0.3567	0.753*
Single fruit weight	0.1669	-0.0002	0.1112	0.0722	-0.0154	0.0013	0.0168	0.0006	-0.0264	0.4086	0.735*
Style elongation	-0.0074	0.0002	-0.0164	-0.0100	0.0014	-0.0146	-0.0019	0.0002	0.0029	-0.0818	-0.127
Chlorophyll stability index	-0.1343	0.0002	-0.0973	-0.0638	0.0089	-0.0009	-0.0289	-0.0002	0.0222	-0.3107	-0.604*
Root length	0.0025	-0.0001	0.0023	0.0035	0.0005	0.0002	-0.0003	-0.0186	-0.0001	0.0021	-0.007
Root / shoot ratio	-0.1767	0.0003	-0.1255	-0.0750	0.0103	-0.0011	-0.0163	0.0000	0.0394	-0.4069	-0.751*
Dry matter accumulation	0.1591	-0.0001	0.1332	0.0727	-0.0119	0.0022	0.0170	-0.0001	-0.0303	0.5296	0.871*

Residual effect = 0.1690 Direct effects on main diagonal * indicates significance of value at P=0.05

Table 8 : Direct and indirect effects on fruit yield as partitioned by path analysis in the cross P_3 X P_6

Characters	Plant height	Flowering duration	Number of fruits plant	Number of primary branches per plant	Single fruit weight	Style elongation	Chlorophyll stability index	Root length	Root / shoot ratio	Dry matter accumulation	Correlation coefficient with fruit yield
Plant height	-0.3173	-0.3297	0.9173	0.0022	0.0008	0.0007	0.5339	0.0020	0.0863	-0.0360	0.860*
Flowering duration	-0.2922	-0.3580	0.7728	0.0035	0.0008	0.0003	0.5006	0.0021	0.0644	-0.0218	0.672*
Number. of fruits per plant	-0.3016	-0.2867	0.9650	0.0019	0.0008	0.0011	0.4992	0.0019	0.0913	-0.0458	0.927*
Number. of primary branches per plant	0.0157	0.0275	-0.0406	-0.0452	-0.0001	0.0017	-0.0285	-0.0002	0.0102	0.0048	-0.054
Single fruit weight	-0.0149	-0.0166	0.0453	0.0003	0.0164	-0.0002	0.0312	0.0001	0.0092	0.0061	0.076
Style elongation	0.0176	0.0075	-0.0810	0.0056	0.0002	-0.0135	-0.0307	0.0000	-0.0097	0.0057	-0.098
Chlorophyll stability index	0.3045	0.3221	-0.8657	-0.0023	-0.0009	-0.0007	-0.5564	-0.0018	-0.0806	0.0314	-0.850*
Root length	0.2147	0.2531	-0.6359	-0.0032	-0.0005	-0.0002	-0.3433	-0.0029	-0.0493	0.0235	-0.544
Root / shoot ratio	0.2286	0.1926	-0.7357	0.0038	-0.0013	-0.0011	-0.3745	-0.0012	-0.1198	0.0201	-0.788*
Dry matter accumulation	-0.1491	-0.1021	0.5768	0.0028	-0.0013	0.0010	0.2285	0.0009	0.0314	-0.0765	0.512

Residual effect = 0.0839 Direct effects on main diagonal * indicates significance of value at P=0.05

Table 9 : Direct and indirect effects on fruit yield as partitioned by path analysis in the cross P_4 X P_6

Characters	Plant height	Flowering duration	Number. of fruits plant	Number of primary branches per plant	Single fruit weight	Style elongation	Chlorophyll stability index	Root length	Root / shoot ratio	Dry matter accumulation	Correlation coefficient with fruit yield
Plant height	-0.0127	0.2810	0.2746	0.0647	0.2820	0.0460	0.2070	0.2512	-0.1242	-0.4836	0.785*
Flowering duration	-0.0102	0.3499	0.2851	0.0686	0.3433	0.0548	0.2196	0.2484	-0.1357	-0.5131	0.910*
Number of fruits per plant	-0.0110	0.3156	0.3161	0.0758	0.3022	0.0508	0.2302	0.2907	-0.1433	-0.5441	0.883*
Number of primary branches per plant	-0.0104	0.3026	0.3022	0.0793	0.2623	0.0472	0.2148	0.2695	-0.1347	-0.4947	0.838*
Single fruit weight	-0.0079	0.2663	0.2118	0.0462	0.4510	0.0552	0.1784	0.1914	-0.1067	-0.4155	0.870*
Style elongation	0.0093	-0.3043	-0.2551	-0.0594	-0.3955	-0.0630	-0.2098	-0.2279	0.1223	0.4791	-0.904*
Chlorophyll stability index	0.0106	-0.3090	-0.2926	-0.0685	-0.3235	-0.0531	-0.2487	-0.2621	0.1401	0.5497	-0.857*
Root length	0.0106	-0.2886	-0.3051	-0.0710	-0.2865	-0.0476	-0.2165	-0.3012	0.1371	0.5296	-0.839*
Root / shoot ratio	0.0106	-0.3199	-0.3052	-0.0720	-0.3241	-0.0519	-0.2346	-0.2781	0.1485	0.5483	-0.878*
Dry matter accumulation	-0.0107	0.3130	0.2999	0.0684	0.3267	0.0526	0.2383	0.2781	-0.1419	-0.5736	0.850*

Residual effect = 0.0488 Direct effects on main diagonal * indicates significance of value at P=0.05

Table 10 : Direct and indirect effects on fruit yield as partitioned by path analysis in the cross P_4 X P_5

Characters	Plant height	Flowering duration	Number of fruits plant	Number of primary branches per plant	Single fruit weight	Style elongation	Chlorophyll stability index	Root length	Root / shoot ratio	Dry matter accumulation	Correlation coefficient with fruit yield
Plant height	0.0306	-0.0316	-0.6606	0.0565	0.0957	-0.1927	0.6116	0.5630	0.1512	0.2150	0.838*
Flowering duration	0.0255	-0.0379	-0.6329	0.0595	0.0930	-0.1963	0.6417	0.5552	0.1501	0.2116	0.869*
Number of fruits per plant	0.0226	-0.0268	-0.8931	0.0521	0.1006	-0.1675	0.5991	0.6422	0.1493	0.2106	0.689*
Number. of primary branches per plant	0.0269	-0.0351	-0.7255	0.0642	0.1038	-0.2109	0.6873	0.6122	0.1650	0.2297	0.917*
Single fruit weight	0.0259	-0.0312	-0.7946	0.0589	0.1131	-0.2021	0.6567	0.6502	0.1727	0.2335	0.883*
Style elongation	-0.0232	0.0293	0.5895	-0.0533	-0.0900	0.2538	-0.6050	-0.5422	-0.1465	-0.2187	-0.806*
Chlorophyll stability index	-0.0267	0.0347	0.7637	-0.0630	-0.1060	0.2192	-0.7006	-0.6335	-0.1668	-0.2346	-0.913*
Root length	-0.0256	0.0313	0.8533	-0.0585	-0.1094	0.2048	-0.6603	-0.6721	-0.1670	-0.2349	-0.838*
Root / shoot ratio	-0.0265	0.0326	0.7642	-0.0607	-0.1119	0.2131	-0.6694	-0.6432	-0.1745	-0.2380	-0.914*
Dry matter accumulation	0.0263	-0.0321	-0.7530	0.0591	0.1057	-0.2223	0.6580	0.6323	0.1663	0.2497	0.890*

Residual effect = 0.0833 Direct effects on main diagonal * indicates significance of value at P=0.05

Table 11 : Direct and indirect effects on fruit yield as partitioned by path analysis in the cross P_4 X P_8

Characters	Plant height	Flowering duration	Number of fruits plant	Number of primary branches per plant	Single fruit weight	Style elongation	Chlorophyll stability index	Root length	Root / shoot ratio	Dry matter accumulation	Correlation coefficient with fruit yield
Plant height	-0.3948	0.6958	-0.0009	0.3568	-0.0478	0.0011	0.3485	0.1493	0.0006	-0.2612	0.847*
Flowering duration	-0.3730	0.7365	-0.0009	0.3660	-0.0478	0.0013	0.3640	0.1528	0.0008	-0.2667	0.933*
Number. of fruits per plant	-0.0366	0.0650	-0.0100	0.0337	-0.0038	0.0001	0.0242	0.0079	0.0001	-0.0071	0.073
Number. of primary branches per plant	-0.3736	0.7151	-0.0009	0.3770	-0.0478	0.0015	0.3636	0.1497	0.0007	-0.2606	0.924*
Single fruit weight	-0.3773	0.7044	-0.0007	0.3609	-0.0500	0.0014	0.3615	0.1514	0.0007	-0.2758	0.876*
Style elongation	0.0446	-0.0970	0.0001	-0.0559	0.0071	-0.0098	-0.0595	-0.0241	-0.0001	0.0466	-0.147
Chlorophyll stability index	0.3510	-0.6839	0.0006	-0.3497	0.0461	-0.0015	-0.3920	-0.1406	-0.0008	0.2649	-0.905*
Root length	0.3608	-0.6890	0.0005	-0.3455	0.0463	-0.0014	-0.3374	-0.1634	-0.0009	0.2641	-0.866*
Root / shoot ratio	0.0385	-0.1005	0.0002	-0.0428	0.0055	-0.0001	-0.0479	-0.0228	-0.0062	0.0304	-0.145
Dry matter accumulation	-0.3451	0.6573	-0.0002	0.3288	-0.0461	0.0015	0.3475	0.1444	0.0006	-0.2988	0.789*

Residual effect = 0.0805 Direct effects on main diagonal * indicates significance of value at P=0.05

Table 12 : Direct and indirect effects on fruit yield as partitioned by path analysis in the cross P_5 X P_8

Characters	Plant height	Flowering duration	Number of fruits plant	Number of primary branches per plant	Single fruit weight	Style elongation	Chlorophyll stability index	Root length	Root / shoot ratio	Dry matter accumulation	Correlation coefficient with fruit yield
Plant height	1.2876	-0.3907	-0.0523	-0.3997	0.1120	0.3746	-0.0073	0.1649	0.0976	-0.2516	0.935*
Flowering duration	1.2724	-0.3953	-0.0514	-0.3910	0.1099	0.3559	-0.0073	0.1605	0.0963	-0.2455	0.904*
Number of fruits per plant	1.2427	-0.3744	-0.0542	-0.3900	0.1101	0.3703	-0.0069	0.1610	0.0916	-0.2409	0.909*
Number of primary branches per plant	1.2572	-0.3776	-0.0517	-0.4094	0.1108	0.3790	-0.0070	0.1667	0.1005	-0.2454	0.923*
Single fruit weight	1.2741	-0.3838	-0.0527	-0.4006	0.1132	0.3812	-0.0071	0.1656	0.0954	-0.2483	0.936*
Style elongation	-1.1453	0.3341	0.0477	0.3684	-0.1025	-0.4212	0.0065	-0.1514	-0.0943	0.2285	-0.929*
Chlorophyll stability index	-1.2585	0.3877	0.0503	0.3870	-0.1073	-0.3649	0.0075	-0.1584	-0.0998	0.2446	-0.911*
Root length	-1.2522	0.3741	0.0515	0.4026	-0.1106	-0.3762	0.0070	-0.1696	-0.0979	0.2436	-0.927*
Root / shoot ratio	-1.1369	0.3444	0.0449	0.3721	-0.0977	-0.3592	0.0067	-0.1502	-0.1105	0.2245	-0.861*
Dry matter accumulation	1.2728	-0.3813	-0.0513	-0.3948	0.1105	0.3782	-0.0072	0.1623	0.0975	-0.2545	0.932*

Residual effect = 0.0745 Direct effects on main diagonal * indicates significance of value at P=0.05

Path analysis:

The estimation of correlation coefficient indicated the inter relationship of the characters, but did not furnish information on the cause, effect and the relative importance of direct and indirect effects of the various characters on yield. In such a case, the correlation coefficient are insufficient to explain true association for analysis effective manipulation of the characters and path coefficient analysis suggested by Dewey and Lu (1959) facilitates the partitioning of the correlation coefficients of various characters into direct and indirect effects on yield per plant.

It is evident from the results of the present study that plant height, number of fruits per plant and flowering duration emerged as the direct and positive contributory characters to yield per plant due to their high direct effects on yield in most of the crosses. Positive direct contribution was reported by Supe and Kale (1992). This is suggested that if attention bestowed for the improvement towards plant height, number of fruits per plant and flowering duration would automatically increase fruit yield.

Dry matter accumulation, number of primary branches per plant and plant height showed highest indirect effects towards fruit yield per plant. Hence, emphasis is to be given primarily to these characters in exercising selection. Substantial indirect contribution towards fruit yield was provided by Khattra *et al.* (1990), Kumar (1978), Dudi and Kaloo (1982) and Rattan *et al.* (1983).

Conclusion:

The phenotypic correlation coefficient was higher than the genotypic correlation coefficient but, both these values were close to each other indicating the minor role of environment on all the characters.Plant height was positive and significant association with fruit yield in all the crosses and the chlorophyll stability index was negative and significant correlation with fruit yield per plant in all the six crosses.The traits such as number of primary branches per plant and dry matter accumulation were positive and significant correlation with fruit yield in five crosses except in the cross P_3 x P_6 (Co 3 x CLN 1462 AG) where it registered non significant values.The trait numbers of fruits per plant were registered positive and significant correlation with fruit yield for four crosses except in the cross P_4 x P_8 (Arka Meghali x H 24) where it was recorded positive and non significant relationship with fruit yield.From the path analysis revealed that in the cross P_3 x P_4 (Co 3 x Arka Meghali) the character dry matter accumulation recorded the highest direct effect on fruit yield. The cross P_3 x P_6 (Co 3 x CLN 1462 AG) showed that number of fruits per plant recorded the highest direct effect. In the cross P_4 x P_6 (Arka Meghali x CLN 1462 AG) single fruit weight accounted highest direct effect on fruit yield per plant.Style length registered the highest direct effect on fruit yield per plant in the cross P_4 x P_5 (Arka Meghali x Paiyur 1) and in the cross P_4 x P_8 (Arka Meghali x H 24) recorded highest direct effect on fruit yield through flowering duration. In the cross P_5 x P_8 (Paiyur 1 x H 24) plant height exhibited highest direct effect towards fruit yield per plant.

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