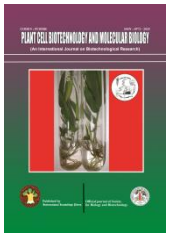

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Effect of Correlation and Path Analysis in Brinjal (*Solanum melongena* L.)

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The present investigation was carried out in thirty two genotypes of brinjal with a view to estimate the extent of variability, analysis of variance and genetic divergence. The experiment was conducted in Randomized Block Design with three replications at Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology Narendra Nagar, (Kumarganj), Ayodhya (U.P.), during Kharif, 2020-21. Each treatment consisted of twelve plant in two rows, having spacing of 60 cm x 50 cm with net plot size of 1.2 m x 3.00 m^2. The magnitudes of genotypic correlation was higher than the phenotypic correlation coefficients for all the character combinations. The most important trait, total fruit yield per plant had exhibited highly significant and positive phenotypic correlation with average fruit weight (0.747), number of fruits per plant (0.672) and fruit circumference (0.468) at both phenotypic and genotypic levels. Positive direct effect on total fruit

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yield was exerted by total sugars (0.474), average fruit weight (0.396), fruit circumference (0.358), number of fruits per plant (0.254), plant height (0.242), fruit polar length (0.194) and day to 50 % flowering (0.168). The higher magnitude of positive direct effect on total fruit yield was exerted by total sugars (0.474), average fruit weight (0.396), fruit circumference (0.358), number of fruits per plant (0.254), plant height (0.242), fruit polar length (0.194), day to 50 % flowering (0.168).

Keywords: Brinjal; genotypic correlation; phenotypic correlation; path analysis; analysis.

1. INTRODUCTION

"Brinjal (*Solanum melongena* L., 2n=2x=24) belongs family Solanaceae. Brinjal or egg plant is a perennial but grown commercially as annual crop. Inflorescence is often solitary but some time it constitutes a cluster of 2-5 flowers. Solitary or clustering nature of inflorescence is a varietal character. Flower is complete and hermaphrodite. Heterostyly is a common feature, and fruit setting flower consist of long (70-85%) and medium styled (12-55%) flower" [1]. According to botanical classification, the fruit is a berry, and the placenta, which is soft and white and fleshy, has many tiny, soft seeds buried in it. The seeds have nicotinoid alkaloids, which make them bitter even though they are edible. Because it is favoured by individuals from various socioeconomic backgrounds, brinjal is known as the "vegetable of masses." Owing to the growing population and increased demand for the crop, its production level needs to be further raised [2-4]. Brindajals have been improved since the early 1900s, and research is currently ongoing to find a superior cultivar because most commercial cultivars are deficient in one or more desired characteristics. Using hybrid vigour has been a viable strategy for improving eggplant. Nagai and Kida Although egg plants are mostly self-pollinating, reports of cross-pollination as high as 29% have led to the classification of these plants as frequently cross-pollinated or facultative cross-pollinated [5-7].

"Correlation and path co-efficient analysis are the important biometrical technique to determine the yield components. The characters that are positively correlated with yield are of considerably important to plant breeder for selection purpose. Correlation provides a measure of genetic association between the characters and reveals the traits that might be useful as an index of selection" [1]. According to Feyzian et al. (2009) "investigation of the interrelationships between yield and its components will improve the efficiency of a breeding programme with appropriate selection criteria. All the changes in the components need not, however be expressed by changes in the yield. This is due to varying degrees of positive and negative correlations between yield and its components and among the components themselves". "A study of association of these characters helps in selection of genotypes and also suggests the advantage of a selection scheme for more than one character at a time, which could be explained that improvement of one character results in improvement of all positively related characters. In the present study, the simple correlation coefficients between yield and its components and their inter correlations among the components were estimated. Although the correlation co-efficient indicates the nature of association among the different traits, path analysis splits the correlation co-efficient into measure of direct and indirect effects thus providing understanding of the direct and indirect contribution of each character towards yield. Hence, the present investigation was planned to unravel the correlation and path co-efficient of yield and yield attributing traits in brinjal" [1].

In addition to allowing the partitioning of correlation coefficients into direct and indirect effects, which indicates the relative importance of each of the causal components, further path coefficient analysis can be performed to identify the features that have the biggest impact on yield. Breeders can assess each variable's contribution and ascertain the direct and indirect effects of an independent variable on a dependent variable by using the idea of path coefficient as a decision-making tool (Akinnola, 2012). In order to identify and choose the best genotypes for a future programme aimed at improving brinjal yield, an inquiry was conducted to examine the relationship between characteristics and yield as well as the direct and indirect effects of yield attributes on brinjal yield.

2. MATERIALS AND METHODS

The study comprised 32 genotypes of brinjal including one check. The experiment was

conducted in Randomized Complete Block Design with three replications at the Main Experiment Station, Department of Vegetable Science, Narendra Deva University of Agriculture and Technology Narendra Nagar, (Kumarganj), Ayodhya (U.P.), during autumn-winter season 2020-21.

Each treatment consisted of 12 plants in two rows, having spacing of 60cm x 50cm with net plot size of 1.2x3.0 m^2. The observations were recorded on fifteen quantitative traits viz. days to 50% flowering, plant height (cm), primary branches per plant, days to first fruit harvest, crop duration, fruits per plant, fruit length (cm), fruit circumference (cm), average fruit weight (g), total soluble solids (ºBrix), reducing sugars (%), non-reducing sugars (%), total sugar (%), total phenol content (mg/100g), ascorbic acid content (mg/100g)and total fruit yield per plant (kg).

2.1 Estimation of Correlation

The correlations between different characters at genotypic (g) and phenotypic (p) levels were worked out between characters as suggested by Searle [8].

i) Phenotypic correlation coefficient between characters X and Y

$$r_{xy\,(p)} = \frac{\text{Cov.}_{xy\,(p)}}{\sqrt{\text{Var. X (p). Var. Y (p)}}}$$

ii) Genotypic correlation between characters X and Y

$$r_{xy\,(g)} = \frac{\text{Cov.}_{xy\,(g)}}{\sqrt{\text{Var. X (g). Var. Y (g)}}}$$

Where,

r_{xy} = Correlation coefficients between X and Y.
Covariance XY = Co-variance between characters X and Y
Var. X = Variance for X character
Var. Y = Variance for Y character

The significance of phenotypic correlation coefficients was tested against (n-2) degrees of freedom at 5% and 1% probability level. Where, n is the number of germplasm on which the observations were recorded.

2.2 Path-Coefficient Analysis

Path-coefficient analysis was carried out according to Dewey and Lu [9]. Yield per plant was assumed to be dependent variable (effect) which is influenced by all the characters. The independent variable (causes), directly as well as indirectly through other characters. The variation in total yield per plant unexplained by the 11 causes was presumed to be contributed by residual factor (x) which is uncorrelated with other factors. Path-coefficients were estimated by solving the following simultaneous equations indicating the basic relationship between correlation and path-coefficient. The equations used are as follows:

$$riy = P_{iy} + \sum_{j-1}^{11} r_{iy} P_{jy}\, for_{ij} = 1.$$

$$riy = P_{iy} + \sum_{j-1}^{11} r_{iy} P_{jy}\, for_{ij} = 1,2...11.$$

The above equation can be written in the form of matrix.

[A] 14x1= [B]14x1[C]14x1

Where,

A is column vector of correlations r_{iy}
B is the correlation matrix of r_{ij}, and
C is the column vector of direct effects, P_{iy}

Residual factor was calculated as follows:

$P_{xy} = \sqrt{1 - R^2}$

Where,

$$R^2 = \sum_{j} P_{iy}\, r_{iy}$$

The r_{ij}'s i.e., $r_{1.2}$ to $r_{13\text{-}14}$ denote correlations between all possible combination of independents characters P_{1y} to P_{14y} denote direct effect of various characters on charactery.

r_{iy}= Correlation coefficient between 1th and y character.
p_{iy}= Direct effect of ith character on Y.

3. RESULTS AND DISCUSSION

A perusal of data (Tables. 1 and 2) revealed that the most important trait , total fruit yield per plant had exhibited highly significant and positive phenotypic correlation with average fruit weight (0.747), number of fruits per plant (0.672) and fruit circumference (0.468). Average fruit weight, number of fruit per plant and fruit circumference were found significantly and positively correlated among themselves. Thus the selection for average fruit weight, number of fruits per plant and fruit circumference or either of it may automatically improve the total fruit yield per plant. Many earlier research workers have also reported significant and positive association of total fruit yield per plant with average fruit weight, number of fruit per plant and fruit circumference. These finding are in covered to the report of earlier [10,11].

Correlation measures the mutual relationship between various plant characters and determines the component characters, on which selection can be based for genetic improvement in yield without indicating the cause of relationship, whereas, path analysis splits the correlation coefficients into direct and indirect components, indicating the cause of relationship, assisting in genotype selection and also calculating the relatives.

To resolve direct and indirect impacts of fourteen traits on total fruit yield per plant, route coefficient analysis was performed using phenotypic and genotypic correlation coefficients. Tables and showed the direct and indirect effects of several features on total fruit yield at the phenotypic and genotypic levels.

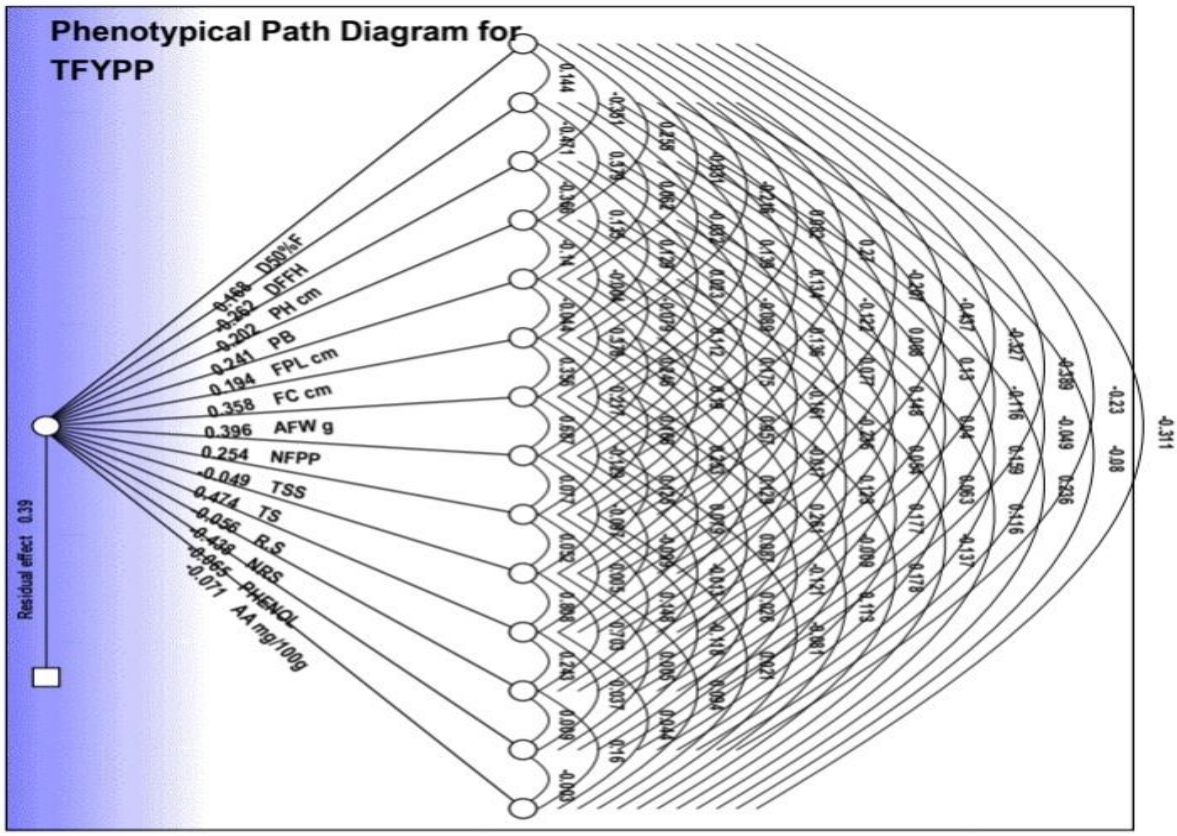

Fig. 1. Phenotypical path diagram For TFYPP

Table 1. Estimates of phenotypic correlation coefficients among fourteen characters in brinjal germplasm

Traits	Day to 50% flowering	Day to first fruit Harvest	Plant height	Primary branches per Plant	Fruit polar length	Fruit circumference	Averag fruit weight	Number of fruit per Plant	T.S.S	Total sugars	Reducing sugars	Non-reducing sugar	Total phenol content	Ascorbic acid	Total fruit yield per plant
Day to 50% flowering	1	0.145	-0.351*	0.255	-0.031	-0.216	0.082	0.27	-0.207	-0.437*	-0.327	-0.389*	-0.231	-0.311	0.309
Day to first fruit harvest		1	-0.471*	0.379*	0.062	-0.032	0.139	0.134	-0.123	0.008	0.13	-0.116	-0.049	-0.08	0.101
Number of primary branches per plant			1	-0.366*	0.135	0.129	0.023	-0.089	0.136	0.077	0.148	0.04	0.159	0.236	-0.19
Plant height				1	-0.14	-0.004	-0.079	0.112	0.175	-0.161	-0.236	0.054	0.063	0.116	0.12
Fruit Polar length					1	-0.044	0.378*	0.246	0.19	0.057	-0.017	0.123	0.177	-0.137	0.27
Fruit circumferenc						1	0.356	0.217	0.166	0.253	0.129	0.261	-0.009	0.178	0.468**
Average fruit weigl							1	0.687**	-0.129	0.125	0.079	0.087	-0.121	0.113	0.747**
Number of fruit pe plant								1	0.077	-0.097	-0.099	-0.013	0.026	-0.081	0.672**
T .S.S									1	0.052	0.005	0.149	-0.118	0.021	-0.006
Total sugars										1	0.808**	0.703**	0.005	0.094	0.107
Reducing sugars											1	0.243	0.037	0.044	0.087
Non-reducing sug												1	0.009	0.16	-0.019
Total phenol content													1	-0.003	-0.116
Ascorbic acid														1	-0.089

**- Significant at 5 per cent probability level, **- Significant at 1 per cent probability level*

Table 2. Estimates of genotypic correlation coefficients among fourteen characters in brinjal germplasm

Traits	Day to 50% flowering	Day to first fruit harvest	Plant height	Primary Branches per Plant	Fruit polar length	Fruit circumference	Average fruit weight	Number of fruit per Plant	T.S.S	Total sugars	Reducing sugars	Non-reducing sugar	Total phenol content	Ascorbic acid	Total fruit yield per plant
Day to 50% flowering	1.00	-0.044	-0.389*	0.307	-0.096	-0.258	0.092	0.369*	-0.251	-0.484**	-0.359*	-0.434*	-0.258	-0.342	0.373*
Day to first fruit harvest		1.000	-0.654*	0.566**	-0.153	-0.026	0.169	0.235	-0.229	0.004	0.172	-0.150	-0.069	-0.103	0.142
Number of primary branches per plant			1.000	-0.399*	0.241	0.154	0.024	-0.111	0.134	0.082	0.153	0.039	0.159	0.246	-0.203
Plant height				1.000	-0.240	-0.032	-0.081	0.122	0.171	-0.167	-0.252	0.060	0.067	0.123	0.119
Fruit Polar length					1.000	-0.116	0.615**	0.439*	0.338	0.089	0.000	0.200	0.329	-0.244	0.400*
Fruit circumference						1.000	0.361*	0.239	0.187	0.273	0.137	0.284	-0.010	0.193	0.478**
Average fruit weight							1.000	0.741**	-0.139	0.126	0.083	0.090	-0.124	0.115	0.764**
Number of fruit per plant								1.000	0.091	-0.105	-0.105	-0.015	0.043	-0.090	0.705**
T.S.S									1.000	0.056	-0.001	0.157	-0.126	0.023	0.003
Total sugars										1.000	0.816	0.708**	0.003	0.095	0.113
Reducing sugars											1.000	0.248	0.039	0.044	0.097
Non -reducing sugar												1.000	0.009	0.163	-0.020
Total phenol content													1.000	-0.004	-0.117
Ascorbic acid														1.000	-0.091

**- Significant at 5 per cent probability level, **- Significant at 1 per cent probability level*

Table 3. Direct and indirect effect of fourteen characters on fruit yield per plant at phenotypic level in brinjal

Traits	Day to 50% flowering	Day to first fruit harvest	Plant height	Primary branches per Plant	Fruit polar length	Fruit circumference	Average fruit weight	Number of fruit per Plant	T.S.S	Total sugars	Reducing sugars	Non-Reducing sugar	Total phenol content	Ascorbic acid	Correlation with total fruit yield per plant
Day to 50% flowering	**0.168**	-0.038	0.071	0.062	-0.006	-0.077	0.032	0.069	0.010	-0.207	0.018	0.170	0.015	0.022	0.309
Day to first fruit harvest	0.024	**-0.262**	0.095	0.092	0.012	-0.012	0.055	0.034	0.006	0.004	-0.007	0.051	0.003	0.006	0.101
Number of primary branches per plant	-0.059	0.124	**-0.202**	-0.089	0.026	0.046	0.009	-0.023	-0.007	0.037	-0.008	-0.017	-0.010	-0.017	-0.19
Plant height	0.043	-0.099	0.074	**0.242**	-0.027	-0.002	-0.031	0.029	-0.009	-0.076	0.013	-0.024	-0.004	-0.008	0.12
Fruit Polar length	-0.005	-0.016	-0.027	-0.034	**0.194**	-0.016	0.150	0.062	-0.009	0.027	0.001	-0.054	-0.012	0.010	0.27
Fruit circumference	-0.036	0.008	-0.026	-0.001	-0.009	**0.358**	0.141	0.055	-0.008	0.120	-0.007	-0.114	0.001	-0.013	0.468**
Average fruit weigh	0.014	-0.037	-0.005	-0.019	0.073	0.128	**0.396**	0.174	0.006	0.059	-0.005	-0.038	0.008	-0.008	0.747**
Number of fruit per plant	0.045	-0.035	0.018	0.027	0.048	0.078	0.272	**0.254**	-0.004	-0.046	0.006	0.006	-0.002	0.006	0.672**
T.S.S	-0.035	0.032	-0.027	0.042	0.037	0.059	-0.051	0.020	**-0.049**	0.025	0.000	-0.065	0.008	-0.002	-0.006
Total sugars	-0.074	-0.002	-0.016	-0.039	0.011	0.091	0.050	-0.025	-0.003	**0.474**	-0.045	-0.308	0.000	-0.007	0.107
Reducing sugars	-0.055	-0.034	-0.030	-0.057	-0.003	0.046	0.031	-0.025	0.000	0.383	**-0.056**	-0.107	-0.002	-0.003	0.087
Non-reducing sugai	-0.066	0.030	-0.008	0.013	0.024	0.094	0.035	-0.003	-0.007	0.333	-0.014	**-0.438**	-0.001	-0.011	-0.019
Total phenol conter	-0.039	0.013	-0.032	0.015	0.034	-0.003	-0.048	0.007	0.006	0.002	-0.002	-0.004	**-0.066**	0.000	-0.116
Ascorbic acid	-0.059	0.021	-0.048	0.028	-0.027	0.064	0.045	-0.021	-0.001	0.045	-0.003	-0.070	0.000	**-0.071**	-0.089

R SQUARE= 0.8476, RESIDUAL EFFECT = 0.3903

Table 4. Direct and indirect effect of fourteen characters on fruit yield per plant at genotypic level in brinjal

Traits	Day to 50% flowering	Day to first fruit harvest	Plant height	Primary branches per Plant	Fruit Polar length	Fruit Circumfer-ence	Average fruit weight	Number of fruit per Plant	T.S.S	Total sugars	Reducing sugars	Non-reducing sugar	Total phenol content	Ascorbic acid	Correlation With total fruit yield per plant
Day to 50% flowering	**0.3581**	0.0076	0.0814	0.0364	0.0124	-0.0667	0.0802	-0.0325	-0.0589	-0.1938	0.0186	0.1321	-0.0463	0.0446	0.373*
Day to first fruit harvest	-0.0158	**-0.1720**	0.1368	0.0673	0.0196	-0.0067	0.1479	-0.0207	-0.0537	0.0016	-0.0089	0.0455	-0.0123	0.0134	0.142
Number of primary branches per plant	-0.1393	0.1124	**-0.2093**	-0.0474	-0.0310	0.0397	0.0208	0.0098	0.0315	0.0327	-0.0079	-0.0119	0.0286	-0.0320	-0.203
Plant height	0.1098	-0.0974	0.0834	**0.1188**	0.0308	-0.0083	-0.0712	-0.0107	0.0402	-0.0668	0.0130	-0.0183	0.0120	-0.0160	0.119
Fruit Polar length	-0.0345	0.0263	-0.0505	-0.0285	**-0.1284**	-0.0300	0.5391	-0.0386	0.0794	0.0357	0.0000	-0.0607	0.0592	0.0318	0.400*
Fruit circumference	-0.0923	0.0045	-0.0321	-0.0038	0.0149	**0.2587**	0.3160	-0.0210	0.0439	0.1095	-0.0071	-0.0863	-0.0019	-0.0252	0.478**
Average fruit weight	0.0328	-0.0290	-0.0050	-0.0096	-0.0790	0.0933	**0.8764**	-0.0652	-0.0326	0.0506	-0.0043	-0.0273	-0.0223	-0.0150	0.764**
Number of fruit per plant	0.1322	-0.0405	0.0233	0.0144	-0.0563	0.0618	0.6494	**-0.0880**	0.0213	-0.0419	0.0054	0.0045	0.0078	0.0117	0.705**
T.S.S	-0.0900	0.0394	-0.0281	0.0203	-0.0435	0.0484	-0.1219	-0.0080	**0.2346**	0.0222	0.0001	-0.0477	-0.0227	-0.0029	0.003
Total sugars	-0.1733	-0.0007	-0.0171	-0.0198	-0.0114	0.0707	0.1107	0.0092	0.0130	**0.4005**	-0.0422	-0.2153	0.0005	-0.0124	0.113
Reducing sugars	-0.1287	-0.0296	-0.0320	-0.0300	0.0000	0.0355	0.0724	0.0092	-0.0003	0.3267	**-0.0517**	-0.0754	0.0070	-0.0058	0.097
Non-reducing sugar	-0.1554	0.0257	-0.0082	0.0072	-0.0256	0.0733	0.0785	0.0013	0.0368	0.2834	-0.0128	**-0.3043**	0.0016	-0.0212	-0.020
Total phenol content	-0.0923	0.0118	-0.0333	0.0079	-0.0423	-0.0027	-0.1090	-0.0038	-0.0296	0.0011	-0.0020	-0.0028	**0.1797**	0.0005	-0.117
Ascorbic acid	-0.1226	0.0177	-0.0514	0.0146	0.0314	0.0500	0.1009	0.0079	0.0053	0.0380	-0.0023	-0.0495	-0.0007	**-0.1303**	-0.091

R SQUARE= 0.8824, RESIDUAL EFFECT = 0.3429

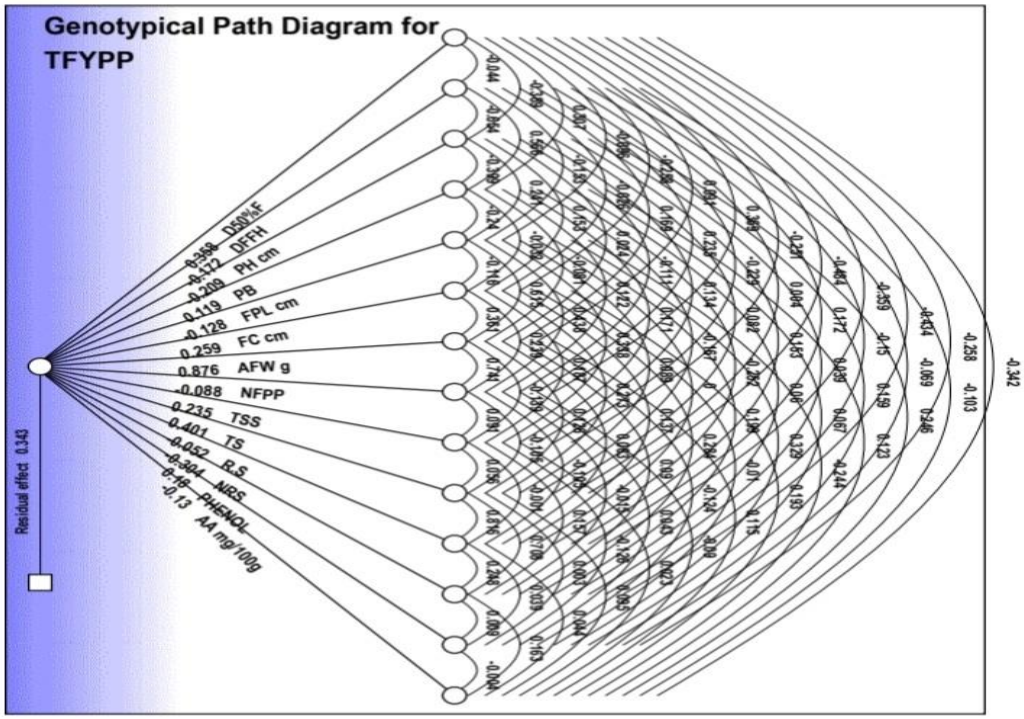

Fig. 2. Genotypical path diagram for TFYPP

The genotypic direct and indirect effects of most of the traits were similar in nature and higher in magnitude than the phenotypic direct and indirect effect. The higher magnitude of positive direct effect on total fruit yield was exerted by total sugars (0.474), average fruit weight (0.396), fruit circumference (0.358), number of fruits per plant (0.254), plant height (0.242), fruit polar length (0.194), day to 50 % flowering (0.168). While, negative direct effect on total fruit yield per plant was exerted by non-reducing sugar (-0.438), days to first fruit harvest (-0.262), number or primary branch per plant (-0.202), ascorbic acid (-0.071), total phenol content (-0.066), reducing sugars (-0.056), T.S.S (-0.049).

The average fruit weight was not only found to have maximum direct effect on total fruit yield per plant but it also contributed substantial positive indirect effect on total fruit yield *via*; number of fruits per plant (0.272), fruit polar length (0.150), fruit circumference (0.141),days to first fruit harvest (0.147),total sugars (0.1107),ascorbic acid (0.045),day to 50% flowering (0.032),non-reducing sugar (0.035),reducing sugars (0.031),number of primary branch per plant (0.009). Similar results had also been reported by many workers Patel et al. [12], Sujin et al. [13] and Verma et al. [14].

4. CONCLUSION

The magnitudes of genotypic correlation was higher than the phenotypic correlation coefficients for all the character combinations. During selection average fruit weight, number of fruit per plant and fruit circumference should take into consideration for enhancing the fruit yield per plant.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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