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Correlation and path analysis using growth, flowering, fruiting and biochemical parameters in cape gooseberry

Priyanka Dahiya, Kiran Kour*, Parshant Bakshi, Sarabdeep Kour[1], D. B. Singh[2] and Bharat Bhushan[3]

Division of Fruit Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu-180009, J&K, India.

ABSTRACT

The present investigation was conducted during the year 2020-21, wherein ten genotypes of cape gooseberry were studied for correlation and path analysis using growth, flowering, fruiting and biochemical parameters. The fruit yield per plant was significantly and positively correlated with stem thickness (0.955), shoot number (0.610), leaf area (0.404), fruit weight (0.963), fruit length (0.226), fruit breadth (0.407) and fruit volume (0.518). The earliness parameters viz., days to initiation of flowering (0.937), days for initial fruit set (0.950) and days for fruit harvest (0.897) also showed positive and significant correlation with yield per plant. On the other hand, the resistance to viral infection (-0.857) and resistance to fruit cracking (-0.576) showed substantial negative correlations with yield per plant. The path coefficient analysis revealed the direct and positive effect of plant height, fruit weight, fruit breadth and days for fruit harvest on fruit yield, thus indicating the significance of these traits in cape gooseberry improvement. Fruit number, in conjunction with fruit weight, fruit breadth and fruiting period, were the most important factors contributing to the main yield component. Hence, these attributes should be prioritised in the breeding and selection programme for the development high yielding genotypes of cape gooseberry

Keywords: *Physalis peruviana* L., Path coefficient analysis, Yield, Fruit quality.

INTRODUCTION

Cape gooseberry (*Physalis peruviana* L.) is one of the most important minor fruit crop which is highly nutritious and a good source of vitamins and minerals. It belongs to genus *Physalis* of family Solanaceae which is among the largest genera in subfamily Solanoideae. Its name is derived from the “Cape of Good Hope” of South Africa where it was commercially grown (Chattopadhyay, 5). Being an annual herbaceous crop, cape gooseberry is an excellent alternative for the inter-space utilization in perennial fruit orchards. Unfortunately, there is no named variety available of this fruit in India, and farmers are bound to grow the inferior type of strains.

It is also rich in ascorbic acid, carotenoids and pectin, and ripens at a time, when very few fruits are available in the market. Considering the immense potentiality, there is a need for improvement and the development of varieties that are adapted to various agro-ecological situations as well as specific end uses. A thorough study about the amount of genetic diversity present for various traits is required for the successful crop improvement programme of cape gooseberry. Character association analysis is an important tool that is being successfully utilized for estimating the impact of various yield traits in different strains leading to the selection of superior genotypes to give a greater understanding into supplementary traits under selection (Ekka *et al.*, 7). Plant breeders can use information about the relationship between different traits like growth, earliness, yield and quality to generate commercial varieties or hybrids. Most of these traits are interrelated in desirable and undesirable manner. Correlation coefficient analysis determines the mutual relationship between various traits, and helps in determining the component trait on which selection can be made for improvement in yield of the crop. Therefore, knowledge of desirable and undesirable association between the various traits can substantially aid in avoiding inversely linked compensatory effects during selection. The path coefficient analysis makes it easier to separate the correlation coefficients into direct and indirect contributions of various traits on specific yield. As a result, it assesses the direct impact of one variable on another. Such data would be extremely useful in allowing a breeder to find significantly important component traits of yield and use genetic stock for improvement in a systematic manner, hence in the present study, correlation coefficient and path

*Corresponding author: kirranhort@gmail.com
[1]Soil Science and Agril. Chemistry, SKUAST, Jammu-180009, J&K, India.
[2]ICAR-CITH,Srinagar-19000, J&K, India.
[3]Registrar Office, SKUAST, Jammu-180009, J&K, India.

analysis among various traits in cape gooseberry were worked out.

MATERIALS AND METHODS

The present investigation was conducted at Research Farm, Division of Fruit Science, Faculty of Agriculture, Sher-e-Kashmir University of Agricultural Sciences and Technology, Jammu during 2020-21. Ten genotypes of cape gooseberry were procured from Central Institute of Temperate Horticulture (CITH), Srinagar as a basis of the plant material, and evaluated in a Randomized Block Design with three replications with standard package of practices. Five plants were randomly selected and tagged in each replication of the treatment for data collection. Observations on growth, flowering behaviour, physical parameters of fruit, biochemical parameters and plant resistance to viral infection and fruit cracking were recorded. Correlation coefficient and path analysis were worked out according to procedure given by Al-Jibouri *et al*. (1) and Dewey and Lu (6), respectively. The data obtained were statistically analyzed using windostat 9.3 version Software.

RESULTS AND DISCUSSION

The genotypic and phenotypic correlation coefficients among twenty two parameters presented in the Table 1 showed that genotypic correlation coefficients were higher in magnitude than the phenotypic correlation coefficients among the parameters. The correlation coefficients were estimated in order to estimate how fruit yield in cape gooseberry is influenced by other component parameters. The highest magnitude of genotypic correlation coefficients showed a strong inherent association between the various parameters in the study of Johnson *et al*.(10) which also might be due to the environment masking or modifying influence, changing the expression of parameters and lessened the phenotypic effect (Chandrasekhar and Reddy, 4). Some parameter combinations had very close genotypic and phenotypic correlations such as TSS, acidity and fruit weight with non-reducing sugar, fruit weight with non-reducing sugar content, and fruit length with ascorbic acid content, which could be due to a reduction in environmental variances (Dewey and Lu, 6).The dual nature of phenotypic correlation, which is determined by genotypic and environmental correlations, as well as the heritability of the characters, resulted in a significant difference between two types of correlations between any two characters (Ara *et al*., 2).

Growth parameters *viz*., stem thickness, shoot number and leaf area were positively correlated with plant height, indicating the strong correlations between the vegetative parameters. The coupling phase of linkage produces a positive correlation, while the repulsion phase of linkage produces a negative correlation of genes controlling separate traits. If there is no association, it means that the genes are either far apart on the same chromosome or on distinct chromosomes. Days to initiation of flowering, days for initial fruit set and days for fruit harvest were significantly and positively correlated with stem thickness and shoot number, which indicated the direct relation between earliness and vegetative parameters. Days to initiation of flowering, days for initial fruit set and days for fruit harvest were positively correlated among themselves. These results are in close proximity with the findings of (Bernousi *et al.,*3; Mayavel *et al*., 13; Singh *et al*., 18). Fruit weight was positively and significantly correlated with fruit length, fruit breadth and fruit volume whereas, it was negatively correlated with plant height, because of the inverse relationship between fruit weight and plant height, indicating the strong competition for photosynthates. These results are in conformity with the finding of Kumar *et al*. (12) who noticed the significant positive correlation of tomato fruit weight with pericarp thickness, fruit length, stem end scar size and fruit diameter. Fruit weight was positively correlated with earliness parameters *viz*., days to initiation of flowering, days for initial fruit set and days for fruit harvest. Trivesani *et al*. (19) also observed the positive relationship of fruit weight with equatorial fruit diameter and number of seeds. Yield is the result of the interaction of multiple component characters, and the surrounding environment. Simple correlation analysis reveals the nature and extent of the relationship between two sets of metric characters. It would be feasible to achieve genetic advancement in one character by selecting the other of a pair of characters. In the present study, the yield per plant was significantly and positively correlated with stem thickness, shoot number, leaf area, fruit weight, fruit length, fruit breadth and fruit volume because all the growth and fruit parameters contributed towards the high yield and it was also positively and significantly correlated with days to initiation of flowering, days for initial fruit set and days for fruit harvest, while it showed negative correlation with resistance to viral infection and resistance to fruit cracking.

The data on genotypic path analysis is depicted in Fig. 1 revealed the direct and indirect effects of various attributes on fruit yield which was counted as the dependent variable. Path analysis determines whether the relationship between these parameters

Table 1. Genotypic (G) and phenotypic (P) correlation coefficients among various parameters in cape gooseberry genotypes.

Parameter		2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	P	0.185	0.069	0.089	0.436*	0.494**	0.368*	0.322	0.394*	0.558**	0.494**	0.226	0.378*	0.507**	-0.086	0.267	0.076	0.171	0.228	-0.251	-0.255	0.180
	G	0.455*	0.443*	0.147	0.539*	0.529*	0.646**	0.597**	0.590**	0.818**	0.759**	0.665**	0.565*	0.606**	-0.473*	0.925**	0.606**	0.498*	0.572**	-0.384*	-0.368*	0.955**
2	P		0.512**	0.563**	0.537**	0.527**	0.501**	0.726**	0.322	0.272	0.099	0.578**	0.438*	0.173	-0.406*	0.697**	0.464**	0.411*	0.424*	-0.643**	-0.601**	0.552**
	G		0.885**	0.950**	0.757**	0.829**	0.910**	0.948**	0.509*	0.512*	0.553*	0.849**	-0.190	-0.584**	-0.001	-0.645**	-0.104	-0.048	-0.105	-0.838**	-0.767**	0.610**
3	P			0.404*	-0.646**	-0.661**	-0.672**	-0.591**	-0.318	-0.354	-0.064	-0.693**	-0.154	-0.450*	-0.001	-0.620**	-0.145	-0.024	-0.035	0.796**	0.558**	-0.636**
	G			0.588**	-0.845**	-0.853**	-0.838**	-0.874**	-0.367*	-0.318	-0.204	-0.658**	0.720**	0.074	-0.670**	0.936**	0.817**	0.740**	0.790**	0.786**	0.569*	-0.706**
4	P				0.279	0.237	0.272	0.373*	0.380*	0.396*	0.051	0.127	0.421*	-0.027	-0.374*	0.633**	0.547**	0.493**	0.523**	-0.444*	-0.141	0.145
	G				0.468*	0.588**	0.743**	0.958**	0.358	0.458*	0.421*	0.483*	0.108	0.770**	0.152	0.557*	-0.030	-0.080	-0.057	-0.636**	-0.212	0.404*
5	P					0.870**	0.875**	0.578**	0.476**	0.492**	0.300	0.547**	0.099	0.695**	0.144	0.473**	-0.048	-0.070	-0.055	-0.758**	-0.561**	0.587**
	G					0.970**	0.937**	0.954**	0.565*	0.600**	0.355	0.812**	0.175	0.786**	0.079	0.586**	0.036	-0.003	-0.015	-0.751**	-0.551*	0.937**
6	P						0.861**	0.595**	0.511**	0.496**	0.330	0.602**	0.132	0.681**	0.099	0.554**	0.007	-0.030	0.049	-0.756**	-0.555**	0.589**
	G						0.965**	0.990**	0.577**	0.638**	0.374*	0.820**	0.241	0.752**	0.017	0.689**	0.112	0.056	0.110	-0.788**	-0.572**	0.950**
7	P							0.495**	0.537**	0.498**	0.429*	0.589**	0.197	0.575**	0.017	0.543**	0.131	0.091	0.070	-0.753**	-0.518**	0.544**
	G							0.948**	0.648**	0.723**	0.377*	0.769**	0.650**	0.844**	-0.238	0.986**	0.473*	0.394*	0.409*	-0.801**	-0.536*	0.897**
8	P								0.085	0.428*	0.255	0.556**	0.475**	0.353	-0.176	0.596**	0.325	0.240	0.326	-0.680**	-0.448*	0.682**
	G								0.532*	0.478*	0.589**	0.844**	0.078	0.328	-0.248	0.362*	0.201	0.242	0.245	-0.988**	-0.629**	0.963**
9	P									0.753**	0.083	0.295	0.048	0.296	-0.170	0.381*	0.182	0.254	0.195	-0.258	-0.222	0.124
	G									0.928**	0.345	0.449*	0.289	0.425*	-0.231	0.376*	0.249	0.326	0.297	-0.270	-0.234	0.226
10	P										0.265	0.311	0.275	0.435*	-0.200	0.393*	0.241	0.286	0.265	-0.317	-0.116	0.277
	G										0.462*	0.400*	0.588**	0.350	-0.150	0.484*	0.418*	0.325	0.355	-0.325	-0.108	0.407*
11	P											0.142	0.417*	0.308	-0.112	0.188	0.339	0.251	0.329	-0.147	-0.221	0.142
	G											0.243	0.250	0.914**	-0.295	0.655**	0.191	0.226	0.224	-0.210	-0.282	0.518*
12	P												0.236	0.574**	-0.257	0.580**	0.179	0.225	0.183	-0.675**	-0.723**	0.666**
	G												0.250	0.914**	-0.295	0.655**	0.191	0.226	0.224	-0.731**	-0.774**	0.815**
13	P													0.105	-0.625**	0.611**	0.792**	0.737**	0.771**	-0.394*	-0.189	0.278
	G													-0.591**	0.660**	0.766**	0.701**	0.743**	-0.365*	-0.177	0.401*	0.401*
14	P														0.046	0.264	-0.118	-0.067	-0.085	-0.552**	-0.469**	0.607**
	G														0.313	-0.128	-0.041	-0.091	-0.634**	-0.526*	0.958**	0.958**
15	P															-0.510**	-0.836**	-0.899**	-0.860**	0.069	0.177	0.012
	G															-0.794**	-0.872**	-0.852**	0.062	0.171	0.085	0.0850
16	P																0.664**	0.580**	0.641**	-0.711**	-0.568**	0.416*
	G																0.605**	0.654**	-0.710**	-0.582**	0.553*	0.553**
17	P																	0.933**	0.939**	-0.202	-0.155	0.087
	G																	0.913**	-0.183	-0.144	-0.006	-0.006
18	P																		0.942**	-0.108	-0.060	0.0145
	G																		-0.1030	-0.059	0.024	0.024
19	P																			-0.160	-0.107	-0.001
	G																			-0.106	0.042	0.042
20	P																				0.606**	-0.672**
	G																				0.550*	-0.857**
21	P																					-0.454*
	G																					-0.576**

* Significant at 5%, ** Significant at 1%, *** Significant at 0.1%

1. Stem thickness; 2. Shoot number; 3. Plant height; 4. Leaf area; 5. Days for initiation of flowering; 6. Days for initial fruit set; 7. Days for fruit harvest; 8. Fruit weight; 9. Fruit length; 10. Fruit breadth; 11. Fruit volume; 12. TSS; 13. Acidity; 14. Carotenoids; 15. Pectin; 16. Ascorbic acid; 17. Reducing sugars; 18. Non reducing sugar; 19. Total sugar; 20. Resistance to viral infection; 21. Resistance to fruit cracking; 22. Yield per plant

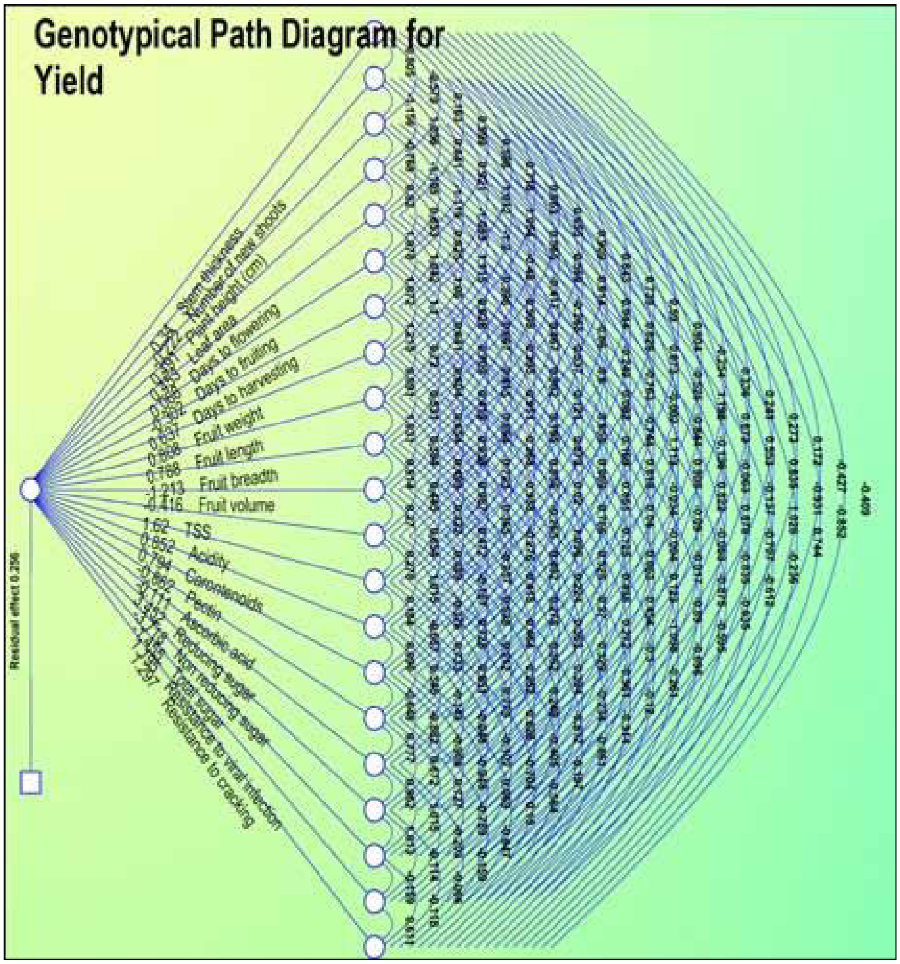

Fig. 1. Genotypic Path diagram showing effects of exogenous traits on fruit yield (kg/plant), curved headed arrows shows correlations coefficients and straight line show direct effect.

and yield is due to direct influences on yield or indirect effects through other component parameters. The plant height showed positive and high direct effect (0.491) on yield per plant, but had negative and high indirect effect through shoot number (-0.568). Emdad *et al*. (8) observed that, a positive direct effect (0.318) of crown height on yield of strawberry per plant, while negative direct effect (-0.198) on number of fruits per plant. Therefore, for improvement of yield per plant, plant height needs to be considered along with shoot number. The shoot number had negative and high direct effect (-0.221) on yield per plant, and also negative and indirect effect through stem thickness (-0.112), leaf area (-0.234) and fruit weight (-0.233). The similar observations were recorded by (Islam *et al*., 9) in tomato.The days taken for initiation of flowering had positive and high direct effect (0.068) on yield per plant, and also positive and high indirect effect through days for fruit harvest (0.071). Days for initial fruit set showed negative and high direct effect (-0.301) on yield per plant and also negative and high indirect effect through days for fruit harvest (-0.323), days for initiation of flowering (-0.325) and shoot number (-0.277). Hence, the indirect causal components also need to be considered for selection. Days for fruit harvest exerted positive and high direct effect (0.636) on yield per plant and also positive and high indirect effect through shoot number (0.664) and days for initial fruit set (0.682). Similar trend is also followed by fruit weight which showed positive and high direct effect (0.808) on yield per plant, also having positive and high indirect effect through fruit volume (0.528), shoot number (0.851) and days for fruit harvest (0.982). Meena and Bahadur (14) stated the highest positive direct effect on the fruit yield per plant by fruit weight in tomato, hence the fruit weight can be used as an important trait for crop improvement in tomato.

The substantial positive and high direct effect on yield per plant was shown by TSS and also had the positive and high indirect effect through shoot number (0.610), fruit length (0.226) and fruit breadth (0.407). The similar results were also reported by Joshi *et al*. (11), Paul *et al*. (15), Shashikanth *et al*. (17) and Rajolli *et al*. (16). Acidity had positive and high direct effect (0.4509) on yield per plant and also positive and high indirect effect through shoot number (1.528), fruit length (0.808) and fruit breadth (0.720). Similarly, carotenoids showed positive and high direct effect (0.156) on yield per plant and also positive and high indirect effect through shoot number (0.534) and days for fruit harvest (0.228).

AUTHORS' CONTRIBUTION

Conceptualization of research (PD, KK, PB); Designing of the experiments (KK and PB); Contribution of experimental materials (PD, KK, PB, DBS); Execution of field/lab experiments and data collection (PD and KK); Analysis of data and interpretation (PB, SK and BB); Preparation of the manuscript (PD, KK, PB and BB).

DECLARATION

The authors declare no conflict of interest.

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