Published with Open Access at Journal BiNET
Vol. 08, Issue 01: 718-725

Journal of Bioscience and Agriculture Research

Home page: www.journalbinet.com/jbar-journal.html

Correlation and path-coefficient analysis of pummelo

Md. Sarowar Alam[a], Md. Saidur Rahman[b], Md. Golam Rahman[c], Md. Mizanur Rahman[d], Sabina Yesmin[e] and Md. Zashim Uddin[f]

[a]Plant Breeding Division, Regional Agricultural Research Station (RARS), BARI, Akbarpur, Moulvibazar
[b]Horticulture Division, RARS, BARI, Akbarpur, Moulvibazar and PhD fellow, Dept. of Horticulture, BAU, Mymensingh
[c]Horticulture Division, Hill Agricultural Research Station, BARI, Khagrachari
[d]Dept. Horticulture, RARS, BARI, Jamalpur
[e]Biotechnology Division, RARS, BARI, Akbarpur, Moulvibazar
[f]Head, RARS, BARI, Akbarpur, Moulvibazar, Bangladesh

✉ asarowar04bau@gmail.com (Alam, M. S.), Published: 14 May 2016

ABSTRACT

The study was conducted at Regional Agricultural Research Station, Akbarpur, Moulvibazar to determine the correlation along with their direct and indirect effects through path coefficient analysis as to estimate the contribution of most important traits towards yield for pummelo. Fruit yield per plant showed highly significant positive correlation with number of fruits per plant (r =0.91) and individual fruit weight (r =0.55). Significant positive relationship were observed between fruit yield per plant and fruit breadth (r =0.38), number of seeds per fruit (r =0.35), weight of seeds per fruit (r =0.38). Highly significant positive relationships were recorded for individual fruit weight and fruit breadth (r =0.8), number of seeds per fruit and weight of seeds per fruit (r =0.83) and also for plant height and canopy spreading at north-south direction (r = 0.51). Number of segments per fruit showed highly significant positive interrelation with number of seeds per fruit (r =0.52) and significant positive relationship with TSS (r =0.39) and weight of seeds per fruit (r =0.38). It was observed that number of fruits per plant had maximum positive direct effect on fruit yield per plant (0.8353) and individual fruit weight showed positive direct effect on fruit yield per plant (0.5027). Fruit breadth exerted negative direct effect (-0.1302) on fruit yield per plant but it had positive significant correlation with fruit yield per plant (r = 0.38). Negative direct effect was mainly counter balanced by individual positive effects of different characters. Correlation andpath coefficient analysis indicated that number of fruits per plant, individual fruit weight and fruit breadth were the most important contributors to fruit yield per plant in pummelo.

Key Words: *C. maxima, Traits, Correlation and Path-coefficients analysis*

Cite article: Alam, M. S., Rahman, M. S., Rahman, M. G., Rahman, M. M., Yesmin, S. & Uddin, M. Z. (2016). Correlation and path-coefficient analysis of pummelo. *Journal of Bioscience and Agriculture Research,* 08(01), 718-725.

I. Introduction

Pummelo is one of the important and the largest citrus fruit of Bangladesh. It is very rich in vitamin-C and is a good source of vitamin A and B and can be grown easily for its tolerance to drought and pest infestation (Rashid et al., 1987). Fruits are palatable and rinds are rich essential oils that has industrial values. Fresh ripe fruits are eaten directly and can also be used for preparation of various kinds of recipes such as jam, jelly, pickles, cakes and drinks (Azmatullah et al., 1987). In Bangladesh, pummelo is cultivated in an area of around 7460 ha with total production of 59198 metric tons and average yield per fruit bearing tree is around 38.0kg (BBS, 2011) and it has a great prospect for wider cultivation due to favourable climate and adaptability.

The adequate knowledge on plant characters association has a great importance in plant breeding. For any crop improvement program, information about interrelationship among and between yield contributing traits is necessary. Grafius (1959) suggested that yield is the outcome of the multiplicative interaction of many genes rather than a single gene.Correlation and the path coefficientanalysis would provide a clear outline of genetic association among different traits (Bhatt, 1973). The correlation and path analysis studies are important assets for crop improvement; especially in case of fruit crop like citrus and mango, where in quantity and quality both are important. Correlation is the biometrical technique to know the nature and degree of association between various traits indicating yield, while path analysis splits the correlation coefficient into direct and indirect effect for measuring the relative contribution of each variable towards yield (Luz et al., 2011). Correlation with path coefficient analysis give information about the direct and indirect contribution of one traits upon another (Dewey and Lu, 1959). Hence, the knowledge of correlation between yield and its contributing characters and among the yield contributing characters themselves is essential for a rational and directed improvement of yield (Rao et al., 2004).Therefore, the present study was undertaken to know the correlation coefficient along with their direct and indirect effects through path coefficient analysis in pummelo for selecting the most important contributing characters towards yield.

II. Materials and Methods

The experiment was conducted at Regional Agricultural Research Station, Bangladesh Agricultural Research Institute, Akbarpur, Moulvibazar during the years 2012 to 2014. The experiment was performed with thirty three pummelo genotypes where each plant was considered as a replication. The distance from plant to plant was 5m and row to row was 5m. Individual plants were fertilized with cowdung (20 kg), urea (500 g), TSP (500 g), MP (500 g), gypsum (200 g), Zinc (4 g), boron (4 g) in two equal splits, one at the onset and other at the end of rainy season. (FRG, 2012). Irrigation, weeding and other crop management practices were followed as recommended by Ullah et al. (2006) to have a good healthy plant. Data on plant height (m), canopy spreading (m), number of flowers per cluster, number of fruits per plant, individual fruit weight (g), fruit length (cm) and breadth (cm), number of segments per fruit, number and weight (g) of seeds per fruit, edible percentage, % Brix (TSS) and yield per plant (kg) were recorded.The correlation coefficients were calculated as per Snedecor (1957). Path coefficients were estimated according to Dewey and Lu (1959), where fruit yield per plant (kg.) was kept asresultant variable and other contributing characters as causal variables. Correlation and Path analysis wereconducted by using R (version 3.1.2) computer software .

III. Results and Discussion

Correlation co-efficient analysis

Fruit yield is a complex product being influenced by several quantitative traits. The analysis of the relationship among those traits and their association with fruit yield is very much essential to establish selection criteria. Breeders always look for genetic variation among traits to select desirable type. Correlation co-efficient between pairs of trait for 33 pummelo genotypes are shown in (Table 01).

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Plant height showed positive and highly significant correlation with Canopy spreading at north-south direction (r = 0.51) followed by fruit breadth (r =0.49) and positive and significant correlation withnumber of fruits per plant (r = 0.39) and with fruit yield per plant (r = 0.39). Plant height showed non-significant and positive correlation with canopy spreading at east-west direction , individual fruit weight, fruit length, weight of seeds per fruit , edible percentage and also presentednon-significant and negative correlation with number of flowers per cluster, number of segments per fruit, number of seeds per fruit, TSS etc. Jahan (2004) reported nonsignificant positive correlation of plant height and diameter of fruitwith yield in lime.

Canopy spreading at north-south direction exhibited positive and significant correlation with canopy spreading at east-west direction (r =0.41) and fruit breadth (r =0.39) but significant negative relationship (r =-0.38) with number of seeds per fruit. All the other traits represented non-significant relationship where number of fruits per plant, individual fruit weight, fruit yield per plant were positive and number of flowers per cluster, fruit length, number of segments per fruit, weight of seeds per fruit, edible percentage and TSS were in negative correlation. Canopy spreading at east-west direction had non-significant and positive correlation with number of flowers per cluster, number of fruits per plant and fruit yield per plant. Again it presented non-significant and negative relationships with individual fruit weight, fruit length, fruit breadth, number of segments per fruit, number and weight of seeds per fruit, edible percentage and TSS.

Number of flowers per cluster presented non-significant and positive relationship with number of fruits per plant, number of seeds per fruit and fruit yield per plant but individual fruit weight, fruit length, fruit breadth, number of segments per fruit, weight of seeds per fruit, edible percentage and TSS had negative correlation.

Number of fruits per plant showed positive and highly significant correlation with fruit yield per plant (r =0.91). It revealed non-significant and positive relationship with individual fruit weight, fruit length, fruit breadth, number of segments per fruit, number and weight of seeds per fruitexcept edible percentage and TSS. Majumder et. al. (2012) also observed positive and highly significant correlation between number of fruits per plant and fruit yield in mango.

Individual fruit weight exhibited highly significant positive interrelation with fruit breadth (r =0.8) and fruit yield per plant (r =0.55), respectively. Significant positive values was recorded for fruit length (r =0.43). All the other characters such as number of segments per fruit, number and weight of seeds per fruitexcept edible percentage and TSS demonstrated non-significant and positive relationship. In case of lime, same findings were reported by Jahan (2004) between fruit weight and yield of lime. Rahman (2006) also observed significant positive correlation between fruit weight and yield.

Fruit length presented non-significant and positive interrelation with fruit breadth, number of segments per fruit,number and weight of seeds per fruit and fruit yield per plant and again non-significant negative correlation with edible percentage and TSS. Ahmed (2005) found significant positive correlation between fruit length and average fruit weight in lime.

Fruit breadth demonstrated significant positive interrelation with fruit yield per plant (r =0.38) and non-significant positive relationship with number of segments per fruit, weight of seeds per fruit and TSS but negative correlation withnumber of seeds per fruit and edible percentage. Torres et al. (1986) observed negative association of fruit diameter and yield in case of Valencia orange. Ahmed (2005) found significant and positive association of fruit circumference and yield per plant in lime.

Number of segments per fruit showed highly significant positive interrelation with number of seeds per fruit (r =0.52) and significant positive relationship with TSS (r =0.39) andweight of seeds per fruit (r =0.38). It had non-significant positive relationship with fruit yield per plant but negative correlation with edible percentage.

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Number of seeds per fruit presented highly significant positive relationship with weight of seeds per fruit (r =0.83) and significant positive correlation with fruit yield per plant (r =0.35). It had non-significant positive relationship with TSS but negative correlation with edible percentage. Hittalmani and Rao (1976) observed positive correlation between seed number and fruit weight of kagzi lime fruit.Weight of seeds per fruit showed significant positive correlation with fruit yield per plant (r =0.38). It had non-significant correlation with edible percentage and TSS.

Edible percentage had non-significant negative interrelation with TSS and fruit yield per plant.

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Table 01. Correlation co-efficient between yield and yield contributing characters in 33 pummelo genotypes

df = 33-2 = 31; r0.05 = 0.344, r0.01 = 0.442, ** Significant at 1% level * Significant at 5% level.

Characters	CSNS	CSEW	NFPCL	NFPP	IFW	FL	FB	NOSG	NOSD	WTSD	EDP	TSS	FYPP
PH	0.51**	0.25	-0.31	0.39*	0.34	0.26	0.49**	-0.06	-0.12	0.01	0.09	-0.27	0.39*
CSNS		0.41*	-0.22	0.24	0.16	-0.01	0.39*	-0.15	-0.38*	-0.16	-0.11	-0.09	0.16
CSEW			0.18	0.18	-0.16	-0.23	-0.05	-0.34	-0.23	-0.23	-0.07	-0.15	0.05
NFPCL				0.15	-0.29	-0.2	-0.34	-0.22	0.15	-0.02	-0.11	-0.01	0.08
NFPP					0.21	0.11	0.18	0.02	0.26	0.31	-0.33	-0.01	0.91**
IFW						0.43*	0.8**	0.31	0.2	0.26	-0.11	0.29	0.55**
FL							0.27	0.05	0.04	0.18	-0.13	-0.21	0.29
FB								0.23	-0.01	0.16	-0.06	0.16	0.38*
NOSG									0.52**	0.38*	-0.05	0.39*	0.15
NOSD										0.83**	-0.17	0.34	0.35*
WTSD											-0.13	0.14	0.38*
EDP												-0.31	-0.32
TSS													0.09

PH= Plant Height (m), **CSNS=** Canopy spreading at north-south direction (m)**, CSEW=** Canopy spreading at east-west direction (m)**, NFPCL=** Number of flowers per cluster**, NFPP=** Number of fruits per plant**, IFW=** Individual fruit weight (g)**, FL=** Fruit length (cm)**, FB=** Fruit breadth (cm)**, NOSG=** Number of segments per fruit**, NOSD=** Number of seeds per fruit**, WTSD=** Weight of seeds per fruit (g)**, EDP=** Edible percentage**, TSS=**% Brix**, FYPP=**Fruit yield per plant(kg.)

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Path co-efficient analysis for yield and yield contributing characters

From path coefficient analysis (Table 02), it was observed that number of fruits per plant had maximum positive direct effect on fruit yield per plant (0.8353). This trait exerted positive indirect effect on fruit yield per plant via individual fruit weight (0.1056) followed by number of seeds per fruit (0.0087), number of flowers per cluster (0.0067), fruit length (0.0023), edible percentage (0.0015), TSS (0.0005), number of segments per fruit (0.0004) and negative indirect effect were found on fruit breadth (-0.0234), weight of seeds per fruit (-0.0088), canopy spreading at east-west direction (-0.0015), canopy spreading at north-south direction (-0.0099) and plant height (-0.0072). Finally it showed highly significant positive correlation with fruit yield per plant (r = 0.91). Majumder et. al. (2012) also reported maximum positive direct effect of number of fruits per plant on yield in case of mango.

Individual fruit weight had positive direct effect on fruit yield per plant (0.5027) and positive indirect effect via number of fruits per plant (0.1754), fruit length (0.0089), number of seeds per fruit (0.0067), number of segments per fruit (0.0055), canopy spreading at east-west direction (0.0013), edible percentage (0.0005). This trait had also negative indirect effect via fruit breadth (-0.1041), number of flowers per cluster (-0.0129), weight of seeds per fruit (-0.0074), TSS (-0.0138), canopy spreading at north-south direction (-0.0066), plant height (-0.0063). Finally, highly significant positive correlation was observed between Individual fruit weight and fruit yield per plant (r = 0.55). Saha (2004) found highest positive direct effect for average weight of fruit on yield in lemon. Majumder et. al. (2012) observed positive direct effect of average fruit weight on yield in case of mango.

Fruit breadth showed negative direct effect (-0.1302) on fruit yield per plant but it had positive significant correlation with fruit yield per plant (r = 0.38). The negative direct effect was mainly counter balanced by individual positive effects of different characters. Fruit breadth had positive indirect effect on fruit yield per plant through individual fruit weight (0.4021), number of fruits per plant (0.1504), fruit length (0.0056), number of segments per fruit (0.0041), edible percentage (0.0003), canopy spreading at east-west direction (0.0004) and negative indirect effect via number of flowers per cluster (-0.0151), weight of seeds per fruit (-0.0048), canopy spreading at north-south direction (-0.0161), plant height (-0.009), TSS (-0.0138), number of seeds per fruit (-0.0003).

The residual effect (R) of path analysis was 0.0168 which indicated that the character under the study contributed to 98.32 % of the fruit yield per plant. It also indicated that there were some other factors which contributed 1.68 % to the fruit yield per plant in pummelo which were not included in the present study.

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Table 02. Genotypic path coefficient analysis showing direct (diagonal bold) and indirect (non-diagonal) effect of 13 characters on yield of pummelo

Characters	PH	CSNS	CSEW	NFPCL	NFPP	IFW	FL	FB	NOSG	NOSD	WTSD	EDP	TSS	FYPP
PH	**-0.0184**	-0.0211	-0.0021	-0.0138	0.3258	0.1709	0.0054	-0.0638	-0.0011	-0.0040	-0.0003	-0.0004	0.0128	0.39*
CSNS	-0.0094	**-0.0413**	-0.0034	-0.0098	0.2005	0.0804	-0.0002	-0.0508	-0.0027	-0.0127	0.0045	0.0005	0.0043	0.16
CSEW	-0.0046	-0.0169	**-0.0084**	0.0080	0.1504	-0.0804	-0.0048	0.0065	-0.0060	-0.0077	0.0065	0.0003	0.0071	0.05
NFPCL	0.0057	0.0091	-0.0015	**0.0444**	0.1253	-0.1458	-0.0042	0.0443	-0.0039	0.0050	0.0006	0.0005	0.0005	0.08
NFPP	-0.0072	-0.0099	-0.0015	0.0067	**0.8353**	0.1056	0.0023	-0.0234	0.0004	0.0087	-0.0088	0.0015	0.0005	0.91**
IFW	-0.0063	-0.0066	0.0013	-0.0129	0.1754	**0.5027**	0.0089	-0.1041	0.0055	0.0067	-0.0074	0.0005	-0.0138	0.55**
FL	-0.0048	0.0004	0.0019	-0.0089	0.0919	0.2161	**0.0208**	-0.0351	0.0009	0.0013	-0.0051	0.0006	0.0100	0.29
FB	-0.0090	-0.0161	0.0004	-0.0151	0.1504	0.4021	0.0056	**-0.1302**	0.0041	-0.0003	-0.0045	0.0003	-0.0076	0.38*
NOSG	0.0011	0.0062	0.0029	-0.0098	0.0167	0.1558	0.0010	-0.0299	**0.0177**	0.0173	-0.0108	0.0002	-0.0185	0.15
NOSD	0.0022	0.0157	0.0019	0.0067	0.2172	0.1005	0.0008	0.0013	0.0092	**0.0333**	-0.0236	0.0008	-0.0161	0.35*
WTSD	-0.0002	0.0066	0.0019	-0.0009	0.2589	0.1307	0.0037	-0.0208	0.0067	0.0277	**-0.0284**	0.0006	-0.0066	0.38*
EDP	-0.0017	0.0045	0.0006	-0.0049	-0.2757	-0.0553	-0.0027	0.0078	-0.0009	-0.0057	0.0037	**-0.0046**	0.0147	-0.32
TSS	0.0050	0.0037	0.0013	-0.0004	-0.0084	0.1458	-0.0044	-0.0208	0.0069	0.0113	-0.0040	0.0014	**-0.0474**	0.09

Residual Effect: 0.0168

PH= Plant Height (m),**CSNS=** Canopy spreading at north-south direction (m), **CSEW=** Canopy spreading at east-west direction (m), **NFPCL=** Number of flowers per cluster, **NFPP=** Number of fruits per plant, **IFW=** Individual fruit weight (g), **FL=** Fruit length (cm), **FB=** Fruit breadth (cm), **NOSG=** Number of segments per fruit, **NOSD=** Number of seeds per fruit, **WTSD=** Weight of seeds per fruit (g), **EDP=** Edible percentage, **TSS=**% Brix, **FYPP=**Fruit yield per plant (kg).

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IV. Conclusion

Correlation and path coefficient analysis revealed that number of fruits per plant, individual fruit weight and fruit breadth were the most important contributors to fruit yield per plant in pummelo. Thus, emphasis should be given for the selection of these characters for the improvement of pummelo.

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