SHORT COMMUNICATION

Correlation and Path Analysis of Yield and its Components in Strawberry (*Fragaria* × *ananassa* Duch.)

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Eighteen varietal germplasm was selected for correlation and path analysis of yield and their plant and berry characters. The fruit yield per plant exhibited significant positive correlation with flower truss per plant, number of flower per plant, number of crown per plant, number of leaves per plant and fruit weight suggesting that yield can be effectively improved through selection of these components whereas, it showed non-significant negative correlation with days to 50% flowering, fruit set, fruit weight, fruit breadth, fruit volume and total sugars indicating that these characters have least significance for improving fruit yield in strawberry. The path coefficient analysis revealed that fruit length, acidity and fruit breadth showed maximum direct effect whereas fruit volume, total sugars, fruit weight and days to 50% flower had negative direct effect on strawberry yield. From present study, it can be concluded that characters like days to 50% flowering, number of flowers per plant, fruit weight, fruit volume and fruit set which exhibited appreciable direct effect on yield proved as important component of yield and the selection based on these characters may result in development of high yielding genotypes

Key Words: Genetic diversity, Strawberry, Varietal screening

Strawberry (*Fragaria×ananassa* Duch.) being temperate region crop, is cultivated in the states of J&K, HP and Uttarakhand. Presently, its cultivation is also getting momentum in sub tropical and tropical states like Haryana, Punjab, Uttar Pradesh, Maharashtra, Karnataka and West Bengal. Strawberry is known for its attractive, luscious appearance, taste and nutritive value with pleasant aroma. Now, it enjoys a very lucrative market avenue owing to its heavy demand in the food beverage and processing industries. Strawberries genotypes under cultivation have much variability in quality and yield related parameters. Yield is complex and polygenic character which depends on various components and is highly affected by internal and external factors. The state of J&K is known to give maximum avenue to a degree of clonal variation in this crop and high degree of variability as has been seen and reported in strawberry in India (Das *et al.,* 2006). This crop is being propagated by runners which provide unique advantage in bringing improvement through clonal selection. Very little efforts have been made in the state to make it a remunerative enterprise. Therefore, sustained efforts are needed for genetic amelioration of this crop. Hence, the present investigation was carried out to assess the association between yield and its components and their direct and indirect contribution to the yield.

The present investigation was carried out at strawberry block of Division of Pomology, Sher-e-Kashmir University of Agricultural Sciences and Technology (Kashmir), Shalimar, situated at latitude 35º5´-34º7´N and 74º5´-74º9´E with an elevation of 1,588 msl. In the study, there were 18 varietal germplasm which included collection from different strawberry growing states of India, including some exotic cultivars. The cultivars were grown in Randomized Block Design with three replications at spacing of 30 cm × 30 cm in plot size of one square meter during the years 2006 to 2008. All recommended cultural practices were followed as per the packages and practices. Observations were recorded for three consecutive years and accordingly five random plants were taken per cultivar in each replication. Berry characters, *viz*., berry length, berry breadth, berry weight, berry volume, acidity, total soluble solids and total sugars were analyzed. TSS was determined by Atago pocket refractrometer (0-93-º Brix), and acidity was determined by the method suggested by AOAC (1970). Whereas, plant characters, *viz*., days to 50% flowering, flower truss per plant, number of flowers per plant, number of crowns per plant, number of leaves per plant, number of berries per plant, fruit set and yield per plant were recorded in field and data generated was pooled. The correlation study was computed as per

the method suggested by Johnson *et al.* (1955) and path coefficient as per Dewey and Lu (1959).

The analysis of variance revealed highly significant difference among the genotypes for all the characters. The fruit yield per plant exhibited significant positive correlation association with flower truss per plant, number of flowers per plant, number of crowns per plant, number of leaves per plant and fruit weight suggesting that yield can effectively be improved through selection of these component characters (Table 1) whereas, it showed non-significant negative correlation with days to 50% flowering, fruit set, fruit breadth, fruit volume and total sugars indicating that these characters have least significance for improving fruit yield in strawberry. Significant positive correlations with fruit yield for number of flower per plant, number fruit per plant and fruit weight were also reported by Mohanty (2003), and Devi and Arumugam (1999).

Significant positive correlation also existed between number of flowers per plant with fruit set, number of flowers per plant with TSS, number of flowers per plant with yield per plant, days to 50% flowering with fruit. There were a positive correlations with number of trusses per plant, number of crowns per plant, number of leaves per plant, fruit set (%), fruit weight with the yield per plant. However, negative correlations existed between TSS with fruit volume, acidity with total sugars and total sugars with fruit volume and fruit breadth. Since, there is a positive association among these component characters, the selection aimed for improvement of any character shall itself influence other character in desirable direction. Significant negative correlation existed between days to 50% flowering with flower truss per plant, fruit set with flower trusses per plant, number of leaves per plant with number of flower per plant and number of crowns per plant suggesting that such type of negative correlation among these components will not be helpful as selection for particular character shall have adverse affect on the other traits.

Among the quality parameters, TSS and acidity revealed significant positive association with fruit yield, fruit volume and total sugars with fruit weight which otherwise is less important as low acidity and high fruit volume and total sugars are desirable in strawberry. It is therefore, suggested that the undesirable linkage between fruit yield and acidity needs to be broken through a suitable hybridization programme followed by selection of transgressive segregation (Dalia and Wilson, 2002). On the other hand, fruit set had significant positive association with days to 50% flowering indicating that there is possibility to select genotypes with high percentage of fruit set. However, fruit set had negative significant correlation with flower truss per plant and number of flower per plant suggesting that selection for genotype with high percentage of fruit set have adverse effect on flower truss per plant and number of flower per plant. From this study, it is quite obvious that fruit set, fruit weight, fruit length, fruit breadth and fruit volume are the major characters affecting the yield and hence simultaneous selection for all these traits would lead to overall improvement in yield.

Although correlation studies are helpful in determining the components of yield but they do not provide a clear picture of nature and extent of contributions made by number of independent traits. Path coefficient analysis technique devised by Wright (1921), which provides an effective means of finding out specific forces producing a given correlation. Such information provides a realistic basis for allocation of appropriate weightage of various attributes, while designing a pragmatic breeding programme for improvement of yield. On the basis of correlation analysis, fruit set, fruit weight, fruit length, fruit breadth and fruit volume were observed to be significantly and positively correlated with yield. However, direct and indirect effects of all the characters worked out in present study gave somewhat different picture. The path coefficient analysis (Table 2) revealed that fruit length, acidity and fruit breadth showed maximum direct effect followed by flower truss per plant, number of crown per plant, TSS whereas fruit volume, total sugars, fruit weight and days to 50% flower had negative direct effect. Yadav and Singh (1996) suggested that the characters which showed maximum direct effects should be considered in selection programme for improving yield.

Regarding indirect effect, it was observed that days to 50% flower exhibited positive indirect effect towards yield through fruit length and flower truss per plant, through fruit length and days to 50% flowering, fruit set through number of crowns per plant and number of flower per plant, fruit weight through number of flower per plant and fruit volume, fruit volume through fruit weight, TSS through fruit weight. Indirect effect towards yield through various characters was also reported by Das *et al*. (2006) and Nazir *et al.* (2006) suggested that for selecting genotype with higher yield the indirect

Table 1. Correlation association between various pairs of characters in strawberry

Parameters	Days to 50% flowering	Flower trusses per plant	No. of flowers per plant	No. of crowns per plant	No. of leaves per plant	Fruit set (%)	Fruit weight (g)	Fruit length (mm)	Fruit breadth (mm)	Fruit volume (cc)	TSS (%)	Acidity (%)	Total sugars (%)	Yield per plant (g)
Days to 50% flowering	**1.000**	-0.3607	-0.4998	-0.0435	-0.3380	0.1978	-0.3161	-0.4292	0.1506	-0.1494	0.0788	0.1574	0.1055	-0.3770
Flower trusses/plant	-0.3607	**1.000**	0.5303**	0.2699*	0.1744*	-0.0506	0.2512	0.3118	-0.1507	-0.0080	-0.0415	0.1804	-0.4123	0.6827
No. of flowers/plant	-0.4998	0.5303	**1.000**	0.5600**	-0.2477	-0.3058	-0.2563	-0.2008	-0.5465	-0.3056	0.0041	0.5213	-0.3425	0.5245
No. of crowns/plant	-0.0435	0.2699	0.5600	**1.000**	-0.1032	0.1290	0.0637	-0.0738	-0.2416	0.0244	-0.0136	0.4720	-0.2320	0.2949
No. of leaves/plant	-0.3380	0.1744	-0.2477	-0.1032	**1.000**	0.2797**	0.0919**	0.4012	0.3986	0.5283	-0.0329	-0.5594	0.2492	0.1044
Fruit set (%)	0.1978	-0.0506	-0.3058	0.1290	0.2797	**1.000**	0.6584	-0.5085	0.5034	0.2797	-0.6802	0.1309	0.4286	-0.3850
Fruit weight (g)	-0.3161	0.2512	0.2563	0.0637	0.0919	0.6584	**1.000**	0.0202*	0.2947	0.0827	-0.1865	-0.0311	-0.3405	-0.0082
Fruit length (mm)	-0.4292	0.3118	0.2008	-0.0738	0.4012	-0.5085	0.0202	**1.000**	-0.0393	0.1163*	0.3067	-0.2141	-0.1130	0.6759
Fruit breadth (mm)	0.1506	-0.1507	-0.5465	-0.2416	0.3986	0.5034	0.2947	-0.0393	**1.000**	0.5991	-0.2221	-0.2865	-0.5392	0.1215
Fruit volume(cc)	-0.1494	-0.0080	-0.3056	0.0244	0.5283	0.2797	0.0827	0.1163	0.5991	**1.000**	-0.1119	-0.1814	0.0323	0.0086
TSS (%)	0.0788	-0.0415	0.0041	-0.0136	-0.0329	-0.6802	-0.1865	0.3067	-0.2221	-0.1119	**1.000**	-0.1310	0.4477	0.1025
Acidity (%)	0.1574	0.1804	0.5213	0.4720	-0.5594	0.1309	0.0311	-0.2141	-0.2865	-0.1814	-0.1310	**1.000**	-0.1880	0.3773
Total sugars (%)	0.1055	-0.4123	-0.3425	-0.2320	0.2492	0.4286	0.3405	0.1130	0.5392	0.0323	-0.4477	-0.1880	**1.000**	-0.2192
Yield per plant (g)	-0.3770	0.6827	0.5245	0.2949	0.1044	-0.3850	0.0082	0.6759	-0.1215	-0.0086	0.1025	0.3773	-0.2192	**1.000**

* Significant at 0.05 % and ** at 0.01%

Table 2. Path coefficient analysis showing direct (bold) and in direct effect of different characters on yield of strawberry

Parameters	Days to 50% flowering	Flower trusses per plant	No. of flowers per plant	No. of crowns per plant	No. of leaves per plant	Fruit set (%)	Fruit weight (g)	Fruit length (mm)	Fruit breadth (mm)	Fruit volume (cc)	TSS (%)	Acidity (%)	Total sugars (%)	Yield per plant (g)
Days to 50% flowering	**-0.3830**	0.1381	0.1951	0.0167	0.1294	-0.0758	0.1211	0.1644	-0.0577	0.0572	-0.0302	-0.0603	-0.0404	0.1444
Flower trusses/plant	-0.1278	**0.3543**	0.1879	0.0956	0.0618	-0.0179	0.0890	0.1105	-0.0534	-0.0028	-0.0147	0.0639	-0.1461	0.2418
No. of flowers/plant	0.1138	-0.1207	**-0.2277**	-0.1275	0.0564	0.0696	-0.0583	-0.0457	0.1244	0.0696	-0.0009	-0.1187	0.0780	-0.1194
No. of crown/plant	-0.0078	0.0483	0.1003	**0.1760**	-0.0185	0.0231	0.0114	-0.0132	-0.0432	0.0044	-0.0024	0.0845	-0.0415	0.0528
No. of leaves/plant	-0.0112	0.0058	-0.0082	-0.0034	**0.0332**	0.0093	0.0031	0.0133	0.0133	0.0176	-0.0011	-0.0186	0.0083	0.0035
Fruit set (%)	0.0093	-0.0024	-0.0143	0.0060	0.0131	**0.0469**	0.0309	-0.0238	0.0236	0.0131	-0.0319	0.0061	0.0201	-0.0180
Fruit weight (g)	0.0882	-0.0701	-0.0715	-0.0178	-0.0256	-0.1837	**-0.2790**	-0.0056	-0.0822	-0.0231	0.0520	-0.0087	-0.0950	0.0023
Fruit length (mm)	-0.2933	0.2130	0.1372	-0.0504	0.2741	-0.3474	0.0138	**0.6832**	-0.0269	0.0795	0.2096	-0.1463	0.0772	0.4618
Fruit breadth (mm)	0.0850	-0.0850	-0.3083	-0.1363	0.2249	0.2840	0.1662	-0.0222	**0.5642**	0.3380	-0.1253	-0.1616	0.3042	-0.0686
Fruit volume (cc)	0.0674	0.0036	0.1378	-0.0110	-0.2382	-0.1261	-0.0373	-0.0524	-0.2701	**-0.4509**	-0.0506	0-0818	-0.0145	0.0039
TSS (%)	0.0066	-0.0035	0.0003	-0.0011	-0.0028	-0.0571	-0.0156	0.0257	-0.0186	0.0094	**0.0839**	-0.0110	-0.0376	0.0086
Acidity (%)	0.0985	0.1129	0.3263	0.2954	-0.3501	0.0819	0.0195	-0.1340	-0.1793	-0.1135	-0.0820	**0.6259**	-0.1176	0.2361
Total sugars (%)	-0.0226	0.0883	0.0734	0.0497	-0.0534	-0.0918	-0.0729	-0.0242	-0.1155	0.0069	0.0959	0.0403	**-0.2142**	0.0469

Residual effect = 0.06

influence of different traits should be given due weightage along with characters which exerted direct effect.

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