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Correlation and path coefficient analysis for various traits in chilli (*Capsicum annuum* L.) genotypes

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Abstract
In the present investigation, thirty genotypes of chilli (*Capsicum annuum* L.) were evaluated at the Experimental Farm of Division of Vegetable Science, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar during *kharif* season, 2015. Correlation coefficients revealed that fruit yield per hectare exhibited significant positive association with plant height, plant spread, placenta length, fruit length, fruit diameter, fruit weight and number of fruits plant^{-1} and significant negative association with days to harvesting. Path coefficient analysis revealed high direct positive effect on fruit yield exerted by plant height, plant spread, fruit weight, number of fruits plant^{-1}, days to 50% fruiting, dry matter content, hence direct selection may be executed considering these traits as the main selection criteria.

Keywords: Biometrical traits, correlation, path analysis, chilli

Introduction
Chilli (*Capsicum annuum* L.), (2n=2x=24) belonging to Solanaceae family, is the leading spice-cum-vegetable crop grown commercially throughout the world. It is highly valued for its green or red ripe fruits with characteristic pungency, colour and flavour. It is consumed fresh, dried or in powder form. Since yield is a complex trait, governed by a large number of components traits. It is imperative to know the interrelationship between yield and its component traits to arrive at an optimal selection index for improvement of yield. The basic concept of correlation was put forward by Galton (1889) and later elaborated by Fisher (1918) and Wright (1921) [14]. Correlation simply measures the association between yield and other traits, whereas path coefficient analysis partitions correlation into direct effects (Path coefficient) and indirect effects (Effects exerted through other variables). Hence the present investigation was carried out with a view to study the character association and direct and indirect effect of different independent characters on dependent variable, fruit yield in chilli genotypes.

Material and Methods
The experimental material for the present investigation consisted of thirty genotypes of chilli which were evaluated during *Kharif* 2015 at Vegetable Experimental Farm, Division of Vegetable Science, SKUAST-Kashmir, Shalimar. The statistical design adapted was RCBD with three replications. Recommended pacꞞage of practices were adopted to raise a healthy crop. Observations were recorded from five randomly selected plants in each experimental plot for seventeen parameters *viz*., plant height, plant spread, stem diameter, number of branches plant^{-1}, days to flower initiation, days to 50% flowering, days to 50% fruiting, days to harvesting, placenta length, fruit length, fruit diameter, fruit weight plant^{-1}, fruit pedicel length, fruit pedicel diameter, number of fruits plant^{-1}, fruit yield hectare^{-1} and dry matter content. Statistical analysis for calculation of correlation was worked out as per Panse and sukhatme (1985) [10] and path coefficient of various characters was calculated according to Dewey and Lu (1959).

Results and Discussion

From the present study it was observed that the economically important trait fruit yield hectare^{-1} exhibited significant and positive association with plant height, plant spread, placenta length, fruit diameter, fruit weight, fruit length and number of fruits plant$^{-1,}$ at both phenotypic and genotypic levels, which suggested that rational improvement in yield is possible through simultaneous selection for these component characters. However this trait had significant and negative association with days to harvesting indicating that simultaneous selection of these traits is not possible. Traits like stem diameter, number of branches plant^{-1}, days to 50% flowering, days to 50% fruiting and dry matter content exhibited positive but non-significant association with fruit yield and negative non-significant association with days to flower initiation, fruit pedicel length and fruit pedicel diameter, which clearly indicated the independent nature of these characters and selection for fruit yield based on these is not reliable. These results are in corobation with findings of Acharya and Rajput (2003), Rao *et al.* (2005) and Tembhurne *et al.* (2008), Kumari *et al.* (2011) [12, 7]. Fruit length showed significant and positive correlation with plant height, plant spread, days to 50% flowering, placenta length, fruit weight, dry matter content and fruit yield per hectare, at both phenotypic and genotypic levels therefore, improvement aimed at any of these traits will automatically lead to improvement in yield. These results are in conformity with earlier observations of Jabeen *et al.* (2009), Patel *et al.* (2009), Singh *et al.* (2009), Padhar and Zaveri (2010), Arup *et al.* (2011), Singh and Singh (2011), Kumar *et al.* (2012) and Lahbib *et al.* (2012), Bijalwan *et al.* (2014) [6, 11, 9, 3, 8, 4]. Similarly fruit weight showed significant positive correlation with placenta length, fruit length, dry matter content and fruit yield per hectare, but it showed significant negative association wih days to harvesting, fruit pedicel length and number of fruits plant^{-1}.The number of fruits plant^{-1} exhibited positive significant correlation with yield but negative significant association with fruit weight and days to harvesting. This was in agreement with the study of Rohini *et al.* (2015).

In current study the path coefficient analysis (Table-2) revealed that appreciable amount of direct positive effect was exerted by component traits like fruit weight, fruit length, number of fruits plant^{-1}, days to 50% fruiting, plant spread, plant height, dry matter content on fruit yield hectare^{-1}.Moreover these traits show significant positive genotypic correlation coefficients with yield indicating that direct selection of these traits will be effective in realizing improvements in yield. Similar results were obtained by Patel *et al*. 2009, Sarkar *et al*. 2009, Bijalwan *et al.* 2014 [11, 4] for fruit weight and number of fruits plant^{-1}; Khurana *et al.* 2003, Patil *et al.* 2009, Bijalwan *et al*. 2014, Ibrahim *et al.* 2017, Jabeen *et al*. 2009, Vidya *et al.* 2014 [4, 5, 6, 13] for plant spread and fruit length, The direct effects of component traits days to flower initiation, days to 50% flowering, days to harvesting, number of branches plant^{-1} and stem diameter were negative and their correlation with yield was either negative or non-significant. Therefore these traits should be considered of little importance in the selection programme of chilli. Traits like placenta length and fruit diameter showed positive association with yield, however their direct effect on yield plant was negative which suggests that indirect casual factors are to be considered for simultaneous selection. These results are in agreement with those reported by Ahmed *et al.* (2006), Bijalwan *et al.* (2014), Chakrabarty *et al.* (2017), Vidya *et al.* (2018) [2, 4, 13]. In conclusion, correlation studies with thirty genotypes of chilli revealed the importance of number of fruits plant^{-1}, plant height, plant spread, fruit weight, fruit length, fruit diameter, placenta length in determining fruit yield. The path coefficient analysis brought out number of fruits plant^{-1}, days to 50% fruiting, plant height, plant spread, fruit weight as major yield components. Hence a perusal of correlation and path analysis studies of the present investigation reveal that the number of fruits plant^{-1}, fruit length, fruit girth and fruit weight were highly important yield components having direct effect on fruit yield per hectare.

Table 1: Estimation of genotypic (Above diagonal) and phenotypic (below diagonal) correlation coefficients among different characters in Chilli (*capsicum annuum* L.)

S. No.	Parameters	Plant height	Plant spread	Stem diameter	No. of branches plant^{-1}	Days to flower initiation	Days to 50% flowering	Days to 50% fruiting	Days to harvesting	Placenta length	Fruit length	Fruit diameter	Fruit weight	Fruit pedicel length	Fruit pedicel diameter	No. of fruits plant^{-1}	Dry matter content	Genotypic Correlation with yield hectare^{-1}
1.	Plant height	0.5901	0.0892	-0.0651	0.0192	-0.2160	-0.0103	0.171	0.125	-0.128	0.037	0.0136	0.0653	0.0188	-0.0012	0.105	-0.002	0.8115
2.	Plant spread	0.0827	0.6374	-0.051	-0.0584	-0.0323	-0.0032	0.196	-0.315	-0.146	0.039	-0.0575	-0.0381	-0.0747	-0.0016	-0.0175	0.0853	0.2450
3.	Stem diameter	0.1477	0.1248	-0.2607	0.0099	0.0059	0.0024	0.348	-0.34	0.086	-0.023	-0.021	-0.0379	-0.0638	-0.0004	0.0143	0.0232	0.0154
4.	No. of branches plant^{-1}	-0.0397	0.1301	0.009	-0.2863	-0.0021	0.0001	-0.259	0.323	-0.0005	-0.001	0.0662	-0.0386	-0.0076	-0.0009	0.0402	0.1035	0.0363
5.	Days to flower initiation	0.2010	0.0324	0.0024	-0.001	-0.6351	-0.007	0.292	-0.209	0.0575	-0.01	0.0288	0.0656	0.0251	-0.002	0.0815	0.0467	-0.0311
s6.	Days to 50% flowering	0.2789	0.0947	0.0287	-0.0003	-0.2058	-0.0218	-0.146	0.133	-0.136	0.037	0.0147	0.0862	0.0111	-0.0013	-0.0475	-0.0225	0.1031
7.	Days to 50% fruiting	0.102	0.1257	-0.0858	0.0747	-0.1865	0.003	0.999	-0.7840	0.0254	-0.0075	-0.0385	-0.0687	-0.0285	0.0006	-0.0428	0.0109	0.0960
8.	Days to harvesting	0.0821	0.2149	-0.0977	0.101	-0.1466	0.0032	0.860	-0.91	0.086	-0.023	-0.0513	-0.402	-0.039	0.0006	-0.184	0.0039	-0.5018
9.	Placenta length	0.1377	0.1681	0.0411	-0.0004	0.0662	-0.0054	-0.045	0.141	-0.553	0.147	0.0039	0.1432	0.0045	-0.0009	-0.0705	0.0821	0.2596
10.	Fruit length	0.1481	0.1693	0.0407	-0.0023	0.0431	-0.0055	-0.05	0.143	-0.551	0.148	0.0055	0.1426	0.0054	-0.001	-0.0554	0.0838	0.2643
10.	Fruit diameter	-0.0667	0.3054	-0.0455	0.1578	0.1522	0.0027	0.319	-0.388	0.017	-0.0067	-0.1201	-0.0386	-0.04	-0.0006	0.0934	-0.0352	0.3061
11.	Fruit weight	0.0926	-0.0583	0.0237	0.0265	-0.0999	-0.0045	-0.163	0.879	-0.189	0.05	0.0111	0.4168	0.0587	-0.0009	-0.494	0.0598	0.6086
12.	Fruit pedicel length	-0.0592	0.2533	-0.0884	-0.0116	0.0849	0.0013	0.151	-0.191	0.021	-0.0041	-0.0255	-0.13	-0.188	0.0001	-0.0114	0.0485	-0.1491
13.	Fruit pedicel diameter	-0.1260	-0.1784	0.0167	0.0454	0.2289	0.0052	0.113	-0.092	0.092	-0.027	0.0128	-0.0696	-0.0038	0.0056	0.0371	-0.0957	-0.0358
14.	No. of fruits plant^{-1}	0.1167	-0.0217	-0.0072	-0.0224	-0.1007	0.002	-0.082	0.325	0.059	-0.015	-0.0218	-0.401	0.0042	0.0004	0.514	-0.0128	0.3367
15.	Dry matter content	-0.0051	0.2373	-0.0264	-0.1293	-0.1294	0.0021	0.046	-0.017	-0.197	0.054	0.0185	0.1087	-0.0398	-0.0023	0.0287	0.2292	0.1782

Table 2: Estimates of genotypic (above diagonal) and phenotypic (below diagonal) correlation coefficients among different traits in chilli (*Capsicum annuum* L.)

S. No.	Parameters	Plant height	Plant spread	Stem diameter	No. of branches plant	Days to flower initiation	Days to 50% flowering	Days to 50% fruiting	Days to harvesting	Placenta length	Fruit length	Fruit diameter	Fruit weight	Fruit pedicel length	Fruit pedicel diameter	No. of fruits plant^{-1}	Fruit yield hectare^{-1}	Dry matter content
1.	Plant height	1.00	0.139	0.249*	-0.067	0.341*	0.471**	0.172	-0.138	0.233*	0.250*	-0.112	0.156	-0.100	-0.197	0.197	0.811**	-0.008
2.	Plant spread	0.139	1.00	0.195	0.204	0.050	0.148	0.197	0.347*	0.263*	0.265*	0.479**	-0.091	0.397**	-0.279*	-0.034	0.245*	0.372**
3.	Stem diameter	0.247*	0.194	1.00	-0.034	-0.009	- 0.109	0.349*	0.374**	-0.157	-0.156	0.174	-0.090	0.339*	-0.063	0.028	0.015	0.101
4.	No. of branches plant^{-1}	-0.051	0.141	-0.025	1.00	0.003	0.001	-0.260	-0.356**	0.001	0.008	-0.551**	-0.092	-0.040	-0.158	0.078	0.036	0.451**
5.	Days to flower initiation	0.342*	0.050	-0.008	0.015	1.00	0.324*	0.293*	0.230*	-0.104	-0.069	-0.239	0.157	-0.133	-0.364**	0.158	-0.031	0.203*
6.	Days to 50% flowering	0.468**	0.147	-0.109	0.003	0.316*	1.00	-0.137	-0.147	0.246*	0.253*	-0.122	0.206	-0.059	-0.241*	-0.092	0.103	-0.098
7.	Days to 50% fruiting	0.172	0.195	0.346*	-0.177	0.287*	-0.137	1.00	0.861**	-0.046	-0.051	0.320	-0.164	0.151	0.114	-0.083	0.096	0.047
8.	Days to harvesting	-0.136	0.343*	0.363**	-0.267	0.220*	-0.144	0.860**	1.00	-0.156	-0.158	0.427**	-0.966**	0.210*	0.102	-0.358**	-0.501**	0.017
9.	Placenta length	0.211*	0.243*	-0.145	0.007	-0.097	0.226*	-0.046	-0.151	1.00	0.998**	-0.032	0.343*	-0.023	-0.168	-0.137	0.259*	0.358**
10.	Fruit length	0.229*	0.245*	-0.144	0.004	-0.065	0.234*	-0.050	-0.153	0.996**	1.00	-0.045	0.342*	-0.028	-0.187	-0.107	0.264*	0.365**
11.	Fruit diameter	-0.068	0.296*	0.100	-0.262*	-0.150	-0.077	0.175	0.252*	-0.031	-0.047	1.00	-0.092	0.212*	-0.106	0.181	0.306*	-0.153
12.	Fruit weight	0.147	-0.084	-0.083	-0.040	0.136	0.176	-1.140	-0.960**	0.252*	0.323*	-0.102	1.00	-0.312*	-0.166	-0.962**	0.608**	0.260*
13	Fruit pedicel length	-0.092	0.361**	0.307*	-0.022	-0.112	-0.057	0.127	0.189	-0.044	-0.052	0.145	-0.241*	1.00	0.020	-0.022	-0.149	0.211*
14.	Fruit pedicel diameter	-0.197	-0.248*	-0.064	-0.093	-0.303*	-0.211*	0.099	0.083	-0.159	-0.181	-0.038	-0.140	0.077	1.00	0.072	-0.035	-0.417**
15.	No. of fruits plant $^{-1}$	0.192	-0.033	0.029	0.054	0.156	-0.156	-0.080	-0.355**	-0.112	-0.085	0.098	-0.962**	-0.021	0.071	1.00	0.336*	-0.055
16.	Fruit yield hectare $^{-1}$	0.805**	0.240*	0.015	0.032	-0.020	0.102	0.090	-0.501**	0.254*	0.263*	0.302*	0.600**	-0.144	-0.035	0.325*	1.00	0.176
17.	Dry matter content	-0.0085	0.372**	0.100	0.325*	0.201*	-0.097	0.046	0.017	0.330*	0.338*	-0.092	0.233*	0.191	-0.371**	-0.055	0.178	1.00

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