Correlation estimates of phenotypic and genotypicperformance and Path coefficients in chilli (*Capsicum annuum* L.)

Abstract

The significant positive correlation of phenotypic and genotypic performance as well as path correlation of crops helps in selection of the superior cultivars. Based upon important significance of these estimates, it was applied in our research. For thisan experiment was conducted on different genotypes of chilli during winter season of 2021-22. Herein explore the genetic association and path coefficients of 40 genotypes of chilli (*Capsicum annuum* L.) including control (Kashi Anmol). The phenotypic estimates include, fruit production per plant, demonstrated a highly significant and positive correlation with average fruit weight, number of fruits per plant, and fruit circumference. The number of fruits per plant was shown to have a greater direct positive correlationwith fruit yield followed by average fruit weight. Fruit yield per plant was most negatively correlated with fruit circumferencefollowed by secondary branches per plant. Fruit circumference showedindirect positive correlation with number of total fruits yield per plant followed by number of fruits per plant, while indirect negative correlation maximum in secondary branches per plant followed by plant height and days to mature red ripe stage. Thus, it can be inferred from the data above that selecting for these qualities will effectively enhance the crop for increased production and contributing traits.

Keywords:chilli(*Capsicum annuum* L.**)**correlationgenotypic, phenotypic, path coefficient, quantitative trait.

Introduction

Chilli is a major vegetable crop growing practically everywhere in the country. It has the chromosomal number 2n=24 and belongs to the Solanaceae family. Chilli is one of Asia's most significant and widely produced spice crops. India, China, Ethiopia, Myanmar, Mexico, Peru, Vietnam, Pakistan, Ghana, and Bangladesh are the world's major chilli-growing nations. India leads the pack in terms of chilli exports. It accounts for around 33% of total spice exports from India and accounts for approximately 16% of global spice trade. Andhra Pradesh, Karnataka, Maharashtra, Orissa, Tamil Nadu, Madhya Pradesh, West Bengal, and Rajasthan are the primary chilli-growing states in India. Green chillies (spice) are cultivated on an area of 411 thousand hectares in India, with a production of 4363 thousand MT, and dried chillies(spice) on an area of 702 thousand ha, with a production of 2049 thousand MT (Anony., 2020-2021). Green chillies are high in proteins, calcium, magnesium, potassium, copper, and sulphur, as well as vitamins such as thiamine, riboflavin, and vitamin C. Cayenne pepper is used in chicken feed, and green chillies are high in Rutin, which has therapeutic use. Capsaicin is responsible for the chilli's pungency. The pigment (colour) of chilli is caused by capsanthin, although it also includes a variety of other oleoresins, It is also a good source of 'oleoresin,' which allows for better dispersion of colour and flavor in dishes (Chattopadhyay et al., 2011).

Both genotypic and environmental factors contribute to phenotypic variability. Environmental conditions have little effect on genotypic variability.Two or more variables might have reciprocal linear connections, which are known as correlation coefficients. Characters have a correlation coefficient that might be high, low, positive, or negative. To determine the direction of selection and maximise yield in the least amount of time, estimation of the correlation coefficient is required. Path coefficients measure the relative importance of each causative element and provide an effective method of distinguishing between the primary and indirect causes of the selection relationship. Due to its importance as a crop in our nation, chillies require attention in terms of genetic development.

Material and Methods

The current study was conducted at the Main Experiment Station, Department of Vegetable Science, Acharya Narendra Deva University of Agriculture and Technology (Narendra Nagar), Kumarganj, Ayodhya (U.P), during the Rabi season 2021- 22. Based on the analysis of 40 genotypes, the experiment was carried out in a Randomized Block Design with three replications in the autumn-winter season of 2021–2022. The goal was to determine the correlation between various features. Twelve plants in two rows, spaced 60 x 50 centimetres apart, made up each treatment, with a net plot of 3.0 x 1.8 metres. The seed was planted on April 10, 2021, after being shown on a nursery bed on August 28, 2021. To produce a high-quality crop, every suggested set of agronomic practises and plant protection measures was adhered to. Observations were recorded on thirteen quantitative characters *viz.*, days to 50% flowering, days to mature green fruit, days to mature red ripe stage, plant height (cm), primary branches per plant, secondary branches per plant, no. of fruit per plant, fruit length (cm), pedicel length (cm), fruit circumference (mm), average fruit weight (g), ascorbic acid (mg/100g), fruit yield per plant (kg).

The correlations between different characters at genotypic (g) andphenotypic (p)levels were workedout as suggestedby**Searle**(1961).

i) Phenotypiccorrelationcoefficient betweencharactersX andY

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

ii) GenotypiccorrelationbetweencharactersXandY

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

Where,

r_{xy} =Correlation coefficients between X and Y.

CovarianceXY=Co-variancebetweencharactersX andY

Var.X=Variancefor Xcharacter

Var.Y=VarianceforY character

Thesignificanceofphenotypiccorrelationcoefficientswastested against(n-2)degreesoffreedomat5%and1%probabilitylevel.Where,nisthenumberofgermplasmonwhichtheobservationswererecorded.

According to Singh and Chaudhary (1985), statistical analysis was performed on the data to determine the genotypic and phenotypic correlation coefficient. Following Dewey Lu's advice, the route analysis approach was used to quantify the direct and indirect impacts of component characteristics on yield (1959).

Result

The type and degree of the relationship between yield and its constituent features is required for successful selection in future generations. The nature of the population under consideration, as well as the amount of the correlation coefficient, are frequently impacted by the people observed. Correlations between character pairs are caused by gene linkage or pleiotropy. As a result, choosing one attribute influences the other related or pleiotropically impacted qualities. Correlation studies have received a lot of attention in plant improvement since they aid with successful selection.

Tables 1 and 2 show the phenotypic and genotypic correlation coefficients obtained among the thirteen characteristics under consideration. In general, genotypic correlation coefficients were greater than phenotypic correlation coefficients, suggesting a significant intrinsic link between distinct pairs of features in chilli genotypes. Fruit production per plant, the most important feature, demonstrated a highly substantial and favourable phenotypic connection with average fruit weight (0.925), no. of fruits per plant (0.595) and fruit circumference (0.464). Ascorbic acid had exhibited highly significant and positive phenotypic correlation with days to maturity of green fruit (0.211). Average fruit length had exhibited highly significant and positive phenotypic correlation with fruit circumference (0.536) and no. of fruit per plant (0.258). Pedicel length had exhibited highly significant and positive phenotypic correlation with fruit length (0.349). Fruit length had exhibited highly significant and positive phenotypic correlation with days to 50% flowering (0.374). Secondary branches per plant had exhibited highly significant and positive phenotypic correlation with plant height (0.239) and positive correlated with primary branches per plant (0.213). Primary branches per plant acid had exhibited highly significant and positive phenotypic correlation with plant height (0.257). Days to mature red ripe stage had exhibited highly significant and positive phenotypic correlation with days to mature green stage (0.537) and positive correlated with days to 50% flowering (0.218). Days to mature green stage had exhibited highly significant and positive phenotypic correlation with days to 50% flowering (0.431). Similar association of traits in chilli had also been reported by Pujar *et al*. (2017), Bundela *et al.* (2018), Vidya *et al.* (2018), Srinivas *et al*. (2020) and Chavan *et al*. (2021).

6 Path Coefficient Analysis:

The path coefficient is simply a standardized partial regression coefficient that splits the correlation coefficient into direct and indirect effects of a set of independent factors on the dependent variable. This study created a mechanism for identifying the direct and indirect impacts of various variables on fruit yield per plant at the phenotypic and genotypic levels.

Using phenotypic and genotypic correlation coefficients, path coefficient analysis was used to estimate the direct and indirect effect of thirteen characteristics on fruit yield per plant. Tables 3 and 4 indicate the direct and indirect effects of different traits on fruit yield per plant at the phenotypic and genotypic levels.

The higher magnitude of positive direct effect on fruit yield per plant was exerted by average fruit weight (0.835) followed by no. of fruits per plant (0.385). The higher magnitude of negative direct effect on fruit yield per plant was exerted by fruit circumference (-0.018) followed by secondary branches per plant (-0.011). While maximum positive indirect effect on total fruit yield per plant shown by fruit circumference (0.448), followed by no. of fruit per plant (0.216). while negative indirect effect shown by secondary branches per plant (-0.143) followed by plant height (-0.127) and days to mature red ripe stage (-0.124).

The higher magnitude of positive direct effect on fruit yield at genotypic level was exerted by average fruit weight (0.859) and no. of fruit per plant (0.387). The higher magnitude of negative direct effect on fruit yield per plant was exerted by secondary branches per plant (-0.0609) and fruit circumference (-0.0448). while maximum positive indirect effect shown by fruit circumference (0.5975) and no. of fruit per plant (0.2462). The higher magnitude of negative indirect effect shown by secondary branches per plant (-0.2443) and days to mature red ripe stage (-0.2393). This indicated that direct selection based on average fruit weight and no. of no. of fruit per plant would result in an appreciable improvement of fruit yield per plant in chilli. Similar results were also reported by Meena *et al.* (2016), Ain *et al.* (2019) and Lakshmidevamma*et al.* (2021).

Table1:Estimatesof phenotypiccorrelationcoefficientsamongthirteencharactersinchilli

Traits	Days to 50% flowering	Days to mature green fruit	Days to mature red ripe stage	Plant height	Primary branches per plant	Secondary branches per plant	No. of fruit per plant	Fruit length	Pedicel length	Fruit circumference	Average fruit weight	Ascorbic acid	Fruit yield per plant
Days to 50% flowering	**1.000**	0.431**	0.218*	0.071	-0.095	0.053	0.015	0.374**	0.127	0.099	0.114	0.140	0.097
Days to mature green fruit		**1.000**	0.537**	0.014	-0.113	-0.011	-0.027	-0.018	0.011	0.008	-0.058	0.211*	-0.053
Days to mature red ripe stage			**1.000**	0.084	0.004	0.048	-0.202	-0.066	-0.018	-0.044	-0.148	0.160	-0.190*
Plant height				**1.000**	0.257**	0.239**	-0.136	0.015	0.075	-0.167	-0.152	-0.088	-0.170
Primary branches per plant					**1.000**	0.213*	-0.063	-0.128	-0.191*	0.007	-0.038	-0.186	-0.036
Secondary branches per plant						**1.000**	0.003	0.105	0.047	-0.199	-0.172	-0.128	-0.143
No. of fruit per plant							**1.000**	0.132	-0.011	0.080	0.258**	-0.173	0.595**
Fruit length								**1.000**	0.349**	-0.065	0.043	-0.216*	0.082
Pedicel length									**1.000**	0.113	0.067	-0.020	0.059
Fruit circumference										**1.000**	0.536**	0.137	0.464**
Average fruit weight											**1.000**	-0.105	0.925**
Ascorbic acid												**1.000**	-0.161

Significant at 5%and1%,respectively

Table-2:Estimates ofgenotypiccorrelationcoefficientamongthirteencharactersinchilli

Traits	Days to 50% flowering	Days to mature green fruit	Days to mature red ripe stage	Plant height	Primary branches per plant	Secondary branches per plant	No. of fruit per plant	Fruit length	Pedicel length	Fruit circumference	Average fruit weight	Ascorbic acid	Fruit yield per plant
Days to 50% flowering	**1.000**	0.429**	0.287**	0.081	-0.113	0.012	0.135	0.511**	0.143	0.094	0.122	0.178	0.144
Days to mature green fruit		**1.000**	1.100**	0.031	-0.361	-0.018	-0.039	-0.074	0.059	-0.233**	-0.161	0.401**	-0.142
Days to mature red ripe stage			**1.000**	0.112	-0.054	0.080	-0.481**	-0.129	0.111	-0.296**	-0.279	0.307**	-0.386**
Plant height				**1.000**	0.458**	0.417**	-0.171	0.007	0.144	-0.215*	-0.150	-0.097	-0.182
Primary branches per plant					**1.000**	0.518**	-0.180	-0.286**	-0.179	-0.190*	-0.091	-0.278**	-0.106
Secondary branches per plant						**1.000**	0.115	0.179	0.248**	-0.523**	-0.285**	-0.234**	-0.187*
No. of fruit per plant							**1.000**	0.143	-0.052	0.068	0.287**	-0.188*	0.594**
Fruit length								**1.000**	0.445**	-0.149	0.075	-0.241**	0.105
Pedicel length									**1.000**	0.082	0.037	-0.041	0.013
Fruit circumference										**1.000**	0.696**	0.171	0.584**
Average fruit weight											**1.000**	-0.112	0.939**
Ascorbic acid												**1.000**	-0.171

Significant at 5%& 1%

Table- 3: Direct and indirect effect of twelve characters on fruit yield per plant at phenotypic level in chilli

Traits	Days to 50% flowering	Days to mature green fruit	Days to mature red ripe stage	Plant height	Primary branches per plant	Secondary branches per plant	No. of fruit per plant	Fruit length	Pedicel length	Fruit circumference	Average fruit weight	Ascorbic acid	Fruit yield per plant
Days to 50% flowering	**-0.003**	0.002	0.002	0.000	-0.002	-0.001	0.006	-0.003	0.002	-0.002	0.095	-0.001	0.097
Days to mature green fruit	-0.001	**0.006**	0.005	0.000	-0.003	0.000	-0.010	0.000	0.000	0.000	-0.048	-0.001	-0.053
Day to first red ripe fruit harvesting	-0.001	0.003	**0.010**	0.000	0.000	-0.001	-0.078	0.001	0.000	0.001	-0.124	-0.001	-0.190*
Plant Height	0.000	0.000	0.001	**0.000**	0.006	-0.003	-0.053	0.000	0.001	0.003	-0.127	0.000	-0.170
Primary Branch	0.000	-0.001	0.000	0.000	**0.024**	-0.002	-0.024	0.001	-0.003	0.000	-0.032	0.001	-0.036
Secondary Branch	0.000	0.000	0.001	0.000	0.005	**-0.011**	0.001	-0.001	0.001	0.004	-0.143	0.001	-0.143
Fruit per plant	0.000	0.000	-0.002	0.000	-0.002	0.000	**0.385**	-0.001	0.000	-0.001	0.216	0.001	0.595**
Fruit length	-0.001	0.000	-0.001	0.000	-0.003	-0.001	0.051	**-0.007**	0.006	0.001	0.036	0.001	0.082
Pedicle length	0.000	0.000	0.000	0.000	-0.005	-0.001	-0.004	-0.003	**0.017**	-0.002	0.056	0.000	0.059
Fruit circumference	0.000	0.000	0.000	0.000	0.000	0.002	0.031	0.001	0.002	**-0.018**	0.448	-0.001	0.464**
Average fruit weight (g)	0.000	0.000	-0.001	0.000	-0.001	0.002	0.099	0.000	0.001	-0.010	**0.835**	0.001	0.925**
Ascorbic acid mg/100g	0.000	0.001	0.002	0.000	-0.005	0.001	-0.066	0.002	0.000	-0.003	-0.087	**-0.005**	-0.161

3**R SQUARE= 0.9924, RESIDUAL EFFECT = 0.0873**

Table-4:Directandindirecteffectsoftwelvecharactersonfruityieldperplant(g)atgenotypiclevelinchilli

Traits	Days to 50% flowering	Days to mature green fruit	Days to mature red ripe stage	Plant height	Primary branches per plant	Secondary branches per plant	No. of fruit per plant	Fruit length	Pedicel length	Fruit circumference	Average fruit weight	Ascorbic acid	Fruit yield per plant
Days to 50% flowering	**-0.0313**	0.0089	0.0058	-0.0015	-0.0106	-0.0007	0.0523	0.0138	0.0041	-0.0042	0.1049	0.0026	0.144
Days to mature green fruit	-0.0135	**0.0206**	0.0221	-0.0006	-0.0342	0.0011	-0.0152	-0.0020	0.0017	0.0104	-0.1380	0.0058	-0.142
Days to mature red ripe stage	-0.0090	0.0227	**0.0201**	-0.0021	-0.0051	-0.0049	-0.1861	-0.0035	0.0032	0.0133	-0.2393	0.0044	-0.386**
Plant height	-0.0026	0.0006	0.0023	**-0.0183**	0.0433	-0.0254	-0.0662	0.0002	0.0042	0.0096	-0.1285	-0.0014	-0.182
Primary branches per plant	0.0035	-0.0075	-0.0011	-0.0084	**0.0946**	-0.0316	-0.0694	-0.0077	-0.0052	0.0085	-0.0778	-0.0040	-0.106
Secondary branches per plant	-0.0004	-0.0004	0.0016	-0.0076	0.0490	**-0.0609**	0.0443	0.0048	0.0072	0.0234	-0.2443	-0.0034	-0.187*
No. of fruit per plant	-0.0042	-0.0008	-0.0097	0.0031	-0.0170	-0.0070	**0.3867**	0.0039	-0.0015	-0.0030	0.2462	-0.0027	0.594**
Fruit length	-0.0160	-0.0015	-0.0026	-0.0001	-0.0270	-0.0109	0.0552	**0.0270**	0.0128	0.0067	0.0644	-0.0035	0.105
Pedicle length	-0.0045	0.0012	0.0022	-0.0026	-0.0169	-0.0151	-0.0201	0.0120	**0.0289**	-0.0037	0.0321	-0.0006	0.013
Fruit circumference	-0.0029	-0.0048	-0.0059	0.0039	-0.0180	0.0318	0.0263	-0.0040	0.0024	**-0.0448**	0.5975	0.0025	0.584**
Average fruit weight	-0.0038	-0.0033	-0.0056	0.0027	-0.0086	0.0173	0.1109	0.0020	0.0011	-0.0311	**0.8587**	-0.0016	0.939**
Ascorbic acid	-0.0056	0.0083	0.0062	0.0018	-0.0262	0.0142	-0.0728	-0.0065	-0.0012	-0.0076	-0.0961	**0.0145**	-0.171

RSQUARE=0.9997,RESIDUALEFFECT=0.0163

Conclusion:

Based on the above result of correlation studies it could be concluded that characters like average fruit weight, no. of fruits per plant and fruit circumference showed highly positive significant correlation with the yield. Thus,this finding indicated that these traits could utilize in various breeding as well as improvement programmes. The information may further help the breeders in formulating appropriate strategy aimed at getting higher yield and character improvement in chilli.

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