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Association of Yield and its Attributing Characters for Selecting Superior Genotypes in Chilli (*Capsicum annuum* L.)

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ABSTRACT: The study aimed to assess the degree of association between the yield and its various contributing attributes in chilli and to determine the path through which each character is contributing towards yield. Thirteen different characters recorded from ninety-four genotypes in chilli were used for estimating the correlation and path coefficient analysis. The result of correlation study indicated that yield per plant is significantly and positively correlated with fruit number, fruit bearing period, fruit weight, fruit set percentage, fruit length and fruit wall thickness and negatively correlated with days to first flowering and days to fruit maturity. Further, path analysis revealed that importance should be given to the characters namely fruit number, fruit weight, days to fruit maturity, fruit set percentage, plant height and fruit bearing period as it showed direct positive effect on the trait yield per plant. Consequently, selecting genotypes that are promising for these characteristics will improve yield in chilli.

Keywords: Chilli, Correlation, Path coefficient analysis, Association.

INTRODUCTION

Chili is an important vegetable and condiment crop that is widely grown in tropical and subtropical parts of the world. It is an essential ingredient in the culinary purposes, adding color, vitamin C, flavour, and spiciness to a variety of foods. Among the different five cultivated species, *C. annuum* is the most popular and economically significant species. *Capsicum* sp. originated in the New World and is considered as one of the oldest domesticated crops in the America (Vavilov, 1951). Since its introduction to India by Portuguese during the end of the fifteenth century, it became an essential ingredient in the diet of rich and poor of our country. India accounts for a significant portion of the area under chilli cultivation and holds an important position in production and export of chilli. Also, India is considered as a secondary centre of diversity for *Capsicum annuum* (Thakur *et al*., 2019). Hence the genetic variability available in our germplasm can be utilized to develop high-yielding hybrids possessing resistance characters. According to FAO statistics (2018) chilli is cultivated in an area of around 791,000 hectares in India and it contributed an average production of about 1,888,000 metric tonnes. India is a leading player in the global market for dry chilli, holding a significant share in export of dry chilli. Dry chilli is exported as commercial spice and it is the second-largest spice exporting from India, following black pepper. It accounted for around 42% of the country's total spice exports in 2022 (FAO, 2022). The exceptional quality of Indian dry chilli, especially for its vibrant color and distinctive pungency has got special recognition in the international market and presently dry chilli from India is exported to countries such as China, Vietnam, Thailand, Sri Lanka, Indonesia, UAE and Malaysia.

The improvement programme in any crop commences with the selection of genetically diverse genotypes that exhibit desired quantitative traits. A population with greater variability increases the likelihood of success in identifying the desirable traits and the selection of genotypes showing high genetic variability and minimal environmental influence for characters is ideal. Hence, an extensive understanding of population variability, interrelationships between yield and its attributed traits, and the relative significance of these traits towards the depended variable is decisive in successful hybridization programme. Furthermore, the quantitative nature of yield and its components, along with their

polygenic inheritance, which is significantly influenced by environmental factors, emphasizes the importance of studying the relationships between these traits (Santoes *et al*., 2014). Genotypic and phenotypic correlation coefficient analysis could assess the degree of association between the characters and the environmental influence in characters (Izge *et al*., 2012).

However, though correlation coefficients can relate the degree of association between the traits, it does not indicate the relative significance of the contributing variables with respect to the dependent variable. Here, path analysis provides an understanding of whether the related traits influence directly or indirectly the yield by partitioning the correlation coefficients into direct and indirect impacts. This knowledge is necessary to understand the influence of yield-related traits on the fruit yield. Though several studies have been conducted in this line in chilli (Vijeth, 2019), the association of different characters need to be studied before a crop improvement programme to understand how the genotypes behave in the environmental condition under study since most of the economic characters contributing towards yield or production is influenced by the environmental factors (Sonania and Singh 2022). Therefore, in this study, the relationship of various characters in chilli among themselves and with the fruit yield was determined and direct and indirect effects of different independent traits on the dependent variable were figured out for effective selection of superior genotypes based on phenotypes.

MATERIALS AND METHODS

The experiment was conducted during the Kharif season of 2021-22 at field of Vegetable Science department, College of Agriculture, Thrissur, Kerala which is situated at a latitude of 10º 32' N and 76º 16' E longitude. The location is 23 m above MSL with sandy clay loam textured acidic soil. The experiment was conducted in augmented design with 94 genotypes out of which two were check varieties namely Anugraha and Ujjwala and other genotypes were obtained from NBPGR, WVC, Taiwan, different SAUs, ICAR institutes and local collections. The data on various observations were recorded from the respective observational plants in each genotype. The data was subjected to character association studies for understanding the relationship between them and for identifying the suitable phenotypes for selection of promising genotypes. Accordingly, the genotypic correlation coefficients between various characters Johnson *et al*. (1955) and the direct and indirect effects of yield related traits (Dewey and Lu 1959) were calculated from the data collected.

RESULTS AND DISCUSSION

Correlation coefficient analysis. The characters used for correlation studies included plant height (cm), days to first flowering, days to fruiting, days to fruit maturity, dry matter content, fruit set percentage, pedicel length(cm), fruit wall thickness (mm), fruit weight (g), fruit bearing period, fruit width (cm), fruit number and yield per plant (g). The estimates of the genotypic correlation between the yield and its related attributes are detailed in the Table 1. The results of the study showed that yield per plant is significantly and positively correlated with fruit number (0.731), fruit bearing period (0.629), fruit weight (0.502), fruit set percentage (0.414), fruit length (0.295) and fruit wall thickness (0.290). Whereas, a significant negative correlation was observed between yield per plant and days to first flowering (-0.489) and fruit maturity (-0.483). Thus, selection of genotypes can be made considering the significant positively correlated characters to ensure improved yield in chilli. The result also showed that earliness in flowering and fruit maturity negatively impact yield. Chakrabarty and Islam (2017) also reported a significant positive correlation between yield and factors such as the number of fruits, days to fruit maturity, fruit-bearing period, and fruit weight. Likewise, the positive correlation of yield with fruit weight, and fruit number was also observed by Saisupriya *et al*. (2020).

The traits plant height was observed to be significantly and positively associated with the parameter fruit number per plant (0.211) while the character fruit number per plant was observed to be in significant positive correlation with fruit set percentage (0.395) and fruit bearing period (0.388). This positive association of plant height with fruit number as well as other quantitative characters of the fruit is due to the increased allocation of photosynthates to the sink. The results are in conformity with the observations made by Chattopadhyay *et al*. (2011); Swetha *et al*. (2018). However, the present study showed a significant negative correlation between the characters such as fruit number per plant, fruit set percentage, and fruit bearing period with days to first flowering and fruit maturity period. Also, the same effect was observed between yield per plant and days to first flowering and fruit maturity. This indicates that selecting genotypes with high fruit setting percentage and bearing period guarantees higher yields and more fruits as well, but early genotypes should be avoided and the same was reported by Dar *et al*. (2011); Bundela *et al*. (2018). Also, the trait fruit set percentage and fruit bearing period showed a non-significant negative relation with fruit width and fruit length which shows that comparatively small fruits may be resulted if going for high setting percentage. These results are in accordance with the findings of Bundela *et al*. (2018); Ganeshreddy *et al*. (2008); Swetha *et al*. (2018).

The fruit characters such as fruit length, fruit weight, pedicel length, fruit wall thickness was fruit weight were found positively correlated. But a significant negative correlation of these characters was found with days to first flowering (-0.136) and fruit maturity (-0.115). Satish (2007); Krishna *et al*. (2007) reported this negative correlation and it denotes that early flowering as well as early maturing genotypes produce fruits with reduced length, width, and weight as reported by Ajjappalavara *et al*. (2005). In this study, fruit length showed a significant positive correlation with fruit bearing period (0.437), yield (0.295), fruit

weight (0.569), pedicel length (0.462) while fruit width was found significant positively correlated with fruit wall thickness and fruit weight was negatively correlated with fruit number (-0.168), fruit set percentage (-0.0.083), pedicel length (-0.101) and fruit length (-0.159). This agrees the observations by Ajjappalavara *et al*. (2005); Swetha *et al*. (2018) and it indicates that the competition among the large number of fruits is responsible for this reduced fruit size. The character fruit bearing period was found positively correlated with all characters except days to first flowering (-0.623) and days to fruit maturity (-0.610) which denotes that long bearing varieties gave high yield with good fruit characters and early bearing adversely affect the economic characters of the crop.

Path coefficient analysis. Path coefficient analysis of characters was carried out to find out the cause-and-effect relationship on yield per plant and among the twelve characters studied, six characters showed positive direct effect on fruit yield per plant at genotypic level. The result showing the direct and indirect effects of various traits are given in the Table 2**.**

Table 1: Genotypic correlation coefficients for quantitative traits in chilli genotypes.

	Yield per plant (g)	Plant height (cm)	Fruit number	Fruit set percent	Pedicel length (cm)	Fruit wall thickness (mm)	Fruit weight (g)	Days to fruit maturity	Fruit length (cm)	Fruit bearing period	Fruit width (cm)	Days to first flowering	Dry matter content (%)
Yield per plant(g)	1												
Plant height(cm)	0.16	1											
Fruit number	0.731***	0.211*	1										
Fruit set percent	0.414***	0.004	0.395***	1									
Pedicel length(cm)	0.090	0.085	-0.063	0.169	1								
Fruit wall thickness (mm)	0.290**	0.135	0.099	0.071	0.088	1							
Fruit weight(g)	0.502***	-0.013	-0.105	0.08	0.299**	0.397***	1						
Days to fruit maturity	-0.483***	0.131	-0.343***	-0.232*	-0.033	-0.115	-0.244*	1					
Fruit length(cm)	0.295**	-0.068	-0.076	-0.003	0.462***	0.138	0.569***	-0.283**	1				
Fruit bearing period	0.629***	0.061	0.388***	0.335***	0.266**	0.246*	0.472***	-0.61***	0.437***	1			
Fruit width(cm)	0.116	0.178	-0.168	-0.083	-0.101	0.304**	0.49***	0.093	-0.159	0.097	1		
Days to first flowering	-0.489***	0.129	-0.326**	-0.207*	-0.062	-0.136	-0.276**	0.989***	-0.349***	-0.623***	0.109	1	
Dry matter content(%)	-0.093	0.032	0.148	0.062	-0.132	-0.137	-0.23*	0.034	-0.179	0.049	-0.109	0.021	1

*** Correlation is significant at 0.001 level ** Correlation is significant at 0.01 level * Correlation is significant at 0.05 level

The diagonal values in the table represents the direct effects and the values on both sides of the diagonal represented indirect effects.

Among the characters studied, the highest direct effect was showed by the traits fruit number (0.722), followed by fruit weight (0.575), days to fruit maturity (0.231), fruit set percentage (0.081), plant height (0.043) and fruit bearing period (0.042). The characters namely days to first flowering (-0.292), pedicel length (-0.085), dry matter content (-0.097), fruit width (-0.050), fruit wall thickness (-0.033) and fruit length (-0.010) showed negative direct effect on fruit yield per plant. The result of direct association of fruits per plant on yield per plant was earlier reported by Athulya (2023); Athulya and Anitha (2022) in tomato and Saisupriya *et al*. (2020) in chilli. The direct positive effect of fruit number and plant height was observed by Bundela *et al*. (2018); Swetha *et al*. (2018); Saisupriya *et al*. (2020). The negative direct effect of the traits such as fruit length and fruit width towards fruit yield per plant was also reported by Chakrabarty and Islam (2018).

Plant height showed a positive indirect effect to yield via fruit number, days to fruit maturity, fruit bearing period and fruit length and negative indirect effect via days to first flowering, pedicel length, fruit wall thickness, fruit weight, fruit width and dry matter content. Fruit number per plant exhibited positive indirect effects to yield through days to first flowering, fruit set percentage, fruit bearing period, plant height, pedicel length, fruit width and fruit length and negative indirect effect via days to fruit maturity, fruit weight, dry matter, and fruit wall thickness. While, fruit set percentage showed positive indirect effects through fruit number per plant, days to first flowering, fruit weight, fruit bearing period, and fruit width and negative indirect effect through days to fruit maturity,

pedicel length, fruit wall thickness dry matter content. Fruit weight displayed positive indirect effects through days to first flowering, dry matter content, fruit bearing period and fruit set percentage and negative indirect effect through plant height, fruit length, fruit wall thickness, fruit width, pedicel length, days to fruit maturity and fruit number per plant. Fruit bearing period showed an indirect positive effect through fruit number per plant, fruit weight, days to first flowering, fruit set percentage, dry matter content and plant height.

In path analysis, the characters that showed positive direct effect on plant yield were fruit number, fruit weight, days to fruit maturity, fruit set percentage, plant height and fruit bearing period. These characters should be considered while selecting the genotype for improving the yield in chilli. Also, the low residual effect obtained in the path analysis indicated that maximum traits contributing to fruit yield per plant were considered in the present study.

Table 2: Path coefficient analysis showing direct and indirect effects.

	Plant height (cm)	Fruit number	Fruit set percentage	Pedicel length (cm)	Fruit wall thickness (mm)	Fruit weight (g)	Days to fruit maturity	Fruit length (cm)	Fruit bearing period	Fruit width (cm)	Days to first flowering	Dry matter content (%)
Plant height (cm)	**0.043**	0.152	0.000	-0.007	-0.005	-0.008	0.030	0.001	0.003	-0.009	-0.038	-0.003
Fruit number	0.009	**0.722**	0.032	0.005	-0.003	-0.061	-0.079	0.001	0.016	0.008	0.095	-0.014
Fruit set percentage	0.000	0.285	**0.081**	-0.014	-0.002	0.046	-0.053	0.000	0.014	0.004	0.060	-0.006
Pedicel length (cm)	0.004	-0.046	0.014	**-0.085**	-0.003	0.172	-0.008	-0.005	0.011	0.005	0.018	0.013
Fruit wall thickness (mm)	0.006	0.072	0.006	-0.007	**-0.033**	0.229	-0.027	-0.001	0.010	-0.015	0.040	0.013
Fruit weight (g)	-0.001	-0.076	0.007	-0.025	-0.013	**0.575**	-0.056	-0.006	0.020	-0.025	0.080	0.022
Fruit maturity	0.006	-0.248	-0.019	0.003	0.004	-0.140	**0.231**	0.003	-0.026	-0.005	-0.288	-0.003
Fruit length (cm)	-0.003	-0.055	-0.000	-0.039	-0.005	0.327	-0.065	**-0.010**	0.018	0.008	0.102	0.017
Fruit bearing period	0.003	0.280	0.027	-0.023	-0.008	0.271	-0.141	-0.005	**0.042**	-0.005	0.182	0.005
Fruit width (cm)	0.008	-0.121	-0.007	0.009	-0.010	0.282	0.022	0.002	0.042	**-0.050**	-0.032	0.011
Days to first flowering	0.006	0.235	-0.017	0.005	0.004	-0.158	0.228	0.004	-0.026	-0.050	**-0.292**	-0.002
Dry matter content (%)	0.001	0.106	0.005	0.011	0.005	-0.132	0.008	0.002	-0.002	0.005	-0.006	**-0.097**

Residual effect 0.103

CONCLUSIONS

The findings of this study indicated a significant positive direct influence of the traits such as number of fruits per plant, fruit bearing period, fruit weight, days to fruit maturity, plant height and fruit set percentage on fruit yield per plant. Additionally, the traits such as fruit number per plant, fruit bearing period fruit weight and fruit set percentage also showed a significant positive correlation at the genotypic level. Therefore, importance should be given to these traits when developing a selection strategy for breeding high yielding varieties in chili.

FUTURE SCOPE

The correlation and path coefficient analysis for thirteen different quantitative characters in chilli showed that the characters namely fruit number per plant, fruit bearing period fruit weight and fruit set percentage should be given due importance while selecting a genotype from the diverse germplasm to bring about the yield improvement in chilli.

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Conflict of Interest. None.

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