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Path Analysis and Quality Character Studies in Some Mid Late and Late Cauliflower (*Brassica oleracea* var. *botrytis* L.) Genotypes

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

Aims: Path analysis study was done to show the cause and effect relationship between marketable curd yield and various yield components in cauliflower and to partition the total correlation coefficient into direct and indirect effect whereas quality character study was done to find out the suitable genotypes for cultivation on the basis of qualitative parameters along with quantitative traits.

Study Design: The experiment was laid out in Randomised Complete Block Design (RCBD) with three replications.

Place and Duration of Study: The present investigation was conducted with twenty mid-late and late cauliflower genotypes at the Experimental Farm of the Department of Vegetable Science, Dr. Y.S. Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during Rabi season of 2016.

Methodology: Path coefficient analysis was carried out using the formula of Dewey and Lu (1959). Qualitative characters were recorded as per the National Bureau of Plant Genetic Resources (NBPGR) plant descriptors.

Results: In this investigation, it was found that leaf number per plant had highest (0.995) positive direct effect on marketable curd yield per plant followed by curd size index (0.411), days to

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marketable curd maturity (0.376), plant height (0.371), leaf size index (0.363), curd depth (0.164) and curd solidity (0.140). On the other hand maximum, negative direct effect was shown by gross weight per plant (-0.133) followed by stalk length (-0.908). Maximum positive indirect effect was shown by the trait stalk length via leaf number per plant (0.981) and plant height via days to marketable curd maturity (0.415) on marketable yield per plant. Regarding quantitative traits, the genotypes were classified into three categories viz., snow white, white and dull for the trait 'curd colour' and the majority of these displayed either snow white or white colour curds. On the other hand, regarding 'plant growth habit', genotypes were classified into three categories i.e. erect, semi-erect and spreading type and the majority of these were categorised as either erect or semi-erect types.

Conclusion: Maximum positive direct effect towards marketable yield per plant was contributed by leaf number per plant followed by curd size index, days to marketable curd maturity, plant height, leaf size index, curd depth and curd solidity. So, for cauliflower varietal improvement programme, the above mentioned horticultural traits should be selected which will ultimately increase marketable curd yield. Regarding quality traits it can be concluded that erect and semi-erect type of plant growth habit is preferred in cauliflower as it is going to protect the curd from sunlight, thereby preventing the discolouration of the curd towards yellowing which may not be preferred in the market.

Keywords: Cauliflower; marketable curd yield; path analysis, quality characters.

1. INTRODUCTION

Cauliflower (*Brassica oleracea* var. *botrytis* L.) is a member of family Brassicaceae, which comprises about 300 genera and more than 3000 species [1]. It is the popular most crop among all 'cole' group vegetables in India [2]. Botanically, the edible part of cauliflower is known as pre-floral fleshy apical meristem or flowering primordial or immature inflorescence and is also called as 'curd [3]. Cauliflower curds contain 70 IU vitamin A, 50 mg/100 g vitamin B and 75 mg/100 g vitamin C and among minerals, 0.38 per cent P, 0.73 per cent Ca, 205 ppm Iron 2.71 per cent K, and 15 ppm Cu. Besides vitamins and minerals, cauliflower also contains 2.47 per cent protein, 4.8 per cent total carbohydrate, 0.2 per cent fat and 91.7 per cent water [4]. Curds are used as sauteed or fried vegetable either separately or with potato, peas, capsicum or other vegetables. It is also cooked in curry and sambhar [5]. In India, cauliflower is cultivated in an area of 452.13 thousand ha of land having a production of 8498.85 thousand tonnes. The productivity is 18.79 t/ ha [6]. India is the second largest producer of this crop in the world but regarding productivity, India is lagging far behind many countries viz., China, Spain and Italy. It is due to unavailability of high yielding improved cultivars and hybrids [7]. Therefore, it is essential to breed the superior cultivars having high curd yield and expand their area under cultivation as much as possible to narrow down the gap in productivity between India and other countries.

Crop improvement through selection in cauliflower depends not only on curd yield alone but also depends upon the inter-relationship of a number of contributing traits as because yield is a complex polygenic character and direct evaluation of this character is difficult. By the use of variance and covariance matrix, the contribution of each character towards yield can be estimated through correlation studies [8]. Although correlation studies are helpful in determining important yield contributing traits when a number of variables in the correlation studies are included then the association becomes more complex. In such cases, two characters may show correlations as because they may correlate with a common third one. Path coefficient analysis is being effectively used for determining the rate of various yield components in different crops, leading to the selection of superior genotypes. Therefore, the study aimed to understand the direct effects of different independent characters or indirect effect in combination with other characters on dependent character i.e. curd yield.

2. MATERIALS AND METHODS

2.1 Experimental Site and Environment

The present study was conducted at the Experimental Farm of the Department of Vegetable Science, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan in Himachal Pradesh, India during Rabi season of 2016. It is located at an altitude of about 1276 m above mean sea level, lying between 30°52'30"

N latitude and 77°11’30” E longitude under sub-humid, sub-temperate and mid hill zones of Himachal Pradesh. The mean temperature during the cropping season ranged from 10.8°C to 21.4°C, while the relative humidity varied from 41.0% to 56.00%. The total rainfall during the growing season was 161.30 mm. The soil pH of Experimental Farm varied from 6.85 to 7.04.

2.2 Experimental Material, Layout and Observation

The experiment was laid out with three replications in a Randomized Complete Block Design and experimental materials comprised of twenty genotypes of mid-late and late-type cauliflower, collected from different parts of the country and abroad (Table 1). The seed sowing of all the genotypes was carried out on September 2016 in raised bed nursery. On 10th October, the healthy seedlings were transplanted at a spacing of 60 cm×45 cm on individual plot size of 3 m×2.25 m. Standard cultural practices recommended in the Package of Practices for Vegetable crops were followed to ensure a healthy crop stand [9]. Observations were recorded on ten randomly selected plants for ten quantitative characters viz., days to marketable maturity from date of transplanting, stalk length (cm), leaf number per plant, curd depth (cm), plant height (cm), leaf size index (cm^2), curd size index (cm^2) and curd solidity (g/cm), gross weight per plant (g) and marketable yield per plant (g). Among the Qualitative traits, curd colour and plant growth habit were studied.

2.3 Statistical Analysis

Path analysis was carried out using the genotypic correlation coefficient. This procedure was developed by Wright [10] and as per consent used by Li [11] and followed by Dewey and Lu [12]. Path coefficients are the standardised partial regression coefficients and as such measure the direct influence of one variable upon another variable and permits partition of correlation coefficient into components of direct and indirect effects. The sum of the direct and all possible indirect effects via all other traits must be equal to a correlation coefficient of dependent traits with independent characters under consideration. The statistical analysis was carried out by using OP-STAT Software available from the website of CCSHAU, Hisar, Haryana.

2.3.1 Statistical formula

The path coefficient was obtained by the simultaneous selection of the following equations, which expressed the basic relationship between genotypic correction (r) and path coefficient (P)

$$r_{14}= P_{14}+ r_{12} P_{24}+ r_{13} P_{34}$$
$$r_{24}= r_{21} P_{14} + P_{24} + r_{23} P_{34}$$
$$r_{34}= r_{31} P_{14} + P_{32} + r_{24} P_{34}$$

Where r_{14}, r_{24} and r_{34} are genotypic correlation of components characters with yield (dependent variable) and r_{13}, r_{23} and r_{24} are genotypic

Table 1. List of cauliflower genotypes along with their sources

Sr. no.	Genotype	Source
1.	UHF-C-2	Dr YSPUHF, Nauni, Solan
2.	Palam Uphar	CSKHPKV, Palampur
3.	King King	HRI, Wellesbourne, UK
4.	Pusa Himjyoti	IARI, Katrain
5.	EC-683466	NBPGR, New Delhi
6.	EC-683461	NBPGR, New Delhi
7.	EC-162587	NBPGR, New Delhi
8.	Hermia	HRI, Wellesbourne, UK
9.	Kt-18	IARI, Katrain
10.	Kt-25	IARI, Katrain
11.	Kt-19	IARI, Katrain
12.	Kt-20	IARI, Katrain
13.	Kt-22	IARI, Katrain
14.	Mukutamani	IARI, Katrain
15.	Sel-I	Dr YSPUHF, Nauni, Solan
16.	Sel-II	Dr YSPUHF, Nauni, Solan
17.	DC-76	IARI, New Delhi
18.	Pant Shubhra	GBPUAT, Pantnagar, Uttarakhand
19.	Snowball-16	IARI, Katrain
20.	PSBK-I (Check)	IARI, Katrain

correlations among the component characters (independent variable) and r_{12} P_{24}, r_{13} P_{34}, r_{21} P_{14}, r_{23} P_{34}, r_{31} P_{14} and r_{24} P_{34} are indirect effects.

The direct effects are calculated by the following set of equestions:

$$P_{14}= C_{11}\, r_{14}+ C_{12}\, r_{24}+ C_{13}\, r_{34}$$
$$P_{24}= C_{21}\, r_{14} + C_{22}\, r_{24} + C_{23}\, r_{34}$$
$$P_{34}= C_{31}\, r_{14} + C_{32}\, r_{32} + C_{24}\, r_{34}$$

Where C_{11}, C_{12}, C_{23} and C_{33} are constants derived by using abbreviated Doultittle's technique as explained by Goulden [13] and P_{14}, P_{24} and P_{34} are the estimates of direct effects.

2.3.1.1 Residual effect

It measures the role of other possible independent variables which were not included in the study on the dependent variable. The residual effect is estimated with the help of direct effect and simple correlation coefficient as given below:

$$I = P^2x_4 + P^2{}_{14} + P^2{}_{24} + P^2{}_{34} + 2P_{14}r_{12}P_{24} + 2P_{14}r_{13}P_{34} + 2P_{24}r_{22}P_{34}$$

3. RESULTS AND DISCUSSION

3.1 Path Analysis

To measure the direct as well as the indirect association of one variable (cause) through another on the end product (effect), path coefficients were calculated at a genotypic level for all the yield attributing traits. The observed correlation coefficients of yield with its contributing traits were partitioned into direct and indirect effects. In the present investigation, important character viz., marketable curd yield per plant has been used as a dependent variable whereas other horticultural traits have been used as an independent variable. The estimates of path coefficient were presented in Table 2. In the present study it was found that quantitative traits like leaf number per plant, curd size index, days to marketable curd maturity, plant height, leaf size index, curd depth and curd solidity had high positive direct effect on marketable curd yield so that purposeful and balanced selection based on these traits would be rewarding for improvement of yield in cauliflower. Similar results were observed by Garg and Lal [7], Mehra [14] and Singh and Dogra [15] for curd size index, Kumar et al. [16] for leaf size index, Mehra [14] and Singh et al. [17] for leaf number per plant and plant height and Singh et al. [17] for curd depth. On the other hand maximum, negative direct effect on marketable yield per plant was showed by gross weight per plant followed by stalk length. Mehra [14] also found negative direct effect of gross weight per plant on curd yield which was in accordance with the above findings.

3.1.1 Direct effects

In present investigation, it was found that leaf number per plant had highest (0.995) positive direct effect on marketable curd yield per plant followed by curd size index (0.411), days to marketable curd maturity (0.376), plant height (0.371), leaf size index (0.363), curd depth (0.164) and curd solidity (0.140). On the other hand maximum, negative direct effect on marketable yield per plant was showed by gross weight per plant (-0.133) followed by stalk length (-0.908).

3.1.2 Indirect effects

3.1.2.1 Days to marketable curd maturity

Days to marketable curd maturity exhibited significant positive indirect effect via plant height (0.40876), curd size index (0.40555), leaf number per plant (0.19323), curd depth (0.16526) and curd solidity (0.10176) on marketable yield per plant. Whereas, adverse indirect effect was visible to be highest via gross weight per plant (-0.16889), stalk length (-0.24795) and leaf size index (-0.38553).

3.1.2.2 Stalk length

Stalk length was reported to have a maximum positive indirect effect via leaf number per plant (0.98170), curd size index (0.11776), days to marketable curd maturity (0.08563), plant height (0.08150), curd depth (0.04292) and curd solidity (0.03611). Highest negative indirect effect was observed through gross weight per plant (-0.05157) and leaf size index (-0.07674).

3.1.2.3 Leaf number per plant

Leaf number per plant exhibited maximum indirect effect through curd size index (0.10575), plant height (0.07427), days to marketable curd maturity (0.07317), curd depth (0.03954) and curd solidity (0.03843). Highest negative indirect effect was found to be via gross weight per plant (-0.04223), leaf size index (-0.08988) and stalk length (-0.89581).

Table 2. Path coefficient analysis at genotypic level in cauliflower

Characters	DMCM	SL	LNPP	LSI	CD	CSI	PH	CS	GWPP	GCMYPP
DMCM	**0.37683**	-0.24795	0.19323	-0.38553	0.16526	0.40555	0.40876	0.10176	-0.16889	0.849**
SL	0.08563	**-0.90810**	0.98170	-0.07674	0.04292	0.11776	0.08150	0.03611	-0.05157	0.309**
LNPP	0.07317	-0.89581	**0.99517**	-0.08988	0.03954	0.10575	0.07427	0.03843	-0.04223	0.298**
LSI	-0.35662	0.19176	-0.19136	**0.36342**	-0.16228	-0.36098	-0.36597	-0.01681	0.10687	-0.791**
CD	0.37853	-0.23690	0.23918	-0.35848	**0.16452**	0.38172	0.38133	0.07895	-0.13625	0.892**
CSI	0.37125	-0.25979	0.25565	-0.31869	0.15255	**0.41164**	0.36794	0.10384	-0.14524	0.939**
PH	0.41509	-0.19945	0.19917	-0.35841	0.16906	0.40816	**0.37108**	0.09749	-0.27619	0.826**
CS	0.27229	-0.23287	0.10455	-0.21700	0.09223	0.30354	0.25688	**0.14083**	0.10455	0.825**
GWPP	0.35964	-0.33070	0.36731	-0.29625	0.14571	0.39409	0.35066	0.11561	**-0.13338**	0.972**

Where, DMCM= Days to marketable curd maturity, SL= Stalk length, LNPP= Leaf number per plant, LSI= Leaf size index, CD= Curd depth, CSI= Curd size index, PH= Plant height, CS=Curd solidity, GWPP= Gross weight per plant, MYPP= Marketable yield per plant, GCMYPP = Genotypic correlation coefficient with marketable curd yield per plant. (Residual effect at genotypic level is 0.01541)

3.1.2.4 Leaf size index

Leaf size index expressed the highest positive indirect effect via stalk length (0.19176) followed by gross weight per pant (0.10687) on marketable yield per plant. Its negative indirect effect was via curd solidity (-0.05869), curd depth (-0.16228), leaf number per plant (-0.19136), days to marketable curd maturity (-0.35662), curd size index (-0.36098) and plant height (-0.36597).

3.1.2.5 Curd depth

Curd depth revealed high values of positive indirect effect on curd size index (0.38172), plant height (0.38133), days to marketable curd maturity (0.37853), leaf number per plant (0.23918) and curd solidity (0.07895). While it showed the high negative indirect effect on the traits gross weight per plant (-0.13625), stalk length (-0.23690) and leaf size index (-0.35848).

3.1.2.6 Curd size index

Curd size index exhibited maximum positive indirect effect via days to marketable curd maturity (0.37125), plant height (0.36794), leaf number per plant (0.25565), curd depth (0.15255) and curd solidity (0.10384) on marketable yield per plant. Highest negative indirect effect was found to be through gross weight per plant (-0.13625), stalk length (-0.25979) and leaf size index (-0.31869).

3.1.2.7 Plant height

Plant height expressed highest positive indirect effect via days to marketable curd maturity (0.41509), curd size index (0.40816), leaf number per plant (0.19917), curd depth (0.16906) and curd solidity (0.09749). This trait showed maximum negative indirect effect via stalk length (-0.19945), gross weight per plant (-0.27619) and leaf size index (-0.35841).

3.1.2.8 Curd solidity

Curd solidity exhibited maximum positive indirect effect via curd size index (0.30354), days to marketable curd maturity (0.27229), plant height (0.25688), leaf number per plant (0.10455), gross weight per plant (0.10455) and curd depth (0.09223). On the other hand maximum, negative indirect effect was shown by the traits namely leaf size index (-0.21700) and stalk length (-0.23287).

3.1.2.9 Gross weight per plant

Gross weight per plant was reported to have a maximum positive indirect effect via curd size index (0.39409), leaf number per plant (0.36731), days to marketable curd maturity (0.35964), plant height (0.35066), curd depth (0.14571). It showed maximum negative indirect effect via leaf size index (-0.29625) and stalk length (-0.33070) on marketable yield per plant.

3.2 Quality Characters

3.2.1 Curd colour

It was observed visually at the time of harvesting (Table 3). The majority of the cultivars shown either snow white or white colour and that result was also found by Kalpna [18].

The genotypes namely Hermia, Kt-25, Kt-20, Snowball-16, DC-76, EC-683461, Pusa Himjyoti, PSBK-I were found to have snow white curds. Whereas the genotypes namely UHF-C-2, Palam Uphar, King King, EC-683466, EC-162587, Kt-22, Sel-I, Sel-II, Pant Shubhra produced white coloured curd. Only three germplasm viz., Kt-19, Mukutamani and Kt-18 produced dull coloured curds.

Table 3. Classification of germplasm according to curd colour

Sr. no.	Curd colour	Number of genotypes	Name of the genotypes
1	Snow white	8	Hermia, Kt-25, Kt-20, Snowball-16, DC-76, EC- 683461, Pusa Himjyoti, PSBK-I
2	White	9	UHF-C-2, Palam Uphar, King King, EC-683466, EC- 162587, Kt-22, Sel-I, Sel-II, Pant Shubhra
3	Dull	3	Kt-19, Mukutamani, Kt-18

Table 4. Classification of germplasm according to plant growth habit

Sr. no.	Plant growth habit	Number of genotypes	Name of the genotypes
1	Erect	7	Hermia, Kt-25, Kt-20, Snowball-16, DC-76, Pusa Himjyoti, PSBK-I
2	Semi-erect	10	UHF-C-2, Palam Uphar, King King, EC-683466, EC-162587, Kt-22, Sel-I, Sel-II, Pant Shubhra, EC-683461
3	Spreading	3	Kt-19, Mukutamani, Kt-18

3.2.2 Plant growth habit

This parameter was recorded at marketable stage (Table 4). Significant variability regarding this character was found among the genotypes under study which was in line with the findings of Santhosha et al. [19].

It was found that majority of the genotypes under study had either erect or semi-erect plant growth habit. The genotypes namely Hermia, Kt-25, Kt-20, Snowball-16, DC-76, Pusa Himjyoti, PSBK-I were found to have erect plant growth habit whereas the genotypes namely UHF-C-2, Palam Uphar, King King, EC-683466, EC-162587, Kt-22, Sel-I, Sel-II, Pant Shubhra, EC-683461 had semi-erect plant growth habit. Only three genotypes namely Mukutamani, Kt-19 and Kt-18 produced spreading the plant. In general, erect and semi-erect type of plant growth habit is preferred in cauliflower as it protects the curd from sunlight, thereby preventing the discolouration of the curd towards yellowing which may not be preferred in the market. The pigments are responsible for colour, and the decrease in the marketability of cauliflower curds appears because of formation of flavonoids due to exposure of curds to sunlight [20].

4. CONCLUSION

From above study it can be concluded that path coefficient analysis of different characters contributing towards marketable curd yield per plant showed that leaf number per plant had highest positive direct effect followed by curd size index, days to marketable curd maturity, plant height, leaf size index, curd depth and curd solidity. So, these ancillary characters may be adjudged to be the best characters while planning for ‘selection' method of a breeding programme for developing high yielding varieties of cauliflower. On the other hand erect and semi-erect type of plant growth habit is preferred which ultimately an influences in determining the curd colour of cauliflower.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Rubatzky VE, Yamaguchi M. World vegetables: Principles, production and nutritive values. 2nd Ed. Gaithersberg, Maryland: Springer-Verlag New York Inc.; 1997.
2. Chatterjee S, Sharma S, Mukherjee D, Patil S. Estimation of genetic divergence in some mid late and late cauliflower (*Brassica oleracea* var. *botrytis* L.) germplasm. The Bioscan. 2018;13(2):459-62.

3. Sidki S. Variability studies in cauliflower for economic character. Am. J. Bot. 1962;49(3):290-97.
4. Manware D, Naidu AK. Path analysis and quality characters in cauliflower. Int. J. Chem. Stud. 2017;5(4):1361-65.
5. Chatterjee S, Aralikatti O, Sharma S, Mukherjee S, Patil S, Kanwar HS, et al. Studies of genetic variability, heritability and genetic gain for some important horticultural traits in cauliflower (*Brassica oleracea* var. *botrytis* L.). Int. J. Curr. Microbiol. App. Sci. 2018;7(4):82-92.
6. Anonymous. Horticultural statistics at a glance 2017. Government of India, Ministry of Agriculture and Farmers Welfare. 2017;202-03.
(Accessed 15 November 2018)
Available:http://nhb.gov.in/statistics/Publication/Horticulture%20At%20a%20Glance%202017%20for%20net%20uplod%20(2).pdf
7. Garg N, Lal T. Studies on standardized potence and gene action in cauliflower. Crop Improv. 2006;33(2):98-101.
8. Pal S, Sharma HR, Das A, Pandav AK. Character association and path analysis for fruit yield and it's contributing traits in cucumber (*Cucumis sativus* L.). Int. J. Agric. Environ. Biotechnol. 2017;10(2):163-70.
9. Anonymous. Package of practices for vegetable crops. Directorate of Extension Education, Dr. YS Parmar University of Horticulture and Forestry, Nauni, Solan. 2013;124. Hindi.
10. Wright S. Correlation and causation. Journal of Agricultural Research. 1921;20: 557-87.
11. Li CC. The concept of path coefficient and its impact on population genetics. Biometrics. 1956;12:190-210.
12. Dewey DR, Lu KH. A correlation and path coefficient analysis of components of crested wheat grass seed production. Agron. J. 1959;51:515-18.
13. Goulden CH. Method of statistical analysis. 1st Edition. New York: John Willey and Sons Inc; 1939.
14. Mehra D. Heterosis, combining ability and gene action studies in early cauliflower (*Brassica oleracea* var. botrytis L.). Ph.D. Thesis. Department of Vegetable Science, G B Pant University of Agriculture and Technology, Pantnagar. 2012;77-80.
15. Singh SP, Dogra RK. Studies on character association in some genotypes of cauliflower under mid hill conditions of western Himalaya. Asian J Hort. 2013;8(1): 29-31.
16. Kumar D, Kohli UK, Kanwar HS, Mehta S. Correlation and path analysis in snowball type cauliflower (*Brassica oleracca* var. *botrytis* L.). Indian J. Hort. 2005;62(4):409-10.
17. Singh KP, Kant K, Roy RK, Jha RN. Correlation and path coefficient analysis in cauliflower (*Brassica oleracca* var. *botrytis* L.). Int. J. Agric. Sci. 2014;10(1):387-89.
18. Sharma K. Genetic variability studies of some genotypes of cauliflower (*Brassica oleracea* var. botrytis L.). M.Sc Thesis. Department of Vegetable Science, Dr Y S Parmar University of Horticulture and Forestry, Solan. 2006;62.
19. Santosha HM, Varalakshmi B, Shivashankara KS. Characterization of early cauliflower germplasm under tropical conditions. The Bioscan. 2014;9(2):869-74.
20. Thomas DS, Turner DW. Covering cauliflower curds during growth reduces floret flavonoids and improves quality. N. Z. J. Crop Hortic. Sci. 1992;20:147-51.