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Original Research Article

Estimation of Character Association in Early Cauliflower (*Brassica oleracea Var. botrytis* L.)

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A B S T R A C T

The present study was undertaken at Vegetable Research Farm, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar during rabi season in 2019-2020. 15 genotypes of cauliflower in Randomized Block Design (RBD) in 3 replications planted. The primary focus of study was assessment of correlation coefficient and path coefficient analysis. It was recorded that the genotypic correlation coefficient was significantly higher than the corresponding phenotypic correlation coefficient for almost all of the parameters. Estimates of phenotypic correlation revealed Total yield quintal per hectare to be highly positive and significantly correlated with net curd weight, gross curd weight, curd length, curd width and harvest index. Path coefficient analysis revealed that positive direct effect was reported by traits such as net curd weight and gross curd weight on total yield (q/ha. The negative direct effect was exhibited by curd length, curd width and harvest index. High positive indirect effect recorded by net curd weight, gross curd weight whereas high negative indirect effect was shown by curd length, leaf length and plant spread. Henceit inferred traits govern by direct effect towards total yield (q/ha) may enhance the total yield of cauliflower.

Keywords

Genotypic correlation, Phenotypic correlation, Path coefficient analysis and Cauliflower

Introduction

Cauliflower *(Brassica oleracea var. botrytis L.*, 2n = 2x = 18) is a highly relevant vegetable crop cultivated all over India (Singh *et al.*, 2005). The edible part of the vegetable is highly suppressed pre-floral apicalmeristem commonly known as 'curd' (Sidki, 1962). For a better quality cauliflower crop, better yield, compactness, white colour and medium-sized curds free from any diseases or disorders, are highly desirable (Varalaxmi, 2009). Cauliflower is considered to have been originated in the Mediterranean region, as the highest range of variability has been reported in cauliflower (Horne, 1954). It has also been reported to originate from *Brassica oleracea* var. *sylvestris*, which is a wild ancestor, existing in Mediterranean areas. The *Brassica oleracea* cytodeme is considered to be polymorphic aggregate species with chromosome number, 2n=18.

Cauliflower is a monogenomic species having genomic constitution C and chromosome number, n=9. It belongs to the Order Cruciferae, Tribe Brassicae, Sub-Tribe Brassica under the family Brassicaceae (Hazra *et al.,* 2011). Indian cauliflowers are characteristically different from European types and are tolerant to high temperature and humid condition and do not require verbalization for bolting (Swarup & Chatterjee 1972) hypothesized that Indian cauliflowers have most of the gene contributed by the 'Cornish" types & few gene by Roscoff. Italian & Northern types contain favourable gene for tolerance to high temperature and rainfall, unknown in temperate type, have been successfully utilized in developing the improved varieties. Early Patna, Early Banaras & Early Market in India and Extra Early in Taiwan. Cornish type perhaps the first to introduced in India, has itself gene of cultivation after contributing many genes to Indian varieties like resistance to black rot, self incompatibility curd flower, open plant habit exposed yellow loose curd etc. (Swarup and Chatterjee, 1972). Cauliflower is highly rich in vitamins to the tune of 70 IU vitamin A, 56 mg/100 g vitamin Band 75mg/100g vitamin C. In addition, cauliflower is fairly a high source of glucosinolates (40-80 mg/100g) predominantly glucobrassicin and sinigrin which have predominantly anti-carcinogenic property.

Correlation coefficient is a measure of the degree of association between two traits worked out at the same time. Yield is very complex trait as it is not only polygenically controlled but also subjected to the fluctuating environment. The extent of observed relationship between two characters is indicated by phenotypic correlation which includes both hereditary and environmental influences, while the real association between two characters is indicated by genotypic correlation coefficient which may be useful for selection (Jonson *et al.,* 1955). Investigation regarding the presence of component and nature of association among themselves is essential and prerequisite for improvement in yield. Correlation analysis depicts the association among the traits although it doesn't give direct effect on the magnitude and nature towards yield. Hence forth, path coefficient analysis was estimated to partition the direct and indirect effect of different traits on yield for efficient weightage & effective improvement of desirable traits. The path analysis discloses whether the association of the studied traits with yield was due to their direct effect on yield or indirect effect via another component trait. Every trait has dual path actions such as direct effect on yield and an indirect effect on yield through mechanisms that were not exposed by the correlation studies. Under such circumstances, path coefficient analysis designed by Dewey and Lu (1959), helps in subdividing the correlation coefficient into direct and indirect component which permit a critical investigation of the relative importance of every traits.

Materials and Methods

Present investigation was carried out at Vegetable Research Farm, Dr. Rajendra Prasad Central Agricultural University, Pusa, Samastipur, Bihar during rabi season in 2019-2020. Research was conducted using 15 genotypes of cauliflower in Randomized Block Design (RBD) in 3 replications. The materials were collected from different districts of Bihar. The genotypes were evaluated for fourteen quantitative characters *viz.,* Plant height (cm), Plant spread (cm), No. of leaves, leaf length(cm) leaf blade width (cm), days to 1st curd initiation, days to 50% curd initiation, net curd weight(g), gross curd weight, curd length, curd width, harvest duration, harvest index (%), total yield (q/ha).

Correlation and path coefficient analysis were computed as per the formulation of Al-jibouri *et al.,* (1958) and Dewey and Lu (1959), respectively.

Results and Discussion

Correlation of yield with different traits is of vital importance as yield is an outcome of many correlated characters. Thus it became necessary to study the association for effective selection. The results of phenotypic correlation coefficient have been discussed only as genotypic and environmental correlation constitutes phenotypic correlation coefficient. Hence, phenotypic correlation will give the correct idea about association of 2 variables. The estimates of both phenotypic and genotypic correlation coefficient for various characters are given in Table 1 and Table 2.

The magnitude of genotypic correlation was higher than phenotypic correlation for all the traits indicating inherent associations between various characters. The findings were in agreement to Rai *et al.,* (2003), Rai and Asati (2004), Meena *et al.,* (2012), Diksha Manaware *et al.,* (2017). In this experiment, plant height not showed neither positive nor negative correlation with any traits. Plant spread exhibited positive correlation with days to 50% curd initiation (0.697) and gross curd weight (0.535). Number of leaves had shown positive correlation with leaf length (0.545), days to first curd initiation (0.651) and days to 50% curd initiation (0.655). These findings are in accordance with findings of Rai *et al.,* 2003. Leaf length had positive correlation with leaf blade width (0.808), gross curd weight (0.729) and harvest duration (0.649). Leaf blade width showed positive correlation with days to first curd initiation (0.533) and Gross curd weight (0.699). Days to first curd initiation positively correlated with days to 50% curd initiation (0.883). These findings are in accordance with findings of Diksha Manaware *et al.,* 2017.None of the characters showed either positive or negative significant correlation with days to 50% curd initiation.

Net curd weight was positively and significantly correlated with gross curd weight (0.624), curd length (0.807), curd width (0.928), harvest index (%) (0.611) and total yield (0.994). These findings are in accordance with findings of Kumar *et al.,* 2005; Singh *et al.,* 2006; Singh *et al.,* 2013.Gross curd weight had shown positive significant correlation with curd length (0.744), curd width (0.714) and total yield (0.620). These findings are in accordance with findings of Rai and Asati (2004) and Meena *et al.,* (2010). Curd length had shown positive significant correlation with curd width (0.850) and total yield (0.806). These findings collaborated the earlier findings of Antonova, 2009. Curd width had shown positive significant correlation with total yield (0.935). None of the characters showed either positive or negative significant correlation with harvest duration. Harvest index (%) had shown positive significant correlation with total yield (0.593).

When a large number of characters are contributing to final product and they are inter-related within themselves in a complex way, such that it becomes difficult to sort out and evaluate such direct associations. Most of the times the influence on the characters is not apparent at first site. Hence, this correlation should be partitioned into direct and indirect effects in order to know the fraction of total correlation, that is due to the effect of character alone known as “direct effect” and the fraction that are due to the correlation of character with remaining characters known as “indirect effect”. Path correlation coefficient is illustrated in Table 3 and 4.

Table.1 Genotypic correlation coefficient between different characters combination in cauliflower

Traits	Plant height (cm)	Plant spread(cm)	No.of leaves	Leaf length(cm)	Leaf blade Width (cm)	Days to 1stcurd initiation	Days to 50%curd initiation	Net curd weight (g)	Gross curd weight (g)	Curd length	Curd width	Harvest Duration (Days)	Harvest index(%)	Total yield (q/ha)
Plant height(cm)	1	0.540*	0.218	0.259	-0.13	-0.176	0.512*	-0.011	0.158	0.026	0.053	0.539*	-0.324	0.058
Plant spread(cm)		1	0.534*	0.597*	0.405	0.643**	0.838**	0.512*	0.664**	0.182	0.35	0.332	-0.069	0.473
No. of leaves			1	0.718**	0.662**	0.929**	0.748**	0.209	0.459	0.425	0.196	0.594*	-0.149	0.156
Leaf length(cm)				1	0.924**	0.496	0.612*	0.267	0.754**	0.543	0.474	0.852**	-0.427	0.329
Leaf blade width (cm)					1	0.726**	0.506	0.28	0.754**	0.326	0.434	0.639*	-0.408	0.281
Days to 1st curd initiation						1	1.289	0.109	0.458	0.129	0.021	0.834**	-0.256	0.131
Days to 50%curd initiation							1	0.146	0.514*	0.101	0.082	0.731**	-0.335	0.13
Net curd weight(g)								1	0.618*	0.894**	0.971**	0.032	0.625*	1.038**
Gross curd weight (g)									1	0.841**	0.749**	0.341	-0.195	0.649**
Curd length (cm)										1	1.004	-0.051	0.357	0.914**
Curd width (cm)											1	0.205	0.462	1.004**
Harvest Duration (Days)												1	-0.335	0.057
Harvest index(%)													1	0.630*

Table.2 Phenotypic correlation coefficient between different characters combination in cauliflower

Traits	Plant height (cm)	Plant spread (cm)	No. of leaves	Leaf length(cm)	Leaf blade width (cm)	Days to 1stcurd initiation	Days to 50%curd initiation	Net curd weight(g)	Gross curd weight(g)	Curd length (cm)	Curd width (cm)	Harvest Duration (Days)	Harvest index (%)	Total yield (q/ha)
Plant height(cm)	1	0.426	0.132	0.269	-0.08	-0.011	0.363	0.012	0.169	0.057	0.087	0.385	-0.268	**0.067**
Plant spread(cm)		1	0.457	0.342	0.326	0.451	0.697**	0.418	0.535*	0.234	0.306	0.234	-0.047	**0.404**
No. of leaves			1	0.545*	0.489	0.651**	0.655**	0.171	0.396	0.258	0.188	0.456	-0.149	**0.174**
Leaf length(cm)				1	0.808**	0.466	0.495	0.286	0.729**	0.395	0.461	0.649**	-0.38	**0.279**
Leaf blade width (cm)					1	0.533*	0.438	0.266	0.699**	0.335	0.396	0.495	-0.346	**0.242**
Days to 1st curd initiation						1	0.883**	0.12	0.41	0.071	0.09	0.494	-0.194	**0.085**
Days to 50%curd initiation							1	0.126	0.434	0.054	0.13	0.527*	-0.269	**0.11**
Net curd weight(g)								1	0.624**	0.807**	0.928**	0.019	0.611*	**0.994****
Gross curd weight(g)									1	0.744**	0.714**	0.295	-0.188	**0.620***
Curd length (cm)										1	0.850**	-0.045	0.335	**0.806****
Curd width (cm)											1	0.126	0.443	**0.935****
Harvest Duration (Days)												1	-0.305	**0.048**
Harvest index (%)													1	**0.593***

** Significant at p = 0.01, * significant at p = 0.05

Table.3 Genotypic direct (Diagonal) and indirect effect of 14 characters in cauliflower

Traits	Plant height(cm)	Plant spread(cm)	No. of leaves	Leaf length(cm)	Leaf blade	Days to 1stcurd initiation	Days to 50%curd initiation	Net curd weight(g)	Gross curd weight	Curd length	Curd width	Harvest Duration	Harvest index (%)	Total yield
Plant height(cm)	**20.588**	0.031	4.523	-12.189	-3.657	1.219	-10.734	0.737	12.696	-0.629	0.335	6.537	-19.391	**0.058**
Plant spread(cm)	11.126	**0.057**	11.069	-28.072	11.366	-4.452	-17.563	-34.003	53.304	-4.446	2.226	4.024	-4.157	**0.473**
No. of leaves	4.494	0.030	**20.717**	-33.721	18.607	-6.435	-15.681	-13.856	36.858	-10.362	1.247	7.205	-8.950	**0.156**
Leaf length(cm)	5.341	0.034	14.866	**-46.991**	25.962	-3.434	-12.817	-17.738	60.571	-13.228	3.017	10.340	-25.585	**0.329**
Leaf blade	-2.681	0.023	13.723	-43.429	**28.091**	-5.026	-10.602	-18.548	60.579	-7.937	2.762	7.750	-24.434	**0.281**
Days to 1st curd initiation	-3.623	0.037	19.254	-23.308	20.388	**-6.924**	-27.027	-7.253	36.810	-3.149	0.133	10.122	-15.329	**0.131**
Days to 50%curd initiation	10.543	0.048	15.498	-28.735	14.208	-8.928	**-20.961**	-9.708	41.307	-2.455	0.521	8.870	-20.085	**0.13**
Net curd weight(g)	-0.229	0.029	4.326	-12.561	7.851	-0.757	-3.067	**-66.360**	49.626	-21.801	6.178	0.384	37.433	**1.038**
Gross curd weight	3.255	0.038	9.509	-35.445	21.192	-3.174	-10.782	-41.010	**80.301**	-20.487	4.768	4.135	-11.651	**0.649****
Curd length	0.531	0.010	8.807	-25.502	9.146	-0.895	-2.111	-59.352	67.493	**-24.375**	6.389	-0.613	21.385	**0.914****
Curd width	1.085	0.020	4.058	-22.269	12.189	-0.145	-1.717	-64.409	60.154	-24.465	**6.365**	2.492	27.669	**1.004**
Harvest Duration	11.089	0.019	12.298	-40.032	17.936	-5.774	-15.318	-2.097	27.359	1.231	1.307	**-20.079**	12.138	**0.057**
Harvest index (%)	-6.664	-0.004	-3.095	20.070	-11.458	1.772	7.028	-41.468	-15.619	-8.702	2.940	-4.069	**59.903**	**0.630***

Table.4 Phenotypic direct (Diagonal) and indirect effect of 14 characters in cauliflower

Traits	Plant height(cm)	Plant spread(cm)	No. of leaves	Leaf length(cm)	Leaf blade	Days to 1stcurd initiation	Days to 50%curd initiation	Net curd weight(g)	Gross curd weight	Curd length	Curd width	Harvest Duration	Harvest index (%)	Total yield
Plant height(cm)	**0.066**	-0.061	0.013	-0.038	-0.001	0.001	0.030	0.013	0.024	-0.006	-0.002	0.018	0.008	**0.067**
Plant spread(cm)	0.028	**-0.143**	0.043	-0.048	0.003	-0.062	0.058	0.465	0.077	-0.025	-0.006	0.011	0.001	**0.404**
No. of leaves	0.009	-0.065	**0.095**	-0.076	0.005	-0.089	0.054	0.190	0.057	-0.028	-0.003	0.021	0.004	**0.174**
Leaf length(cm)	0.018	-0.049	0.052	**-0.139**	0.008	-0.064	0.041	0.318	0.105	-0.043	-0.008	0.031	0.011	**0.279**
Leaf blade	-0.005	-0.046	0.046	-0.113	**0.010**	-0.073	0.036	0.296	0.101	-0.037	-0.007	0.023	0.010	**0.242**
Days to 1st curd initiation	-0.001	-0.064	0.062	-0.065	0.005	**-0.137**	0.073	0.133	0.059	-0.008	-0.002	0.023	0.006	**0.085**
Days to 50%curd initiation	0.024	-0.099	0.062	-0.069	0.004	-0.121	**0.083**	0.140	0.063	-0.006	-0.002	0.025	0.008	**0.11**
Net curd weight(g)	0.001	-0.060	0.016	-0.040	0.003	-0.016	0.010	**1.112**	0.090	-0.088	-0.017	0.001	-0.018	**0.994****
Gross curd weight	0.011	-0.076	0.037	-0.102	0.007	-0.056	0.036	0.693	**0.144**	-0.081	-0.013	0.014	0.005	**0.620***
Curd length	0.004	-0.033	0.024	-0.055	0.003	-0.010	0.004	0.897	0.107	**-0.109**	-0.016	-0.002	-0.010	**0.806****
Curd width	0.006	-0.044	0.018	-0.064	0.004	-0.012	0.011	1.032	0.103	-0.093	**-0.018**	0.006	-0.013	**0.935****
Harvest Duration	0.025	-0.033	0.043	-0.090	0.005	-0.068	0.044	0.022	0.043	0.005	-0.002	**0.047**	0.009	**0.048**
Harvest index (%)	-0.018	0.007	-0.014	0.053	-0.003	0.027	-0.022	0.679	-0.027	-0.037	-0.008	-0.014	**-0.029**	**0.593***

RESIDUAL EFFECT=0.033

Net curd weight exhibited positive direct effect (0.112) on total yield (q/ha) and positive indirect effect on gross curd weight (0.090) *via* number of leaves (0.016) followed by days to 50% curd initiation (0.010) whereas it shown negative indirect effect on curd length (-0.088) followed by leaf length (-0.040) and harvest index (-0.018). However it contributes significantly to the total yield (q/ha) positively. This finding is at conformity with Kumar *et al.,* 2011; Sheemar *et al.,* 2012; Singh *et al.,* 2013and Vanlalneihi *et al.,* 2017.

Gross curd weight had positive direct effect (0.144) on total yield (q/ha) and positive indirect effect on net curd weight (0.693) via number of leaves (0.037) followed by days to 50% curd initiation (0.036) while it shows negative indirect effect on curd length (-0.081) followed by plant spread (-0.076) and days to first curd initiation (-0.056).

Curd length exhibited negative direct effect (-0.109) on total yield (q/ha) and positive indirect effect on net curd weight followed by gross curd weight (0.107) and number of leaves (0.024) whereas it shown negative indirect effect on leaf length (-0.055) followed by plant spread (-0.033) and curd width (-0.016).

Curd width recorded negative direct effect (-0.018) with total yield (q/ha) and positive indirect effect on net curd weight (1.032) via gross curd weight (0.103) whereas curd width revealed negative indirect effect with curd length (-0.093) followed by leaf length (-0.064) and plant spread (-0.044).

Harvest index (%) had negative direct effect (-0.029) on total yield (q/ha) and positive indirect effect with net curd weight (0.679) via leaf length (0.053) followed by days to 1st curd initiation (0.027) while it revealed negative indirect effect on curd length (-0.037) followed by gross curd weight (-0.027) days to 1st curd initiation (-0.022), plant height (-0.018), number of leaves (-0.014) and harvest duration (-0.014).

The phenotypic residual effect was recorded to be 0.0333 which indicates that the 14 characters studied accounted for 96.67 per cent variability in total yield (q/ha) and only 3.33 per cent variability in total yield (q/ha) was due to unknown factors.

The present investigation revealed that positive direct effect was reported by traits such as net curd weight and gross curd weight on total yield (q/ha).The results are in accordance with finding of Kumar *et al.,* 2005, Singh *et al.,* 2006, Singh *et al.,* 2013 and Diksha Manaware *et al.,* 2017. The negative direct effect was exhibited by curd length, curd width and harvest index. Similar findings in agreement with Kumar *et al.,* 2017

High positive indirect effect recorded by net curd weight, gross curd weight whereas high negative indirect effect was shown by curd length, leaf length and plant spread. The findings are in verdict with Sahu, 2017.

Therefore, from above investigation, it could be inferred that those traits which have direct effect towards total yield (q/ha) if selected then there is effective enhancement in yield of cauliflower.

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