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CHARACTER ASSOCIATION AND PATH ANALYSIS OF YIELD AND OTHER HORTICULTURAL TRAITS IN CABBAGE (*BRASSICA OLERACEA* VAR. *CAPITATA* L.)

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ABSTRACT

Character association and path analysis of yield and horticultural traits was carried out during 2013-14 after field evaluation of 41 genotypes of cabbage (*Brassica oleracea* var. *capitata* L.). The association of characters and the magnitude of their relationship with other characters at genotypic level revealed that marketable head yield had positive and significant correlation with net head weight (0.946), equatorial diameter (0.901), heading percentage (0.742), marketable heads per plot (0.740), gross head weight (0.692) and some other traits. Days to harvest (-0.299) showed negative correlation with marketable head yield. Marketable head yield was taken as dependent variable while computing the path co-efficient. Positive direct effect on marketable head yield was the highest for net head weight (0.880), followed by equatorial diameter (0.787), number of marketable heads per plot (0.771) *etc.* Low residual effect (0.116) revealed that all the traits under study accounted for 88.39 % of variability towards marketable head yield. Net head weight was proved to be the most effective selection index while carrying out genetic improvement in cabbage.

INTRODUCTION

Cabbage, *Brassica oleracea* var. *capitata* L. (2n = 2x = 18) is a member of family *Brassicaceae* and is one of the most important Cole-group vegetable crops. It has originated from *Brassica oleracea* var. *oleracea* L. (syn. *sylvestris* L.) commonly known as wild cabbage through mutation, human selection and adaptation. It is a rich source of protein comprising all essential amino acids, especially sulphur containing amino acids, minerals such as calcium, iron, magnesium, sodium, potassium, phosphorus and antioxidants, which is reported to have anti-carcinogenic properties (Singh *et al.*, 2009, Ghebramlak *et al.*, 2004; Kopsell *et al.*, 2004). It is widely grown all over India and abroad for its high nutritive value, high productivity and wider adaptability. However, the national productivity of cabbage is far below the global average productivity (Singh *et al.*, 2015). Low productivity of cabbage may be attributed to poor management practices and less number of high yielding hybrids. The increasing popularity due to adaptability, cheaper and round the year availability and as an integral part of the fast food industry has made it necessary to initiate breeding efforts targeted towards genetic improvement of cabbage. Till now, only limited research work has been carried out to improve cabbage in our country since breeding work has remained confined to few research centers in the hills (Thakur and Vidyasagar, 2016). Head yield and the subtotal of the contributions made by its individual components is a complex polygenic character which is influenced by environmental factors. It is very crucial to assess the nature and extent of association between different yield components and relative importance of direct and indirect influence of each of the component traits on yield so as to improve the plant as a whole rather than the individual traits (Sharma, 2010). Thus, the present study was conceived with objective to examine the magnitude and the direction of correlation and path studies for yield and identify or develop superior genotypes with better performance of all the component traits for obtaining higher yield.

MATERIALS AND METHODS

The experimental materials comprised of forty one genotypes *i.e.* 4 CMS lines, 3 SI lines, 4 testers and 30 hybrids. The experimental farm is situated at 32^0 6' N latitude and 76^0 3' E longitude at an elevation of 1290.8 meters above mean sea level. Severe winters and mild summers with high rainfall characterize the place. Agro-climatically, the location represents the mid-hill zone of Himachal Pradesh and is characterized by humid sub-temperate climate with high rainfall (2500 mm). Transplanting of genotypes was carried out on 26^{th} October, 2013 in randomized block design with three replications. The plot size and spacing were 3.15m x 0.90m and 45cm × 45cm, respectively (14 plants/treatment). All the standard package of practices and plant protection measures were timely adopted to raise the crop successfully. Observations were recorded in each treatment on the plant characters namely plant spread (cm), gross head weight (g), number of non-wrapper leaves, net head weight (g), polar and equatorial diameters of head (cm), days to harvest, marketable heads per plot and marketable head yield/plot (kg). The observations were recorded on 5 plants taken at random in each treatment/plot. Head shape index, compactness of head and heading percentage (%) were calculated from original measured data. The compactness of head was worked out as per method suggested by Pearson (1931).The mean values obtained from one year data were used for estimating the analysis of variance (Panse and Sukhatme, 1984). Genotypic and phenotypic correlation coefficients were calculated as suggested by Al-Jibouri *et al.* (1958) and path analysis by Dewey and Lu (1959).

RESULTS AND DISCUSSION

The analysis of variance for the characters plant spread (cm), non-wrapper leaves, gross head weight (g), net head weight (g), polar and equatorial diameter (cm), days to harvest, head shape index, compactness of head (g/cm^3), marketable heads per plot, heading percentage (%) and marketable head yield per plot (kg) have been presented in Table 1. The analysis of variance indicated significant differences among treatments for all the characters. Significance of mean squares due to genotypes for all the traits indicated existence of high degree of variability in the genetic material.

A perusal of values from (Table 2) revealed that genotypic correlation was higher in magnitude than the corresponding phenotypic correlation. This might be due to the masking effect of environment in the total expression of the genotypes resulting in the reduced phenotypic association. The association of characters and the magnitude of their relationship with other characters at genotypic level unveiled that marketable head yield had positive and significant correlation with net head weight (0.946), equatorial diameter (0.901), heading percentage (0.742), gross head weight (0.692), marketable heads per plot (0.636), polar diameter (0.535) and plant spread (0.185). It may be assumed that the selection based on these characters either in combination or alone will result in identifying the hybrids having high yield potential. Similar views have been reported by Meena *et al.* (2010), Singh *et al.* (2013) and Soni *et al.* (2013).

Non-significant positive correlation of head compactness with yield is in line with Kumar *et al.* (2007). The negative correlation of head shape index with yield (-0.410) and net head weight (-0.361) revealed that that flat or drum head type genotypes would produce cabbage heads with higher net head weight and higher yield but it is not desirable from consumer and marketing point of view, as there is a preference for small (700-800 gm) and round heads among consumers. These results are in line with Singh *et al.,* (2010). The negative correlation of days to harvest (-0.299) with marketable head yield suggested increase in yield by selecting the genotypes with lesser number of days to harvest. Same results had been reported by Kumar *et al*., (2007) and Meena *et al*., (2009 & 2010). The negative correlation of non-wrapper leaves (-0.661) with marketable head yield suggested the selection of genotypes with lesser number of non-wrapper leaves, which is repugnant to the results of Meena *et al.* (2009) and Soni *et al.* (2013).

Correlation coefficients indicate only the general alliances between any two traits without possible causes of such alliances. Path coefficient analysis presents a better idea of cause and effect relationship among different characters and plays an important role in determining the degree of relationship between the yield and yield contributing traits. Therefore, the path coefficient analysis was performed to partition the correlation coefficient into direct and indirect effect of different characters on yield. The data pertaining to path coefficient analysis are presented in Table 3.

Marketable head yield was taken as dependent variable while computing the path co-efficient and only directly measured traits (leaving deduced parameters, head shape index and head compactness) were taken into consideration to avoid confusion on further partitioning effects. Positive direct effect on marketable head yield was the highest for net head weight (0.880), followed by equatorial diameter (0.787), number of marketable heads per plot (0.771), days to harvest (0.290), gross head weight (0.136) and plant spread (0.049); while non wrapper leaves (-0.037) and polar diameter (-1.036) reflected a negative direct effect on yield. These results are in line with Sharma (2010), Meena *et al.,* (2010) and Kibar *et al.,* (2014).

As net head weight had also maximum significant and positive correlation with yield (r = 0.946**), direct selection for net head weight should be done to improve yield of cabbage.

Table 1: Analysis of variance for randomized block design

S.No.	Sources of variation → Traits df→	Replications2	Treatments40	Error80
1	Plant spread (cm)	334.28	46.87*	7.86
2	Non wrapper leaves	7.51	8.19*	1.60
3	Gross head weight (g)	117333.20	84760.28*	5126.94
4	Net head weight (g)	12608.79	31769.24*	1711.31
5	Polar diameter (cm)	10.14	3.45*	0.47
6	Equatorial diameter (cm)	14.22	4.71*	1.03
7	Days to harvest	43.05	52.41*	14.91
8	Head shape index	0.01	0.04*	0.01
9	Compactness of head (g/cm^3)	6.97	29.41*	10.00
10	Marketable heads per plot	10.88	10.50*	2.18
11	Heading percentage (%)	222.01	302.89*	69.01
12	Marketable head yield (kg)	0.25	5.01*	0.25

* Significant at 5% level of significance

Table 2: Estimates of genotypic and phenotypic correlation coefficients for horticultural traits in cabbage genotypes

Trait		1	2	3	4	5	6	7	8	9	10	11	12
1	G		-0.201*	0.705*	0.261*	0.501*	0.458*	0.585*	-0.016	-0.860*	-0.100	0.076	0.185*
	P		-0.102	0.618*	0.280*	0.439*	0.454*	0.223*	-0.127	-0.486*	-0.026	0.066	0.160
2	G			-0.466*	-0.720*	-0.641*	-0.726*	-0.221*	0.186*	0.385*	-0.411*	-0.509*	-0.661*
	P			-0.296*	-0.528*	-0.389*	-0.466*	0.001	0.165	0.075	-0.202*	-0.211*	-0.484*
3	G				0.806*	0.744*	0.852*	0.346*	-0.180	-0.559*	0.172	0.340*	0.692*
	P				0.800*	0.693*	0.776*	0.170	-0.233*	-0.243*	0.166	0.261*	0.640*
4	G					0.635*	0.943*	-0.078	-0.361*	-0.050	0.506*	0.566*	0.946*
	P					0.596*	0.832*	-0.127	-0.377*	0.072	0.395*	0.418*	0.872*
5	G						0.398*	0.714*	0.466*	-0.730*	-0.042	0.103	0.535*
	P						0.456*	0.325*	0.335*	-0.494*	0.031	0.049	0.427*
6	G							0.034	-0.618*	-0.196*	0.452*	0.618*	0.901*
	P							-0.189*	-0.666*	0.001	0.349*	0.384*	0.692*
7	G								0.539*	-0.977*	-0.653*	-0.566*	-0.299*
	P								0.446*	-0.520*	-0.431*	-0.296*	-0.266*
8	G									-0.449*	-0.488*	-0.551*	-0.410*
	P									-0.407*	-0.357*	-0.389*	-0.367*
9	G										0.579*	0.381*	0.125
	P										0.420*	0.298*	0.172
10	G											0.991*	0.740*
	P											0.854*	0.636*
11	G												0.742*
	P												0.615*

G = Genotypic correlation, P = Phenotypic correlation; * Significant at 5% level of significance; 1: Plant spread, 2: Non wrapper leaves, 3: Gross head weight, 4: Net head weight; 5: Polar diameter, 6: Equatorial diameter, 7: Days to harvest, 8: Head shape index; 9: Compactness of head, 10: Marketable heads per plot, 11: Heading percentage; 12: Marketable head yield per plot

Table 3: Genotypic path coefficients showing direct and indirect effects of some horticultural traits on yield in cabbage genotypes

Trait	1	2	3	4	5	6	7	8	9	r value with yield
1	0.049	-0.010	0.035	0.013	0.025	0.023	0.029	-0.005	0.004	0.185*
2	0.008	-0.037	0.018	0.027	0.024	0.028	0.007	0.016	0.019	-0.661*
3	0.097	-0.063	0.136	0.111	0.102	0.117	0.047	0.024	0.047	0.692*
4	0.230	-0.635	0.710	0.880	0.560	0.831	-0.067	0.446	0.498	0.946*
5	-0.521	0.664	-0.773	-0.659	-1.036	-0.414	-0.740	0.043	-0.106	0.535*
6	0.361	-0.572	0.670	0.743	0.314	0.787	0.028	0.356	0.488	0.901*
7	0.170	-0.063	0.100	-0.022	0.207	0.010	0.290	-0.190	-0.164	-0.299*
8	-0.077	-0.315	0.132	0.391	-0.032	0.347	-0.504	0.771	0.762	0.740*
9	-0.022	0.146	-0.097	-0.162	-0.028	-0.177	0.161	-0.283	-0.285	0.742*

* Significant at 5% level of significance ;1: Plant spread, 2: Non wrapper leaves, 3: Gross head weight, 4: Net head weight; 5: Polar diameter, 6: Equatorial diameter, 7: Days to harvest, 8: Marketable heads per plot; 9: Heading percentage

Likewise, gross head weight and equatorial diameter showed positive and significant correlation with yield. Due to significant positive correlation of net head weight and equatorial diameter with yield and also their high positive direct effect on yield, these yield components can be used directly in selection for yield improvement in cabbage breeding. Similar findings were reported by Sharma (2010) and Kibar *et al.,* (2014).

Hence, net head weight proved to be the most effective selection index while carrying out genetic improvement in cabbage. In addition to, non wrapper leaves and polar diameter contributed indirectly to yield. Therefore, considering of these traits as selection criteria will be advantageous for improvement of yield in cabbage. In yield attributing traits the residual effect at genotypic level was less compared to the residual effect at phenotypic level. Residual effect indicates the contribution of other factors on the variability than the studied ones. Low residual effect (0.1161) revealed that all the traits under study accounted for 88.39 % of variability towards marketable head yield.

REFERENCES

Al-Jibouri, H. A., Millar, P. A. and Robinson, H. F. 1958. Genotypic and environmental variances and covariances in an upland cotton cross of inter-specific origin. *Agronomy J.* **50:** 633-37.

Dewey, D. R. and Lu, K. H. 1959. A correlation and path coefficient analysis of crested wheat grass seed production. *Agronomy J.* **51:** 515-18.

Ghebramlak, A. M., Sharma, S. R. and Rattan, R. K. 2004. Genetic variability and correlation studies for quality Characters in cabbage. *Indian J. Genetics and Plant Breeding.* **64:** 83-84.

Kibar, B., Karaaoac, O. and Kar, H. 2014. Correlation and path coefficient analysis of yield and yield components in cabbage (*Brassica oleracea* var. *capitata* L.). *Acta Scientiarum Polonorum Hortorum Cultus.* **13:** 87-97.

Kopsell, D. A., Kopsell, D. E. and Lefsrud, M. G. 2004. Variation in lutein, ß-carotene and chlorophyll concentrations among leafy *Brassica oleracea* cultigens and seasons. *Hort Science.* **39:** 361-4.

Kumar, D., Kohli, U. K. and Kanwar, H. S. 2007. Association and path analsyis among horticultural and seed traits in cabbage. *Indian J.*

Horticulture. **64:** 362-365.

Meena, M. L., Ram R. B. and Rubee L. 2009. Genetic variability and correlation studies for some quantitative traits in cabbage (*Brassica oleracea* var. *capitata* L.) under Lucknow conditions. *Progressive Horticulture*. **41:** 89-93.

Meena, M. L., Ram, R. B., Rubee, L. and Sharma, S. R. 2010. Determining yield components in cabbage (*Brassica oleracea* var. *capitata* L.) through correlation and path analysis. *International J. Science and Nature*. **1:** 27-30.

Panse, V. G. and Sukhatme, P. V. 1984. Statistical Methods for Agricultural Workers. *ICAR,* New Delhi, p. 381.

Pearson, O. H. 1931. Methods of determining the solidarity of cabbage heads. *Hill Gardia*. **5:** 383-393.

Sharma, K. C. 2010. Genetic variability, characters association and path analysis in exotic lines of cabbage under mid hill, sub-humid conditions of Himachal Pradesh. *J. Hill Agriculture*. **1:** 146-150.

Singh, B. K., Sharma, S. R. and Singh, B. 2009. Heterosis for mineral elements in single cross-hybrids of cabbage. *Scientia Horticulturae* **122:** 32-36.

Singh, B. K., Sharma, S. R. and Singh, B. 2010. Variation in mineral concentrations among cultivars and germplasms of cabbage. *J. Plant Nutrition*. **33:** 95-104.

Singh, B., Mishra, A. K., Sanwal, S. K., Singh, P. K. and Rai, M. 2013. Genetic variability and character association analysis in cabbage hybrids. *Indian J. Horticulture*. **70:** 296-299.

Singh, V. K., Shree, S., Kumar, R., Singh, P. and Singh, R. G. 2015. Effect of microbial inoculants and inorganic fertilizers on growth and yield of hybrid cabbage *Brassicaoleracea* var. *capitata* L. *The Bioscan*. **10:** 1227-31.

Soni, S., Kumar, S. and Maj, S. 2013. Correlation and path coefficient analysis studies for the yield and its traits in cabbage (*Brassica oleracea* var. *capitata* L.) *Annals of Horticulture*. **6:** 331-336.

Thakur, H. and Vidyasagar. 2016. Effect of SI and CMS systems on the horticultural performance of F_1 hybrids in cabbage (*Brassica oleracea* var. *capitata* L.) *The Bioscan*. **11:** 933-937.