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DETERMINING YIELD COMPONENTS IN CABBAGE (*BRASSICA OLERACEA* VAR. *CAPITATA* L.)THROUGH CORRELATION AND PATH ANALYSIS

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ABSTRACT
Correlation and path coefficient analysis partitioned into direct and indirect for the 11 quantitative characters were studied in thirty genotypes of cabbage. The positive and significant association of yield was observed with all the characters except days to maturity and stalk length at both genotypic and phenotypic level indicating that selection based on these characters either in combination or alone will result in identifying the genotypes having high yield potential. The path coefficient analysis in the present investigation reveals that among the yield contributing characters viz; gross weight (0.519), leaf length (0.251), stalk length (0.160) and head weight (0.160) had maximum direct effect on yield followed by number of non-wrapper leaves (0.141) and equatorial length (0.092). Therefore, gross weight, leaf length, stalk length head weight and polar length should be considered as selection criteria for yield improvement in cabbage breeding.

KEYWORDS : Vegetable improvement, cabbage, *Brassica oleracea* var. *capitata*, Variability, Correlation and path analysis.

INTRODUCTION

Cabbage (*Brassica oleracea* var. *capitata* L., 2n = 2x = 18) is one of the most important Cole crops grown under temperate to tropical climate conditions for its head in more than ninety countries throughout the world (Singh *et al.*, 2010) and the leading countries are China, India, Russia, Korea, Japan and the USA. In India, it is next only to cauliflower with acreage and production statistics of 240 thousand ha and 43,000 thousand metric tones, respectively Attar *et al.*, (2009). 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 antioxidant and is reported to have anti-carcinogenic properties (Singh *et al.*, 2009). It is also rich source of ascorbic acid, carotene (pro. Vitamin A) and has high fiber content and calcium which reduces the risk of colon cancer (Swarup, 2006). Improvement in any crops depends on the magnitude of genetic variability and the extent of transmission of characters from one generation to the next. The yield and its component characters are polygenic in nature, hence influenced by the environmental factors. The knowledge of inter relationships among the various components and their direct and indirect effect on yield are the important pre-requisites to bring genetic improvement in cabbage. Path coefficient will help plant breeders to decide suitable selection criteria to improved yield. Path analysis facilitates partitioning of correlation coefficients into direct and indirect of various characters on gross weight can prove useful in providing information, which could improve yield or other related characters. The information regarding the correlation and path coefficient analysis in cabbage is inadequate. Therefore, the present study was conceived with objective to examine the association between important yield traits and their path analysis in cabbage, so as to make effective selection for the improvement of this crop.

MATERIALS AND METHODS

The experimental materials comprised of 30 cabbage genotypes of tropical and subtropical origin belongings to white, red and savoy types. Each genotype was planted in a plot having 3.0 × 2.7 m area in randomized block design with three replications. There were 25 plants in each plot planted at row and plant spacing of 60 × 45 cm. All the standard package of practices and plant protection measures were timely adopted to raise the crop successfully. Five randomly selected plants from each replication were utilized for recording observations viz., days to maturity, number of non-wrapper leaves, core length (cm), stalk length (cm), equatorial length (cm), leaf length (cm), leaf width (cm), polar length (cm), gross weight (kg), head weight (kg) and yield (t/ha) at the Horticultural Research Farm of the Department of Applied Plant Science (Horticulture), BBAU, Lucknow during the winter season of 2007 to 2009. The mean values obtained from 2 years data were used for estimating the analysis of variance Panse and Sukhatme,(1978). Correlation and path coefficient analysis were calculated as per formulae suggested by Al-jibouri *et al.*, (1958), and Dewey and Lu (1959), respectively.

RESULTS AND DISCUSSION

A perusal of the data revealed that genotypic correlation coefficients were higher phenotypic correlation coefficients for all the pairs of characters (Table 1). This might be due to the masking effect of environment in the total expression of the genotypes resulting in the reduced phenotypic association. The yield displayed positive and

significant correlation with all the characters except days to maturity and stalk length. It may be assumed that the selection based on these characters either in combination or alone resulted in identifying the hybrid having high yield potential. The present findings are in accordance with that of Prasad *et al.*, (1989) and Jambal *et al.*, (1996) and Rai and Asati (2005) in cabbage. The yield components mostly exhibited positive and significant inter relationship among themselves which indicated the need of their simultaneous selection for improvement on yield. Similar *inter se* associations of yield contributing traits in cabbage were also reported earlier by Prasad *et al.*, (1989), Sharma *et al.*, (2005) and Jambal *et al.*, (1996).

Correlation coefficients indicate only the general association between any two traits without tracing any possible causes of such association. In such association the path coefficient analysis at genotypic level (Table 2) is done to partition the correlation co-efficient into direct and indirect effect of different characters on yield. The path coefficient analysis revealed that the characters like gross weight (0.519), leaf length (0.251), stalk length (0.160) and head weight (0.160) had highest positive direct effect on yield followed by number of non-wrapper leaves (0.141) and equatorial length (0.092), which is in agreement with the result of Rai and Asati, (2005) in cabbage. The days to maturity (-0.135), leaf width (-0.121) and polar length (-0.067) had the direct negative effect but correlation with yield is positive except days to maturity owing to indirect through all the characters. A similar result has also been reported by Rai and Asati, (2005) in cabbage. Hence, gross plant weight proved to be the most effective selection index while carrying out genetic improvement in cabbage. In yield attributing traits, the residual effect at genotypic level was less compared to the residual effect at phenotypic level. All these characters should be considered simultaneously for effective selection of cabbage genotypes.

From the above findings it may be concluded that besides direct selection for gross weight, stalk length, leaf length and head weight indirect selection for days to maturity to yield improvement can be made possible in cabbage through breeding programme.

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Table 1: Estimates of genotypic and phenotypic correlation coefficients for morphological character in cabbage genotypes

Characters		D.M	N.W.L	C.L	S.L	L.W	L.L	E.L	P.L	G.W	H.W	Yield
D.M	**P**	1.000	-0.015	-0.008	-0.080	-0.040	-0.014	-0.152	0.296*	0.193	-0.035	-0.057
	G	1.000	-0.035	-0.005	-0.073	-0.055	-0.028	-0.173	0.334*	0.261	-0.031	-0.060
N.W.L	**P**		1.000	0.198	-0.149	0.159	0.258*	-0.038	0.161	0.008	0.024	0.152
	G		1.000	0.211	-0.166	0.165	0.247	-0.039	0.174	-0.010	0.037	0.163
C.L	**P**			1.000	-0.165	0.241	0.288*	0.341*	0.237	0.469**	0.557**	0.463**
	G			1.000	-0.174	0.254*	0.300*	0.364**	0.253*	0.531**	0.601**	0.483**
S.L	**P**				1.000	-0.163	-0.085	-0.122	-0.062	-0.197	-0.161	-0.007
	G				1.000	-0.178	-0.096	-0.135	-0.061	-0.205	-0.175	-0.007
L.W	**P**					1.000	0.689**	0.337*	0.215	0.368**	0.375**	0.373**
	G					1.000	0.709**	0.346*	0.222	0.443**	0.405**	0.383**
L.L	**P**						1.000	0.338*	0.299*	0.410**	0.401**	0.520**
	G						1.000	0.345*	0.309*	0.468**	0.438**	0.531**
E.L	**P**							1.000	0.216	0.473**	0.438**	0.480**
	G							1.000	0.224	0.535**	0.481**	0.490**
P.L	**P**								1.000	0.356**	0.154	0.222
	G								1.000	0.414**	0.180	0.230
G.W	**P**									1.000	0.689**	0.613**
	G									1.000	0.825**	0.693**
H.W	**P**										1.000	0.643**
	G										1.000	0.691**
Yield	**P**											1.000
	G											1.000

*, ** significant at 5% and 1% level, respectively. P: Phenotypic correlation & G: Genotypic correlation.

List of Abbreviations

D.M = Days to maturity
N.W.L =Non wrapper leaves
C.L =Core length (cm)
S.L =Stalk length (cm)
L.W =Leaf width (cm)
L.L =Leaf length (cm)
E.L =Equatorial length (cm)
P.L =Polar length (cm)
G.W =Gross weight (kg)
H.W =Head weight (kg)

Table-2: Estimate of direct (diagonal) and indirect (off diagonal) effects of various traits towards yield at genotypic level in cabbage genotypes.

Characters	X_1	X_2	X_3	X_4	X_5	X_6	X_7	X_8	X_9	X_{10}	Correlation with yield
X_1	**-0.135**	-0.005	0.000	-0.012	0.007	-0.007	-0.016	-0.022	0.136	-0.005	-0.060
X_2	0.005	**0.141**	0.010	-0.027	-0.020	0.069	-0.004	-0.012	-0.005	-0.006	0.163
X_3	0.001	0.030	**0.047**	-0.028	-0.031	0.076	0.034	-0.017	0.276	0.096	0.483**
X_4	0.010	-0.023	-0.008	**0.160**	0.022	-0.024	-0.013	0.004	-0.107	-0.028	-0.007
X_5	0.007	0.023	0.012	-0.028	**-0.121**	0.178	0.032	-0.015	0.230	0.065	0.383 *
X_6	0.004	0.038	0.014	-0.015	-0.086	**0.251**	0.032	-0.021	0.243	0.070	0.531**
X_7	0.023	-0.006	0.017	-0.022	-0.042	0.087	**0.092**	-0.015	0.278	0.077	0.490**
X_8	-0.045	0.025	0.012	-0.010	-0.027	0.078	0.021	**-0.067**	0.215	0.029	0.230
X_9	-0.035	-0.001	0.00.0	-0.033	-0.054	0.118	0.049	-0.028	**0.519**	**0.132**	0.693**
X_{10}	0.004	0.005	2825	-0.028	-0.049	0.110	0.044	-0.012	0.428	0.160	0.691**

*, ** significant at 5% and 1% level, respectively. Residual effect = 0.360, Direct effect = Bold diagonals

X_1 = days to maturity
X_2 = non-wrapper leaves
X_3 = core length (cm)
X_4 = stalk length (cm)
X_5 = leaf length (cm)
X_6 = leaf width (cm)
X_7 = equatorial length (cm)
X_8 = polar length (cm)
X_9 = gross weight (kg)
X_{10} = head weight (kg)