Genetic Variability, Heritability and Genetic Advance Studies in Cabbage (*Brassica oleracea* var. *capitata* L.)

RS Atter[1], KC Sharma[2] and AS Sundouri[3]

[1,2]*Department of Vegetable Science, CSK Himachal Pradesh Krishi Vishvavidyalaya, Palampur–176 062, Himachal Pradesh, India*

[3] *Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar–191 121, J&K, India*

Genetic variability, heritability and genetic advance were estimated for marketable and its component yield traits in 29 lines of cabbage (*Brassica oleracea* var. *capitata* L.). The study showed high ranges for marketable yield (122.00-363.00), marketable head (75.00-99.00) and days to marketable maturity (69.67-112.00). The highest estimates of PCV and GCV were for marketable yield (PCV= 32.08, GCV= 29.95) followed by net weight of head (PCV= 30.42, GCV= 27.05) and gross weight per plant (PCV= 28.79, GCV= 26.17) and low for harvest index (PCV= 12.53, GCV= 10.73) followed days to marketable maturity (PCV= 11.99, GCV= 9.20) and marketable head (PCV= 9.37, GCV= 3.41). Narrow differences between PCV and GCV, gave evidence to the lines that the variability existing in them was mainly due to their genetic make up. High heritability was noticed for shape of head (93.1%) followed by compactness of head (92.00%), marketable yield (87.2%), and gross weight per plant (82.5). Number of non-wrapper leaves, harvest index, marketable head and length of stalk showed moderate heritability estimates. Days to marketable maturity showed low heritability estimates (49.2%). High heritability in broad sense indicated that large proportion of phenotypic variance was attributable to the genotypic variance and were less influenced by the environment. High genetic advance was observed for marketable yield (58.00), whereas it was low for days to marketable maturity (14.53), marketable head (2.56), length of stalk (15.00) and harvest index (19.00) and indicates that these traits are likely to respond better to selection.

Key Words: Cabbage, Genetic variability, Heritability, Genetic advance

Introduction

Cabbage (*Brassica oleracea* var. *capitata* L.), a member of Brassicaceae, is one of the most important vegetables in the world. It occupies the pride place among the cole crops due to its delicious taste, flavour and nutritive value. Modern compact head cabbage cultivars are descended from wild, non-heading types originating in east Mediterranean and Asia minor. Cabbage is being grown throughout the world 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 tonnes, respectively. Inspite of its economic importance only a limited research on varietal development has been carried out in India on account of crossing work and seed production possible in the high hills only. Of late, breeding and seed production have also been possible in the mid hills and north Indian plains due to the availability of tropical germplasm. There is a wide scope to develop high yielding varieties for seed production in mid and high hills. Estimation of genetic variability in the germplasm of a particular crop is prerequisite for making any effective breeding programme. Selection of parents to be included in the hybridization programme should be based on genetic distance. Most of the important characters including marketable yield are highly influenced by environment, since they are polygenically controlled. This makes the selection process difficult. Therefore, knowledge of heritability for different component traits were essential for any crop improvement programme, because the heritable component is the consequence of genotype and is inherited from generation to generation (Wright, 1921). Estimation of genetic advance together with heritability would be helpful in assessing the nature of gene action. Genetic coefficient of variation together with heritability estimates gives reliable indication of the amounts of the extent of improvement accepted from selection and further remarked that accepted genetic gain under particular system, which provides a true practical information needed by a breeder. Hence, an investigation was carried out for estimating genetic variability, heritability and genetic advance among marketable and its component yield traits in 29 lines of cabbage.

Materials and Methods

The present investigations were carried out at the Experimental Farm of Hill Agricultural Research and Extension Centre, Bajaura, Kullu, Himachal Pradesh with 29 diverse lines of cabbage obtained from different sources. The details of genetic stocks studied are given in Table1. The seeds of all diverse lines were sown on 15 cm raised seedbeds in nursery and the seedlings were transplanted in the main plot after one month. Plot size was 1.8 m x

Table 1. Diverse lines of cabbage and their sources under study

Lines	Sources
EC481002	Horticultural Research International, Wellsborne, UK
EC481006	-do-
EC481007	-do-
EC481015	-do-
EC481016	-do-
EC481019	-do-
EC481022	-do-
EC481030	-do-
EC481031	-do-
EC481035	-do-
EC481039	-do-
EC481040	-do-
EC481045	-do-
EC481055	-do-
EC481056	-do-
EC481058	-do-
EC481060	-do-
EC481067	-do-
Glory	IARI, Katrain
KGAT-l	CSK HPKV, Palampur
KGAT-ll	-do-
KGAT-lll	-do-
First of June	IARI, Katrain
Early Ball Head	-do-
Avon Crest	-do-
Pusa Mukta	-do-
AC-208	-do-
India Market	-do-
Golden Acre	-do-

2.25 m having 20 plants spaced at 45 cm x 45 cm. Gap filling was restored, wherever needed to ensure uniformity. The experiment was laid out in a randomized block design with three replications. Uniform cultural operations were followed as per the recommended package of practices. Observations on the characters, namely, marketable yield (q/ha), marketable head (%), net weight of head (kg), gross weight per plant (kg), compactness of head, shape of head, number of non-wrapper leaves, length of stalk (cm), days to marketable maturity and harvest index in each replication were recorded. Except days to marketable maturity, marketable head (%) and marketable yield, the observations were recorded on 10 randomly selected plants in each plot. In the process of random labeling the border plants were avoided. Phenotypic and genotypic coefficients of variations were estimated according to Burton and Devane (1953). Heritability in broad sense was calculated as per formula given by Burton and Devane (1953) and Allard (1960). The expected genetic advance resulting from the selection of 5% superior individuals were worked out as suggested by Burton and Devane (1953) and Johnson *et al.* (1955). Genetic gain expressed as per cent of population mean was calculated by the method given by Johnson *et al.* (1955).

Results and Discussion

The estimates of genetic parameters of variability, *viz.,* phenotypic and genotypic coefficient of variation (PCV and GCV) along with heritability in broad sense (h^2) and genetic advance (GA) as percentage of mean for different characters are given in Table 2. The data revealed that there were significant differences among lines for various component traits. High ranges for marketable yield (122.00-363.00), marketable head (75.00-99.00) and days to marketable maturity (69.67-112.00) were observed. The higher phenotypic coefficient of variation than those of genotypic coefficient of variation indicated the predominant role of environment in the expression of the traits, which is in consonance with the result obtained by Yadav (1998).

The estimates of PCV and GCV were high for marketable yield (PCV=32.08, GCV=29.95) followed by net weight of head (PCV=30.42, GCV=27.05) and gross weight per plant (PCV= 28.79, GCV= 26.17), whereas low for harvest index (PCV=12.53, GCV=10.73) followed days to marketable maturity (PCV= 11.99, GCV=9.20) and marketable head (PCV=9.37, GCV=3.41). These results were in broad conformity to those of earlier researchers (Swarup and Sharma, 1965; and More and Wallace, 1987) although moderate to high estimates of means, PCV and GCV for marketable yield, gross weight per plant, net weight of head, number of non-wrapper leaves and days to marketable maturity have been reported by them. The low estimates of marketable head, net weight head, gross weight per plant, compactness head harvest index and number of non-wrapper leaves indicated that the cultivars of cabbage included in the present study possessed less genetic variability for these characters. Narrow differences between PCV and GCV, gave evidence to the lines that the variability existing in them was mainly due to their genetic make up.

Heritability is useful in predicting the expected progress to be achieved through selection (Burton and Devane, 1953; Johnson *et al.,* 1955). In the present study, the highest heritability was noticed for the shape of head (93.1%) followed by compactness of head (92.00 %), marketable yield (87.2 %), and gross weight per plant (82.5). All these traits exhibited more than 80% heritability (Table 2). Number of non-wrapper leaves, harvest index, marketable head and length of stalk showed moderate

Table 2. Mean, range, coefficient of variation, heritability and genetic advance for various marketable and yield components in cabbage

Traits	Mean	Range	PCV	GCV	h^2	GA
Marketable yield	203.59	122.00-363.00	32.08	29.95	87.2	58.00
Marketable head (%)	90.43	75.00-99.00	9.37	3.41	13.2	2.56
Net weight of head	0.46	0.27-0.77	30.42	27.05	78.8	50.00
Gross weight per plant	0.77	0.52-1.36	28.79	26.17	82.5	50.00
Compactness of head	38.65	19.13-60.43	27.13	26.03	92.00	51.43
Shape of head	1.01	0.75-1.32	14.52	14.10	94.2	28.00
Number of non-wrapper leaves	13.94	10.27-19.50	16.02	14.28	79.4	26.25
Length of stalk	11.80	10.40-17.60	13.78	9.95	52.2	15.00
Harvest index	55.92	45.24-66.74	12.53	10.73	73.3	19.00

heritability estimates. Days to marketable maturity showed low heritability estimates (49.2%). High heritability in broad sense indicated that large proportion of phenotypic variance was attributable to the genotypic variance and that these character differences among the genotypes were real and showed that the above mentioned traits with high heritability values were less influenced by the environment. High heritability for marketable yield and gross weight of head have been estimated earlier by Lal and Solanki (1975) and More and Wallace (1987), shape of head by Swarup and Sharma (1965) and compactness of head Flory and Walker (1940) and More and Wallace (1987).

Johnson *et al.* (1955) stressed that for estimating the real effects of selection, heritability alone is not sufficient and genetic advance along with heritability is more useful. High genetic advance was observed for marketable yield (58.00), whereas it was low for days to marketable maturity (14.53), marketable head (2.56), length of stalk (15.00) and harvest index (19.00) which is in broad conformity to the findings of earlier researchers (Swarup and Sharma, 1965; Lal and Solanki, 1975; Flory and Walker 1940). Moderate to high genetic advance for net weight of head (Bhagchandani *et al.,* 1977; More and Wallace, 1987), gross weight per plant; compactness of head, number of non-wrapper leaves and shape of head reported by (Swarup and Sharma, 1965; Lal and Solanki, 1975), which was slightly variance with the present findings. High heritability along with moderate genetic advance was observed for shape of head (28.00), compactness of head (51.43), net weight of head (50.00), gross weight per plant (50.00) and number of non-wrapper leaves (26.25), these findings were at variance with those of Swarup and Sharma (1965) and Lal and Solanki (1975), who reported high heritability associated with low genetic advance. High heritability along with moderate genetic advance for these traits may be attributed to the additive gene action linked with non-additive effects and these may be improved through selection followed by hybridization.

However, high heritability associated with high genetic advance was observed for marketable yield in conformity with the findings of (Swarup and Sharma, 1965). High heritability coupled with high genetic advances in marketable yield indicates that this trait is likely to respond better to selection. Length of stalk along with harvest index had moderate heritability associated with low genetic advance and these findings were variance with those of More and Wallace (1987), who reported high heritability associated with moderate genetic advance.

Moderate heritability with low genetic advance was observed for marketable head (2.56) which is in contrast to the findings of Swarup and Sharma (1965) who reported low heritability coupled with low genetic advance for this trait. Low heritability in combination with low genetic advance was observed for days to marketable maturity (14.53), which varies with the findings of Swarup and Sharma (1965), who reported high heritability with high genetic advance for this trait. Characters with low heritability coupled with low genetic advance are more under the influence of non-additive gene action and environment and do not respond to selection.

References

Allard RW (1960) *Principles of Plant Breeding*. John Wiley and sons, Inc. New York, USA.

Bhagchandani PM, TS Verma and N Singh (1977) Study on selection of cabbage cultivars for summer cultivation in hills. *Indian J. Hort*. **34:** 60-63.

Burton GW and EH Devane (1953) Estimating heritability in tall Festuca (*Festuce aurandianacea*) from replicated clonal material. *Agron. J*. **45:** 478-481.

Flory WS and JC Walker (1940) Effect of different on head shape in Marion Market Cabbage. *Proc. Amer. Soc. Hort. Sci.* **37:** 778-782.

Johnson HW, HF Robison and HE Gomostock (1955) Estimate of genetic and environmental variability in soyabean. *Agron. J.* **47:** 314-318.

Lal SD and SS Solanki (1975) Genetic variability in cabbage (*Brassica oleracea* var. *capitata* L.). *Prog. Hort.* **7:** 55-62.

More TA and DH Wallace (1987) Gene action on horticultural characters in self-incompatible lines in cabbage. *Indian J. Genet.* **47:** 15-19.

Swarup V and BR Sharma (1965) Inheritance of some quantitative characters in cabbage. *Indian J. Genet.* **23:** 90-100.

Wright S (1921) Correlation and causation. *J. Agric. Res.* **20:** 557-585.

Yadav DS (1998) Genetic variability and character association in cabbage. *J. Hill Res.* **11:** 229-231.