Estimation of Genetic Variability and Heritability in Lettuce (*Lactuca sativa* L.)

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Twenty-five genotypes of lettuce were evaluated to study the variability and heritability parameters at Experimental Farm, Division of Olericulture, Sher-e-Kashmir University of Agricultural Sciences and Technology (K), Shalimar, Srinagar during 2006 and 2007. The analysis of variance showed significant differences for all the characters. Variability revealed that phenotypic coefficient of variation (PCV) in general were higher that the corresponding genotypic coefficient of variation (GCV) for all the characters. The high phenotypic as well as genotypic variance were observed for carotenoids only, while the characters like number of leaves per plant, leaf yield per plant, vitamin C, average leaf weight, calcium, plant spread and potassium exhibited moderate PCV as well as GCV. High estimates of heritability ranging from 69.90% to 94.10 % were recorded for most of the characters. However, days to first picking (45.60), duration of picking (50.20), leaf breadth (56.20) and plant height (58.70) exhibited low heritability. The characters like carotenoids (50.81%), leaf yield per plant (33.53), number of leaves per plant (32.25%), vitamin C (30.67), calcium (26.03), average leaf weight (23.24), duration of picking (22.67) and potassium (22.42) recorded maximum genetic gain as percent of mean. High heritability associated with high genetic advances was obtained in the case of number of leaves per plant, leaf yield per plant, vitamin C and carotenoids, which further suggested substantial additive gene effect governing these characters and phenotypic selection may be useful in improving these traits.

Key Words: Lettuce, Improvement, Variability, Heritability, Genetic advance

Lettuce is an important salad vegetable, well represented in temperate and sub-tropical growing regions of the world and thrives well in winter season. The leafy type lettuce is a rich sources of vitamin C, pro-vitamin A and minerals and popular for its daily use in diet particularly in USA and Europe. Its crisp and crunchy leaves are used in sandwiches or red leaves for beautiful colour in salads. Recently it is gaining popularity in India too, owing to its nutritional qualities.

The role of genetic variability in a crop is of paramount importance in selecting the best genotypes for making rapid improvement in yield and related characters as well as to select the most potential parents for making the hybridization programme successful. The success of breeding programme depends on the availability of genetic variability present in the available germplasm. The study of biological parameters is often considered to be a successful step in the study of genetic variability. Since most of the plant characters of economic importance are polygenic in nature and are highly influenced by environment, it is necessary to work out whether the observed variability is heritable or due to environment. This suggests the imperative need to work out the phenotypic variation into heritable and non heritable components. Genotypic and phenotypic coefficient of variability helps to access the divergence of the characters. Selection would be more meaningful for characters which exhibit high variability and heritability along with moderate to high genetic gain. Realizing the importance of the crop there is urgent need to isolate such breeding line having desirable horticultural traits, better quality coupled with high yield potential. Under such situation, an attempt was made in the present investigation to analyse variability of its components with hope that the result might be of practical use to the plant breeder to achieve desirable level of improvement in this crop.

The extent of genetic improvement that could be achieved is largely determined by nature and magnitude of variability present in a breeding material of a given crop. Greater the diversity in the material, better are the chances for evolving promising and desired types. Since the genetic facts are inferred from phenotypic observations arising as a result of interaction between genotype and environment, the information on variability parameters becomes essential for selection of genetically superior types. Hence, an attempt was made to assess the available genetic variability in lettuce by partitioning of over all variability into its heritable and non-heritable

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components as genetic parameters like genotypic coefficient of variation, heritability and expected genetic advance.

Materials and Methods

The experiment was carried out at Sher-e-Kashmir University of Agricultural Sciences & Technology (K), Shalimar, Srinagar during winter 2006 and summer 2007. Twenty-five genotypes of lettuce were utilized for the study. Each genotype was sown in 3 rows of 2.25 meters length spaced 45x45 cm apart between row-to-row and plant-to-plant, respectively. The recommended agronomic and plant protection practices were adapted for raising a healthy crop. The observation were recorded on five randomly selected plants in each replication for each genotype on 16 quantitative and qualitative traits viz. plant height (cm), plant spread (cm), number of leaves/plant, average leaf weight (g), leaf size (cm^2), leaf length, leaf breadth, days to first picking, duration of picking, leaf yield/plant(g), dry matter content, vitamin C, carotenoids, calcium, phosphorous and potassium (mg/100 g on fresh weight basis). The mean values obtained from two seasons were used for analysis. For estimation of leaf area, leaf area metre was utilised. The genotypic, phenotypic and environmental coefficient of variation was calculated as per the formula suggested by Burton and De Vane (1953) and Allard (1960). Heritability in broad sense and expected genetic advance were calculated as per the formula given by Allard (1960) and Johnson *et al*. (1955), respectively.

Results and Discussion

The analysis of variance revealed highly significant differences for all the characters studied which indicated that the genotypes differed significantly for all the character. Estimates of range, mean, PCV, GCV, environmental coefficient of variation (ECV), heritability in broad sense (h^2) and genetic advance as per cent of mean for various characters are presented in Table 1. High range of variability also been observed by Singh *et al.* (2007) in lettuce for vitamin C, dry matter content and yield per plant and Khan (2007) in kale for number of leaves, average leaf weight and carotinoids.

High estimates of PCV were observed for carotenoids (26.23) and duration of picking (21.93). The moderate values of PCV were observed for number per of leaves/ plant (17.67), leaf yield per plant (17.61), vitamin C (17.15), average leaf weight (14.47), calcium (14.08), days to first picking (12.05), plant spread (11.74) and potassium (11.97). The lowest value of PCV was obtained for only dry matter content (6.75). PCV is greater than GCV in all cases. Such finding was also observed by Meglic *et al*. (2000) in lettuce and Khan (2007) in Kale.

The GCV was high for only one characters i.e. carotenoids (25.44), while leaf yield per plant (16.93), number of leaves per plant (16.63) vitamin C (15.98), calcium (13.34), duration of picking (15.13), average leaf weight (12.76) and potassium (11.41) showed moderate GCV. The characters which exhibit lower GCV values were phosphorus (4.73), dry matter content (5.65), days

Table 1. Estimation of different genetic parameters for important characters in 25 lettuce genotypes

S.No.	Characters	Range	General Mean ± SE(m)	Coefficient of Variation (%)			Heritability (h^2 %) (broad sense)	Genetic Advance	Genetic Advance as % of Mean
				PCV	GCV	ECV			
1.	Plant height (cm)	13.59 – 20.09	17.17 ± 0.47	7.40	5.61	4.75	58.70	1.54	8.96
2.	Plant spread (cm)	20.80 – 37.73	35.45 ± 0.94	11.74	10.61	2.51	81.70	6.41	19.75
3.	No. of leaves/plant	23.30 – 49.26	37.92 ± 0.13	17.67	16.63	5.97	88.60	12.23	32.25
4.	Leaf weight (g)	6.80 – 11.54	8.99 ± 0.34	14.47	12.76	6.72	78.30	2.09	23.24
5.	Leaf area (cm^2)	143.38 – 247.85	204.47 ± 0.49	10.56	9.68	4.22	84.00	37.37	18.27
6.	Days to first picking	45.00 – 60.00	49.46 ± 0.25	12.05	8.14	8.88	45.60	5.60	11.32
7.	Duration of picking	16.65 – 30.00	26.20 ± 0.23	21.93	15.13	15.47	50.20	5.94	22.67
8.	Leaf yield/plant (g)	131.67 – 367.60	276.81 ± 0.77	17.61	16.93	4.84	92.40	92.83	33.53
9.	Leaf length (cm)	12.43 – 20.94	17.99 ± 0.63	11.17	9.33	6.13	69.90	2.89	16.06
10.	Leaf breadth (cm)	11.17 – 17.44	13.37 ± 0.67	13.26	9.94	8.77	56.20	2.05	15.33
11.	Dry matter content (%)	7.64 – 10.23	8.96 ± 0.19	6.75	5.65	3.68	70.10	0.87	9.70
12.	Vitamin C (mg/100 g)	22.73 – 46.18	35.40 ± 0.12	17.15	15.98	6.21	86.90	10.86	30.67
13.	Carotenoids (mg/100 g)	0.82 – 3.57	2.44 ± 0.89	26.23	25.44	6.34	94.10	1.24	50.81
14.	Calcium (mg/100 g)	66.10 – 123.81	94.44 ± 0.24	14.08	13.34	4.50	89.70	24.59	26.03
15.	Phosphorus (mg/100 g)	39.96 – 57.79	47.33 ± 0.12	6.59	4.73	4.59	51.40	3.30	6.97
16.	Potassium (mg/100 g)	151.24 – 256.13	204.19 ± 256.13	11.97	11.41	3.58	91.00	45.78	22.42

to first picking (8.14), leaf area (9.68) and plant height (5.61). Similar findings were reported by Ruthbenlah and Veeraragavatha (2003) for green yield in amaranth and Sharma *et al*. (2003) in cabbage.

Moderate to high PCV and GCV were observed for number of leaves per plant, average leaf weight, leaf yield per plant, vitamin C, calcium, potassium, duration of picking and caroteniods, indicating that selection of these traits may be comparatively less effective than those having high PCV and GCV. These results are similar to those reported by Tamin and Popova (1977), Thakur *et al.* (1997) and Ruthbenlah and Veeraragavatha (2003).

The environmental coefficient of variation ranged from 2.51% (plant spread) to 15.47 % (duration of picking). In general, estimates of ECV were lower than the corresponding estimates of GCV except days to first picking (8.88) and duration of picking (15.47), indicating that these characters were influenced by the environment. Heritability estimates are high for almost all the characters except days to first picking and duration of picking, which exhibited low heritability of 45.60 and 50.20 percent, respectively. These results were similar to those reported by Tamin and Popova (1977) and Meglic *et al*. (2000) in lettuce.

The highest value of genetic advance as percent of mean was obtained for carotenoids (50.81) followed by leaf yield per plant (33.53), number of leaves per plant (32.25) and vitamin C (30.67), while phosphorous (6.97) showed the lowest value. Johanson *et al.* (1955) suggested that heritability along with the genetic advance would be more useful and reliable than heritability alone. In this context high heritability associated with high genetic advances was obtained in the case of number of leaves per plant, leaf yield per plant, vitamin C and carotenoids, which further suggested substantial additive gene effect governing these characters and phenotypic selection may be useful in improving these traits. The high genetic advance along with high heritability estimates have also been reported by Varalakshmi and Reddy (1994) in amaranthus for number of leaves per plant, Rastogi *et al.* (1995) in Chinese cabbage, and Ruthbeulah and Veeraragvatha (2003) in amaranthus for leaf yield per plant, plant height and vitamin C.

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