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Variability, heritability and genetic advance in lettuce

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ABSTRACT

Genetic variability for different yield contributing characters and important quality characters were studied in 25 genotypes of lettuce during winter, 2006 and summer, 2007. The study indicated existence of considerable amount of genetic variability for all the characters studied except days to first picking and duration of picking. Number of leaves per plant, leaf area, average leaf weight and potassium in both the season exhibited moderate phenotypic coefficient of variation and genotypic coefficient of variation. High estimates of heritability (bs) and genetic advance was observed for carotenoids, calcium, vitamin C, leaf yield per plant and number of leaves per plant. High to moderate estimates of heritability (bs), genotypic coefficient of variation and genetic advance was observed for carotenoids, leaf yield per plant, leaf area and vitamin C. These characters are therefore worth consideration in the improvement of this crop.

Key words: Variability, GCV, PCV, heritability, genetic advance, leafy vegetable, lettuce.

INTRODUCTION

Lettuce (*Lactuca sativa* L.) is a major salad crop in North America, Australia and most countries in Europe and South America. In our country, it is grown in the kitchen gardens to meet the demand of continental hotels. It is unique among major vegetables in its nearly exclusive use as a fresh raw product. It is rich source of vitamins, minerals such as potassium, calcium and sodium. High content of beta-carotene, fibre, folic acid, potassium and high volume of water makes it a heart healthy green vegetables as it help in lowering blood cholesterol level, high blood pressure and other risk factors for heart diseases (Sharma, 10). Further it has great potential for export to neighboring Middle East countries in addition to our own consumption. The exploration of genetic variability in the available germplasm is a pre- requisite in a breeding programme for effective selection for superior genotypes. The partitioning of total variability into heritable and non heritable components will enable the breeder to know whether the superiority of selection is inherited by the progenies. Identification of genotypes with high variability and heritability for the desirable characters is important in selection of varieties with high yielding potential. So there is an urgent need of information on the nature and magnitude of variation available in the material and part played by environment in expression of different characters. Keeping in view the above facts, the present investigation was undertaken to estimate the magnitude of heritable and non heritable component of variation and genetic parameters such as genotypic coefficient of variation, heritability and genetic advance in 25 diverse genotypes of lettuce.

MATERIALS AND METHODS

The present investigation was carried out at the Experimental Farm of the Division of Olericulture, Sher-e-Kashmir University of Agricultural Science and Technology of Kashmir, Shalimar during winter 2006 and summer 2007. Twenty-five genotypes of lettuce maintained by the division were taken for the study. Experiment was laid out in Randomized Block Design with three replications. Sowing was done in mid August for winter crop and first week of February for summer crop and five week old seedling were transplanted in the field during September and March, respectively at a spacing of 45×45 cm. All the recommended agronomic package of practices were followed to raise successful crop. The observations were recorded on five randomly selected plants in each replication for each genotype on fourteen important growth, yield and quality parameters. The analysis of variance was carried out as suggested by Panse and Sukhatme (8). Genotypic and phenotypic coefficient of variation was calculated as per

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the formula suggested by Burton and Devane (2). Heritability in broad sense and expected genetic advance were calculated as per the formula given by Johnson *et al.* (4) and Hanson *et al.* (3).

RESULT AND DISCUSSION

The extent of variability present in the genotypes were measured in terms of ranges, phenotypic variance(σ^2p), phenotypic coefficient of variation (PCV), genotypic variance (σ^2g), genotypic coefficient of variation(GCV), heritability in broad sense and genetic advance (GA) (Table 1 and 2). The analysis of variance revealed highly significant differences for all the characters studied which indicates the genotypes differ significantly for all the characters. Wide range of variation was observed in all the characters except average leaf weight and dry matter content. The GCV which gives a picture of extent of genetic variability in the population range from 7.50% (dry matter content) to 31.73% (carotenoids) during winter and 5.27% (days to first picking) to 28.89% (carotenoids) during summer. The relative magnitude of GCV and PCV when compared indicated that PCV value were greater than the GCV in respect of all the characters under observation and the differences between PCV and GCV were quite less, indicating there by the negligible influence of environments. High estimate of GCV were observed for carotenoids (31.73%, 28.89%) followed by calcium (20.16%, 22.34%) in both the season, indicating that the selection for these characters would be effective. However, most the characters in the present study exhibited moderate GCV *viz.* number of leaves per plant (18.53%, 19.85%), leaf yield per plant (20.94%, 19.01%) and vitamin C (16.60%, 23.62%) in both the seasons, where as plant spread (16.09%), leaf area (15.95%) and duration of picking (16.11%) during winter only, indicating that these characters are more influences by environment. Thus, selection for these traits may be comparatively less effective and need rigorous evaluation in number of environment. Moderate to high PCV and GCV were also be observed by Tamin and Popova (13), Kuamr *et al.* (6), Thakur *et al*. (14) and Meglic *et al.* (7) in lettuce, Shukla *et al.* (11) in amaranthus and Khan (5) in kale. Singh *et al*. (12) reported variability for vitamin C and mineral content in lettuce. A perusal of table 2 shows that there was close relationship between PCV and GCV and was low for all the characters except days to first picking and duration of picking which indicated less influence of environment for most of the characters in both season. With the help of GCV alone, it is not possible to determine the amount of variation that is heritable.

Heritable variation can be found with the greater degree of accuracy when heritability is studied in conjunction with genetic advance. The heritability in broad sense was high for all the characters except days to first picking (47.76%; 28.12%) and duration of picking (48.69%; 39.87%) in both the season, suggesting that the selection based on phenotypic would be more effective. Expected genetic advance and its estimates

Table 1. Mean, range and coefficient of variation for leaf yield, its attributing and quality traits in lettuce genotypes.

Traits	Winter 2006			Summer 2007		
	Mean±SEm	Range	CV (%)	Mean±SEm	Range	CV (%)
Plant height (cm)	15.95±0.56	10.06-18.66	6.30	18.83±0.33	17.13-21.53	3.16
Plant spread (cm)	29.99±0.94	16.76-36.33	5.56	34.91±0.90	24.93-39.13	4.56
No. of leaves/ plant	32.76±0.83	18.20-43.53	4.50	43.08±1.60	27.00-55.00	6.59
Average leaf weight (g)	9.94±0.38	7.06-12.93	6.88	8.04±0.28	6.20-10.30	6.36
Leaf area (cm^2)	221.59±5.56	151.90-277.76	4.43	187.34±4.10	142.86-227.60	3.87
Days to first picking	50.60±2.65	45.00-65.00	9.28	48.30±2.30	45.00-55.00	8.43
Duration of picking	25.20±2.35	13.30-33.33	16.54	27.20±2.22	20.0-36.60	14.47
Leaf yield/ plant (g)	277.37±6.95	138.00-377.66	4.43	276.25±8.15	125.33-386.33	5.21
Leaf yield/ ha (q)	137.01±3.43	68.16-186.56	4.43	137.29±2.99	61.91-190.19	3.85
Dry matter content (%)	9.12±0.12	7.87-10.66	2.47	8.81±0.23	7.13-10.43	4.65
Vitamin C (mg/100g)	37.79±1.32	24.50-49.83	6.20	33.00±1.15	20.96-46.76	6.19
Carotenoids (mg/100g)	2.60±0.09	0.90-4.18	6.30	2.27±0.08	0.73-3.12	6.40
Calcium (mg/100g)	103.95±2.70	67.78-138.78	4.60	84.92±2.07	42.44-113.98	4.30
Phosphorus (mg/100g)	54.89±1.27	41.85-68.16	4.09	39.78±1.18	31.63-52.90	5.27
Potassium (mg/100g)	190.23±3.42	143.39-252.79	3.18	217.96±4.76	159.08-274.15	3.86

Note: quality parameters value calculated on the basis of fresh leaf weight

as percentage of mean for various characters were revealed that carotenoids (64.13%; 58.11%), calcium (40.49%; 45.19%), vitamin C (32.03%; 47.06%), leaf yield per plant (42.20%; 37.78%) and number of leaves per plant (37.10%, 38.81%) had high genetic advance in winter and summer, respectively. Though characters such as plant height, average leaf weight, dry matter content and phosphorous had moderate to high heritability values and their GCV was comparatively less resulting in less genetic advance. This confirms the finding of Burton (1) that GCV together with heritability estimate would give a better picture of genetic advance to be expected from selection. It was clear from Table 2 & 3 that the characters like carotenoids, leaf yield per

Table 2. Estimates of phenotypic, genotypic and environmental coefficient for variation for various characters in lettuce genotypes.

Traits	Phenotypic coefficient variation (%)		Genotypic coefficient variation (%)		Environmental coefficient variation (%)	
	Winter 2006	Summer 2007	Winter 2006	Summer 2007	Winter 2006	Summer 2007
Plant height (cm)	14.72	6.87	13.30	6.09	6.30	3.16
Plant spread (cm)	17.02	9.90	16.09	8.78	5.56	4.56
No. of leaves/ plant	19.07	20.92	18.53	19.85	4.50	6.59
Average leaf weight (g)	16.22	14.79	14.69	13.35	6.89	6.36
Leaf area (cm^2)	16.55	15.45	15.95	14.96	4.43	3.87
Days to first picking	12.84	9.94	8.87	5.27	9.28	8.43
Duration of picking	23.10	18.66	16.11	11.78	16.54	14.47
Leaf yield/ plant (g)	21.40	19.72	20.94	19.01	4.43	5.21
Dry matter content (%)	7.90	9.86	7.50	8.70	2.47	4.65
Vitamin C (mg/100 g)	17.72	24.42	16.60	23.62	6.20	6.20
Carotenoids (mg/100g)	32.36	29.59	31.73	28.89	6.31	6.40
Calcium (mg/100g)	20.68	20.68	20.16	22.34	4.60	4.30
Phosphorus (mg/100g)	13.34	14.21	12.70	13.20	4.09	5.27
Potassium (mg/100g)	15.23	15.89	14.89	15.40	3.18	3.86

Table 3. Estimates of heritability (bs), genetic advance and genetic gain for various characters in lettuce.

Traits	Heritability (bs)		Genetic advance		Genetic gain	
	Winter 2006	Summer 2007	Winter 2006	Summer 2007	Winter 2006	Summer 2007
Plant height (cm)	81.65	78.78	3.90	2.07	24.76	11.14
Plant spread (cm)	89.34	78.73	9.40	5.60	31.33	16.06
No. of leaves/ plant	94.42	90.06	12.15	16.72	37.10	38.81
Average leaf weight (g)	81.97	81.48	2.72	1.99	27.39	24.83
Leaf area (cm^2)	92.82	93.72	70.16	55.89	31.66	29.83
Days to first picking	47.76	28.12	6.39	2.78	12.63	5.76
Duration of picking	48.69	39.87	5.83	4.17	23.16	15.33
Leaf yield/ plant (g)	95.71	93.00	117.05	104.37	42.20	37.78
Dry matter content (%)	90.16	77.76	1.33	1.39	14.67	15.80
Vitamin C (mg/100 g)	87.76	93.76	12.10	15.53	32.03	47.06
Carotenoids (mg/100g)	96.20	95.31	1.67	1.33	64.13	58.11
Calcium (mg/100g)	95.05	96.41	42.09	38.38	40.49	45.19
Phosphorus (mg/100g)	90.60	86.22	13.66	10.04	24.90	25.25
Potassium (mg/100g)	95.63	94.10	57.08	67.14	30.00	30.80

plant, potassium, calcium, number of leaf per plant, leaf area and vitamin possessing high GCV, heritability and genetic advance could be effectively used in selection as it had been suggested by Johnson *et al.* (4), and Ruthbeulah and Veeraragavatha (9) that characters with high heritability coupled with high genetic advance would response to selection better than those with high heritability and low genetic advance. The moderate to high heritability and low genetic advance values observed in other characters namely plant height, average leaf weight, dry matter content and phosphorous indicated that expression of these characters was governed by non additive gene action.

REFERENCES

1. Burton, G.W. 1952. Quantitative inheritance of grasses. Proc. V1th International Grassland Congress **1**: 287-83.
2. Burton, G.W. and Devane, E.H. 1953. Estimation of heritability in tall fescue from replicated clonal material. *Agron. J.* **45**: 478-87.
3. Hanson, C.H., Robinson, H.F; and Comstock, R.E 1956. Biometrical studies of yield in segregating population of Korean Lespedeza. *Agron. J.* **48**: 268-72.
4. Johnson, H.W, Robinson, H.F. and Comstock, R.E 1955. Variability in soybean. *Agron. J.* **46**: 314-18.
5. Khan, S.H. 2007. Genetic divergence and stability analysis for economic traits in kale (*Brassica oleracea* var. acephala), Ph.D. thesis submitted to S.K. University of Agricultural Sciences and Technology of Kashmir, Shalimar. p 225.
6. Kumar, R., Kaushal, S. and Shukla, Y. R. 2010. Variability, correlation and path analysis studies in lettuce. *International J. Vegetable Sci*. **16**: 299-315.
7. Meglic, V., Sustar and Vozlic, J. 2000. Genetic variability of lettuce. *Sodobno-Kanetijstvo (SI-ovenia)* **33**: 215-17.
8. Panse, V.G. and Sukhatme, P.V. 1967. Statistical Method of Agricultural Worker. ICAR, New Delhi.
9. Ruthbeulah, R. and Veeraragavatha, D. 2003. Genetic variability for green yield in amaranthus. *South Indian Hort.* **51**: 173-75.
10. Sharma, J.P. 2002. Crop production technology for cold arid region. Kalyani Publisher, Ludhiana, New Delhi, pp 220-26.
11. Shukla, S., Bhargava, A., Chatterjee, A., Shrivastava, A. and Singh, S.P. 2006. Genotypic variability in vegetable amaranth (*Amaranthus tricolor* L.) for foliage yield and its contributing triats over successive cutting and years. *Euphytica,* **151**: 103-10.
12. Singh, J., Upadhyay, A.K., Prasad, K., Bahadur, A. and Rai, M. 2007. Variability of carotenes, vitamin C, E and phenolics in *Brassica* vegetables. *J. Food Composition and Analysis,* **20**: 106-12.
13. Tamin N.I. and Popova, V.A. 1997. Variability in some characters of lettuce plant. *Tr. VNII-Selektsii-I-Semenovod- ovoshchkulture,* **6**: 66-72.
14. Thakur, M.C., Joshi, A.K., Singh, N.P. and Shukla, Y.R. 1997. Variability studies in heading lettuce (*Lactuca sativa* L.). *Hort. J.* **10**: 43-49.

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