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Genetic variability studies in leaf lettuce under summer season in Solan district of Himachal Pradesh

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Abstract
Lettuce (*Lactuca sativa* L.) is having a significant place in the family Asteraceae, which is broadly developed and devoured around the world. The health promoting properties of leaf lettuce have been credited to minerals, nutrients, vitamins (B_9, C and E) and polyphenols (carotenoids, phenolic acids and flavnoids). In lettuce high amount of phytonutrients is combined with low dietary fats, which makes lettuce an alluring low calorie food. Due to great yield potential and higher health benefit, the area under lettuce is increasing. There is an earnest need to examine the inconstancy in lettuce to recognize explicit genotype for better yield and quality. The success of every breeding programme depends upon the extent of genetic variability in the germplasm and the association of quantitative traits with yield and amongst themselves. The present investigation was carried out on twenty two diverse genotypes of leaf lettuce including standard check cultivar Solan Kriti in a Randomised Complete Block Design (RCBD) with three replications at the Experimental Farm of KVK, Kandaghat during the summer season of 2020, to ascertain the extent of variability, correlation and path coefficient analysis in leaf lettuce for yield and other horticultural traits among the genotypes. High heritability coupled with high genetic gain was recorded for iron content (91.17% and 72.59%) and β carotene content (92.65% and 70.29%), while high estimates of heritability coupled with moderate genetic gain was observed for the traits viz., leaf area (89.62% and 39.03%), calcium content (86.02% and 42.59%) and dry leaf weight (80.10% and 45.81%).

Keywords: Genetic variability studies, leaf lettuce, *Lactuca sativa* L.

Introduction
Lettuce is one of the major leafy vegetables used in salads, soups and occasionally lightly cooked. It belongs to the family Asteraceae and sub family Chicoridae. Lettuce leaves exude milk like sap when cut hence, its name has been derived from the latin word *lactuca* meaning 'milk'. Cultivated lettuce has been derived from the wild or prickly lettuce, *Lactuca serriola* L. Lettuce is also the most used food crop in 'Fourth Range' of vegetables. The term originally meant fresh, cleaned, possibly chopped and mixed vegetables ready to be seasoned and eaten. In world, lettuce and chicory is cultivated over an area of about 1.27 million hectare with the production of 27.25 million tonnes. In India, production of lettuce and chicory is around 1.22 million tonnes over an area of 0.19 million hectare (FAO, 2018).

Leaf lettuce has garnered a central role in human nutrition, as it combines pleasing organoleptic properties with a rich content of nutraceutical compounds (Kim *et al*. 2016) [7]. The health-promoting properties of leaf lettuce have been attributed to minerals, vitamins B_9, C, K. A and E, bioactive terpenoids and polyphenols such as carotenoids, phenolic acids and flavonoids. Lettuce has a high content of phytonutrients combined with a low content of dietary fats, which makes lettuce an attractive low-calorie food, whose consumption is highly suggested within weight-loss dietary plans (Kim *et al*. 2016) [7]. Leaf lettuce also possesses various health benefits. It has anti-inflammatory properties and protects neuronal cells. In India, salad crops are not grown on commercial scale as in the United States and other European countries, where it is being grown by large number of commercial growers.

In India, it is gaining popularity with the change in food habit and health consciousness among the people. There is an increasing demand by consumers for safe and nutritious foods that improves the physical performance, reduces the risk of diseases and increases the life span (Ogden *et al.* 2007) [9]. The nutritional content varies with the degree of leaf colour, green outer leaves having more nutritional value than whitish inner leaves. The regular intake of lettuce helps in lowering high cholesterol level, thereby avoiding cardiovascular diseases. Extracts from *Lactuca virosa* are used as sleep inducers and cough suppressants in Europe

(Ryder 1929) [11].

Mid hills of Himachal Pradesh are a major supplier of solanaceous vegetables i.e. tomato and bell pepper to the plains in summer-rainy season. Intensive cultivation of solanaceous vegetables has resulted in a greater incidence of insects-pests and diseases in the fields of farmers. Hence, leaf lettuce can bring about a diversification in the tomato/bell pepper production system in the summer season. The cultivation of lettuce has already started picking up in Himachal Pradesh and farmers are cultivating lettuce in summers. The produce from hilly areas are available at time when these cannot be grown in the plains due to high temperature, thus bringing lucrative returns to the growers. In spite of such an economic importance of the crop, the work has not been done in leaf lettuce to identify and evaluate the high yielding and superior quality genotypes especially for summer seasons. The role of genetic variability in a crop is of paramount importance in selecting the best genotypes for making rapid improvement in yield and desirable characters as well as to select most potential parents for further breeding programme.

Materials and Methods

The experiment was laid out in Randomized Complete Block Design (RCBD) in three replications. Twenty five plants of each genotype were transplanted at a spacing of 45×30 cm in a plot of 1.80m×1.50 m in the month of February, 2020. Description of lettuce genotypes with sources is given in table 1.The Experimental Farm of Krishi Vigyan Kendra is situated at an elevation of 1425 m above mean sea level with 30.9702° N latitude and 77.1054° E longitude, representing mid hill zone of Himachal Pradesh. The area being in temperate zone of HP has January-February the coldest and May-June the hottest months, in the year. The annual precipitation at Kandaghat generally ranges from 1350-1390 mm. The maximum rainfall occurs from July-September. The soil texture is gravelly loam to gravelly clay loam with pH ranging from 6.85-7.04. The observations were recorded on ten randomly selected plants from each plot on the following traits viz., Days taken to marketable maturity, Leaf colour, Leaf Texture, Fresh leaf weight, Dry leaf weight (g), Leaf length (cm), Leaf breadth (cm), Leaf area (cm^2),Leaf shape, Leaf blistering, Leaf taste, Plant spread (cm), Plant height (cm), Number of leaves per plant, calcium content (mg/100g), Iron content (mg/100g), β carotene content (µg/100g), 1000 seed weight (g), Yield per plant (g). The data recorded on different parameters has been statistically analyzed by using Randomized Complete Block Design (RCBD) given by Gomez and Gomez (1984) [4].

Table 1: List of lettuce genotypes with sources

Sr. No.	EC Number/ Name	Source
1.	KGT-1	YSPUHF, Solan
2.	KGT-3	YSPUHF, Solan
3.	KGT-5	YSPUHF, Solan
4.	KGT-6	YSPUHF, Solan
5.	SBS	CAZRI, Leh
6.	Leh Local Selection	CAZRI, Leh
7.	Revolution Red	SKUAST, Kashmir
8.	Lollo Rosa	SKUAST, Kashmir
9.	Simpson	SKUAST, Kashmir
10.	LS-2 Selection-1	CAZRI, Leh
11.	LS-2 Selection-3	CAZRI, Leh
12.	Lettuce Gentilina	CAZRI, Leh
13.	Lettuce Lob Joits	CAZRI, Leh
14.	Lettuce Red Leaf	SKUAST, Kashmir
15.	Lettuce C1	CAZRI, Leh
16.	Samson Selection-1	SKUAST, Kashmir
17.	Ballmoral	SKUAST, Kashmir
18.	Lettuce Revolution Selection-4	SKUAST, Kashmir
19.	Lettuce Revolution Selection-9	SKUAST, Kashmir
20.	Chinese Yellow	YSPUHF, Solan
21.	LS-2	CAZRI, Leh
22.	Solan Kriti	YSPUHF, Solan

The data recorded on different parameters was statistically analyzed by using Randomized Complete Block Design (RCBD) given by Gomez and Gomez (1984) [4]. The phenotypic and genotypic coefficients of variability were calculated as per formula given by Burton and De Vane (1953) [1].

Results and Discussion

To initiate any breeding programme, information about the genetic variability in the population is a pre requisite. Measurement of genotypic and phenotypic coefficients of variation is useful in detecting the amount of variability present in the germplasm. Presence of high variability offers much scope for improvement and enables the breeders to identify the most potential genotype. As the phenotypic variation is the outcome of genotypic, environmental and interaction between genotypic and environmental variation, so it is not useful in effective selection. For making effective selection, the genetic variation specifically additive genetic variability present in population is used by breeders for improvement of different economic traits. In the present investigation (Table 2), phenotypic coefficients of variability were higher in magnitude than the corresponding genotypic coefficients of variability, though the differences were less in majority of cases thus, indicating that environmental factors have played less influence on the expression of these characters. Similar results were also reported by Kaushal (2009) [6], Thakur (2013) [14] and Shoaib *et al*. (2016) [12].

Highest phenotypic and genotypic coefficients of variability were observed for iron content (38.65% and 36.90%) and β-carotene content (36.83% and 35.45%) in the experiment understudy. Moderate PCV and GCV were recorded for dry leaf weight (27.76% and 24.84%), calcium content (24.03% and 22.29%) and leaf area (21.14% and 20.05%). Low PCV and GCV were recorded for yield per plant (13.07% and 11.69%), leaf breadth (11.62% and 9.71%) leaf length (11.30% and 10.49%), plant height (6.06% and 5.34%), number of leaves per plant (4.49% and 4.39%), plant spread (6.75% and 5.01%), days to marketable maturity (5.76% and 3.53%) and 1000 seeds weight (3.92% and 3.10%).

Heritability is the portion of phenotypic variation which is transmitted from parent to progeny. Higher the heritable variation, greater is the likelihood of fixing the characters selectively. Hence, heritable studies are of foremost importance to judge whether the observed variation for a particular character is due to genotype or due to environment. The estimates of heritability (broad sense) varied from 37.56 to 95.46% (Table 2). It was found high for traits *viz.* number of leaves per plant (95.46%), β carotene content (92.65%), iron content (91.17%), leaf area (89.62%), calcium content (86.02%), fresh leaf weight (87.54%), leaf length (86.32) and dry leaf weight (80.10%) while it was found moderate for yield per plant (79.95%), plant height (77.61%), leaf breadth (69.88%), 1000-seeds weight (62.643%) and plant spread (55.17%) while it was low for days to marketable maturity (37.56%). These results are in consonance with the findings of Gupta *et al.* (2008) [5], Tashi *et al.* (2010) [13], Cassetari *et al.* (2015) [2], Ragheb *et al.* (2015) [10] and Thakur *et al.* (2016) [15].

Johnson *et al*. (1995) stated that heritability estimates together with the genetic advance provide better response during selection than either of the parameters alone. Genetic advance expressed as per cent of population mean (genetic gain) was low to high for various characters studied and ranged from (4.47-72.59%) for different characters under study.It was found high for iron content (72.59%) and β carotene content (70.29%). It was found moderate for calcium content (42.59%), dry leaf weight (45.81%) and leaf area (39.03%), while it was found low for fresh leaf weight (24.07%), yield per plant (21.53%), leaf length (20.09%), leaf breadth (16.32%), plant height (9.69%), number of leaves per plant (8.84%), plant spread (7.67%), 1000-seeds weight (5.07%) and days to marketable maturity (4.46%). Similiar results were also reported by Gupta *et al.* (2008) [5] and Kumar *et al.* (2010) [8].

High heritability coupled with high genetic gain was observed for the traits iron content (91.17% and 72.59%) and β carotene content (92.65% and 70.30%), while, high heritability coupled with moderate genetic gain was found for the traits like leaf area (89.62% and 39.03%), calcium content (86.025% and 42.599%) and dry leaf weight (80.10% and 45.81%) which indicates that these characters were under the strong influence of additive gene action and hence simple selection based on phenotypic performance of these traits would be more effective. High heritability along with low genetic gain was recorded for the characters like fresh leaf weight (87.54% and 24.07%), leaf length (86.32% and 20.095%) and number of leaves per plant (95.46% and 8.84%) while moderate heritability along with moderate genetic gain was observed for the character dry leaf weight (54.68% and 34.85%). Moderate heritability with low genetic gain was observed for the traits like yield per plant (79.95% and 21.53%), leaf breadth (69.88% and 16.32%), plant height (77.61% and 9.69%), plant spread (55.17% and 7.67%) and 1000-seed weight (62.43% and 5.047%) which indicated that these traits are strongly governed by non additive gene effects. Some of these results are in support of the findings of Shoaib *et al.* (2016) [12] and Thakur *et al.* (2016) [15]. The improvement in these traits can be achieved by partitioning the genetic variance further and making selection for suitable types in segregating generations.

Table 2: Estimates of parameters of variability in lettuce (*Lactuca Sativa* L.) for various

Characters	Range	Mean±SE	Phenotypic %	Genotypic %	Heritability %	Genetic Advance	Genetic Gain
Days to marketable maturity	40.42-47.99	43.54±1.620	5.76	3.53	37.56	1.94	4.46
Fresh leaf weight (g)	8.07-12.10	9.796±0.377	13.35	12.49	87.54	2.35	24.07
Dry leaf weight (g)	1.85-5.09	3.34±0.347	27.76	24.84	80.10	1.53	45.81
Leaf length (cm)	16.47-23.19	19.68±0.671	11.30	10.49	86.32	3.95	20.09
Leaf breadth (cm)	10.60-15.12	12.49±0.651	11.62	9.71	69.88	2.09	16.73
Leaf area (cm^2)	153.33-331.05	259.29±14.418	21.14	20.01	89.62	101.21	39.03
Plant spread (cm)	30.43-36.63	32.72±1.209	6.75	5.01	55.17	2.51	7.67
Plant height (cm)	28.56-35.42	31.87±0.746	6.06	5.34	77.61	3.08	9.69
No.of leaves/plant	30.29-34.69	32.60±0.255	4.49	4.39	95.46	2.88	8.84
β carotene content (µg/100g)	1.47-6.04	3.70±0.302	36.83	35.45	92.65	2.60	70.30
Calcium content (mg/100g)	6.63-13.77	9.50±0.697	24.03	22.29	86.02	4.04	42.59
Iron content (mg/100g)	1.13-3.17	1.94±0.182	38.65	36.90	91.17	1.41	72.59
1000-Seed weight (g)	0.857-0.952	0.89±0.018	3.92	3.10	62.43	0.04	5.04
Yield per plant (g)	231.21-420.18	334.47±17.30	13.07	11.69	79.95	72.04	21.53

Conclusion

A wide range of variability and heritability was depicted for the characters viz., dry leaf weight, calcium content, leaf area, iron content and β carotene content. High heritability coupled with high genetic gain was recorded for the traits iron content (91.17% and 72.59%) and β carotene content (92.65% and 70.29%), while high heritability coupled with moderate genetic gain was observed for the traits viz., leaf area (89.62% and 39.03%), calcium content (86.02% and 42.59%) and dry leaf weight (80.10% and 45.81%). Therefore these characters can be improved by selection. Moderate heritability along with low genetic gain was observed for the traits like leaf breadth, plant spread, plant height, 1000-seeds weight and leaf yield per plant. Hence, the improvement in these traits can be achieved by further partitioning the genetic variance and making selection in suitable types in segregating generations.

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