Int.J.Curr.Microbiol.App.Sci (2018) *7*(7): 479-483

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 7 Number 07 (2018)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2018.707.058

Morphological Description and Ecotypic Variability for Germplasm in Sea Buckthorn (*Hippophae salicifolia*D.Don.) Growing Under Higher Himalayan Region

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Keywords

Chamoli, *Hippophae salicifolia*, Sea buckthorn, Variation

Article Info

Accepted:
06 June 2018
Available Online:
10 July 2018

A B S T R A C T

In the present study, morphological traits of growth, fruits and quality were observed in different genotypes of Sea buckthorn growing naturally in Chamoli district of Uttarakhand, India. The mean performance of plant resources was studied and phenotypic characters were evaluated. Mean values for almost all the characters were found higher in genotype CH-41. Different genotypes showed varied morphology from shrub to tree with plant height ranging from 3m to 6m. The canopy width ranged from 2m to 5m. The fruit colour light yellow and yellow were prominent while orange was also observed in few genotypes. Fruits ripened between September and November with profuse to sparse fruit bearing. Among the growth parameters, leaf length ranged from 4mto 8m indicating high variability. Ten genotypes also differed in fruit weight from 2.60 to 4.38 g and similar trend was also observed in fruit length. Biochemical characters were largely dependent on growth characters and also showed remarkable variation in juice percentage and TSS level.

Introduction

Hippophae (commonly known as Sea buckthorn) is an actinorhizal plant having symbiotic association with Frankia. The genus *Hippophae* comprises of seven species. All species are diploid, wind pollinated, and dioecious, and are restricted to the Qinghai Plateau and adjacent areas, with the exception of the species *Hippophae rhamnoides* L. that occurs widely but sporadically in Asia and Europe **(**8). The female plant bears red, orange or yellow berries on two-year-old thorny twigs. Sea buckthorn berries are among the most nutritious of all fruits and have immense medicinal properties. Concentrations of vitamins B_2, B_3, B_5, B_6, B_{12}, C and E are much higher than other fruits such as apricot, banana, mango, orange and peach (7). Sea buckthorn extracts possess antibacterial activities and have shown protective effect against the toxic effect of mustard gas, a chemical warfare agent (10).

Fresh Sea buckthorn berries are rich in nutrients such as carbohydrates, organic acids, amino acids, vitamin C, carotenoids, minerals, vitamin B, vitamin E and vitamin K. The

vitamin content of Sea buckthorn is much higher than any other fruit or vegetable. Because of its high content of vitamin C, Sea buckthorn is usually used to make soft drinks and other similar food products. Seeds contain high quality oil which has many bioactive substances (5). The plant is able to tolerate abiotic stresses like high salt concentration, water, soil nutrient and low temperature stresses etc. under the moist and hostile climatic conditions of dry Himalayas. Other plant parts viz. leaf, stems, seed, bark are also rich in medicinal properties which have been used in traditional system of medication for treatment of various ailments. It is estimated that the age of Sea buckthorn is more than 320 years and it is still bearing fruit. Several studies on physiochemical compounds of sea buckthorn berries have been published in India (4) and China (9). No detailed comparative reports have been published on physiochemical composition of different sea buckthorn genotypes naturally grown in Uttarakhand especially of sea buckthorn growing area in Chamoli region which has a unique geoclimatic conditions of high altitude coupled with extreme variations in temperature.

Thus, present investigation was carried out for evaluation of different genotypes of sea buckthorn from different locations of Chamoli (CH) district in Uttarakhand.

Materials and Methods

The investigation was carried out by using 10 genotype of Sea buckthorn species *salicifolia* from different locations of Chamoli (CH) in Uttarakhand. The genotypes were investigated for morphological and genetic diversity. The mature fruits of *Hippophae salicifolia* were collected from 10 different locations in Chamoli and plant characters were observed. Information about the sampling sites and their locations are given in Table 1.

Morphological characters investigated were plant height (m), plant form, thorniness, immature stem color, canopy width (m), inter branch distance (cm), upper leaf surface (Adaxial side), adaxial leaf surface color, color of the midrib on the adaxial side, leaf tip shape, leaf length (cm), leaf width (cm), leaf pedicel length (mm), fruit color, fruit ripening month, density of fruit bearing, fruit length (mm), fruit width (mm), fruit weight (g), fruit peduncle length (mm), juice percentage, fruit acidity and fruit total soluble solids (TSS). The average values were calculated for each character using different replications.

The fruit characters were observed and seeds were extracted from the berries by squeezing them in muslin cloth. Morphological as well as the genetical investigations were carried out to determine the variability that exists among the different genotypes of Sea buckthorn. The result were subjected to ‘analysis of variance and correlation coefficient’ and tested for significant differences at 5% level of significance.

Results and Discussion

Morphological as well as the genetical investigations were carried out to determine the variability that exists among the different genotypes of Sea buckthorn. The result were subjected to ‘analysis of variance and correlation coefficient’ and tested for significant differences at 5% level of significance. Morphological characters observed in Sea buckthorn plant and fruit are presented in Table 2. Similar results are found regarding to fruit color of yellow and yellow-orange colour with round, spherical, round-oval and round-cylindrical shapes(11).

General mean for the different morphological traits of plant are presented in Table 3. According to the result for leaf characters, leaf length ranges between 4.00 cm - 8.00 cm and mean value is 5.94 cm.

Table.1 Characters of sampling sites

S.No.	Sample No.	Location	Altitude (m)	Longitude	Latitude
1.	**CH – 12**	Jhelam village	2781	30° 38.380	079°49.700
2.	**CH – 13**	Jhelam village	2778	30° 38.312	079°49.725
3.	**CH – 17**	Long tamak river	2442	30°35.701	079°49.700
4.	**CH – 41**	Hanuman chatti	2699	30°40.600	079°30.695
5.	**CH – 43**	Hanuman chatty	2761	30°41.579	079°30.691
6.	**CH - 9**	Jhelamtamak	2784	30°78.718	079°49.812
7.	**CH – 10**	Ghaturi village	2770	30°038.508	079°49.753
8.	**CH – 16**	Long tamak river	2452	30°35.720	079°47.102
9.	**CH – 14**	Jhelam forest nursery	2775	30°38.103	079°49.661
10.	**CH – 15**	Jhelam village	2810	30°38.135	079°49.685

Table.2 Morphological characters observed in Sea buckthorn plants

Characters	CH-12	CH-13	CH-17	CH-41	CH-43	CH-9	CH-10	CH-16	CH-14	CH-15
Plant height (m)	3 – 4	2 – 3	4 – 5	5	5.5	4 – 5	6 – 7	4 – 5	6 - 7	5 – 6
Plant form	Shrub	Shrub	Shrub	Shrub	Shrub	Small tree	Small tree	Small tree	Tree	Tree
Thorniness	Present	Present	Absent	Present	Present	Absent	Absent	Absent	Present	Present
Immature Stem color	Ashy	Silvery	Ashy	Brown	Brown	Silvery	Ashy	Ashy	Silvery	Silvery
Canopy width (m)	2 – 3	2 – 3	3 – 4	4	4 – 5	2 – 3	4 – 5	2 – 3	3 -4	3 – 4
Inter branch distance (cm)	30 – 40	40 – 50	35 - 40	35 – 50	35 – 40	45 – 50	35 – 45	40 – 45	45 - 50	40 – 50
Adaxial side	Smooth	I.M	Smooth	Smooth	I.M	I.M	I.M	Smooth	I.M	I.M
Adaxial leaf surface color	Dark green	Dark Green	Dark green	Dark green	Dark green	Dark green	Dark green	Green	Green	Green
Color of leaf midrib on the abaxial side	G.B	G.B	G.B	Green	Green	G.B	Green	G.B	Green	G.B
Leaf tip shape	Acute	Acute	I.M	Acute	I.M	I.M	Acute	Acute	Acute	I.M
Fruit color	Yellow	L.Y	Orange	L.Y	Yellow	Yellow	Yellow	L.Y	Yellow	L.Y
Fruit ripening month	Oct – Nov	Nov	Sep - Oct	Oct – Nov	Oct – Nov	Oct - Nov	Oct – Nov	Nov	Oct -Nov	Nov
Density of fruit bearing	P	P	S	I.M	P	S	S	I.M	P	P

Table.3 Mean value of different morphological traits for plant characters of Seabuckthorn

S.No.	Character	Range	Mean	S.Em±	C.V
1.	**Leaf length (cm)**	4.00 - 8.00	5.94	0.427	22.769
2.	**Leaf width (cm)**	0.30– 1.50	0.82	0.132	51.032
3.	**Leaf peduncle length (mm)**	0.20 – 0.70	0.33	0.049	47.485
4.	**Fruit length (mm)**	4.02 – 6.91	5.90	0.306	16.400
5.	**Fruit width (mm)**	3.91 – 6.62	5.45	0.278	16.152
6.	**Fruit weight (gm)**	2.60 – 4.38	3.28	0.175	16.939
7.	**Fruit peduncle length (mm)**	0.94 – 3.10	1.69	0.213	39.758
8.	**Juice percentage**	54.34 – 91.00	68.16	3.527	16.365
9.	**Fruit acidity**	3.16 – 4.01	3.51	0.078	07.064
10.	**Fruit total soluble salt**	9.00 – 14.00	11.45	0.761	21.038

Leaf width ranges between 0.30 cm - 1.50 cm and mean value is 0.82cm. Leaf peduncle length ranges between 0.20 mm – 0.70 mm and mean value is 0.33 mm. According to fruit results, fruit length ranges between 4.02 mm - 6.91 mm and mean value is 5.903 mm. Fruit width ranges between 3.91 mm – 6.62 mm and mean value is 5.458 mm. Fruit weight ranges between 2.60 g – 4.38 g and mean value is 3.285. Fruit peduncle length ranges between 0.94 mm – 3.10 mm and mean value ranges between 1.698 mm. The average fruit length varied from 5.0 to 11.0 mm and fruit width ranged from 4.2 – 7.8 mm(3). It have been reported earlier that, berry size varies from 5.38 – 5.42 mm (2). Similar results have been reported by (11) that the fruit length and breadth varied from 5.78 to 7.92 mm and 5.51 to 7.24 mm respectively. It have been reported earlier that, fruit size ranges between 6.17 to 9.87mm in length, 4.16 to 7.86 mm in width(1). The juice percentage, fruit acidity and fruit total soluble solid vary from 54.34 to 91.00, 3.16 to 4.01 and 9.00 to 14.00. It have been reported that juice percentage, fruit acidity and total soluble salt of Sea buckthorn berries varied from 72.9 to 85.0, 1.46 to 3.62 and 8.7 to 13.8 (6).

The pattern of variability in morphological characteristics associated with habitat, plant growth habit, stem, leaf, fruit, flower, seed and biochemical parameters were taken into consideration. Mean values for almost all the characters are found higher in the genotype CH-41. Seed length is found maximum and highly significantly positive at genotypic and phenotypic level with seed form and 100 seed weight, and 100 seed weight show positive and significant correlation with seed width at both genotypic and phenotypic level. Negative and highly significant correlation at genotypic and phenotypic level is found in seed thickness with form of seed cross section. Therefore, it can be noted that genotypes taken for study had wide range of variation for morphological characters, so there is more scope for improvement of these characteristics.

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How to cite this article:

Manisha Negi and Rajani. 2018. Morphological Description and Ecotypic Variability for Germplasm in Sea Buckthorn (*Hippophae salicifolia* D.Don.) Growing Under Higher Himalayan Region. *Int.J.Curr.Microbiol.App.Sci.* 7(07): 479-483.
doi: https://doi.org/10.20546/ijcmas.2018.707.058