DUS characterization of seabuckthorn, *Hippophae salicifolia* D Don

SUMIT NANGLA[1], HARI PAUL SANKHYAN[1] and BHUPENDER DUTT[2]

[1]Department of Tree Improvement and Genetic Resources, [2]Department of Forest Products
College of Forestry, Dr YS Parmar University of Horticulture and Forestry
Nauni, Solan 173230 Himachal Pradesh, India
Email for correspondence: smtnangla@gmail.com

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ABSTRACT

To determine the variation among different populations and growing plants for qualitative characteristics of plant, leaves, thorns, fruits (berries) and seeds, five female plants of *Hippophae salicifolia* D Don at each site were selected at the time of fruit set ie during August-September when males and females could be differentiated. The selected plants were used for the assessment of qualitative variation of *H salicifolia* in Spiti and Baspa valleys of Himachal Pradesh. Variation in qualitative traits of different sites of *H salicifolia* within and between different populations was studied. All the qualitative characters showed significant variation among and between different populations. Based on qualitative characters of populations of different sites, the population of Batseri and Kupa sites were found more promising for growth habit, plant vigour, density of shoot, number of thorns and length of thorns. Due to tremendous variability, the population can be used for future variability approaches and breeding programmes and for preparation of DUS guidelines of this species. It is suggested that for further propagation programmes, gene pools from Sangla should be used and plants planted on wastelands to develop grazing areas for sheep and goats and harvesting of fruits for seabuckthorn value addition chain.

Keywords: Seabuckthorn; qualitative characteristics; genetic variation; DUS guidelines

INTRODUCTION

Seabuckthorn (Genus *Hippophae*) is a berry-bearing, hardy shrub of the family Elaeagnaceae naturally distributed in Asia and Europe and also introduced in north and south America. It includes 4 species (*Hippophae rhamnoides, H salicifolia, H tibetana* and *H neurocarpa*) and 9 sub-species are reported so far from many parts of the world. It is a unique and valuable plant resource currently cultivated in various parts of the world. The natural habitat of seabuckthorn extends widely in China, Mongolia, Russia and most parts of north Europe. It can withstand extreme temperatures from -43 to 40ºC and is considered to be drought resistant. The cold deserts in Himachal Pradesh are found in the districts of Lahaul and Spiti, parts of Kinnaur and Pir Panjal region of Chamba. These areas are characterized by high ridges, difficult terrains with ice field, perpetual snow-covered peaks and hostile climate. Among various indigenous and under exploited plant resources of high mountain area, seabuckthorn (*Hippophae salicifolia* D Don) is one of the best solutions and can certainly metamorph the ecology of cold desert by reclaiming these bare fragile mountains. Willow-leaved seabuckthorn and indigenous source locally Sutz/Sarla offers an opportunity to maintain more sustainable livelihood qualities as well as unique option for the simultaneous management of several problems. It has outstanding qualities such as capability to grow and survive under adverse climatic conditions, extensive root system with soil binding ability, soil stabilization, control of river banks, water retention, nitrogen fixing (60-100 kg/ha/year), higher vitamin C content and economic value of fruit and seed oil, excellent fodder and fuel-wood qualities, wider application in food, cosmetics, beverages, medicines and other pharmaceutical products, excellent fencing hedge and social fencing. Though seabuckthorn is widely found under agroforestry system as well as hazard zones, yet no systematic study has been carried out so far to understand its potential under agroforestry/forestry perspective. It helps to be a valuable tool for land restoration and conservation in the cold desert of the

Lahaul valley (Sankhyan et al 2018). The first pre-requisite step to undertake breeding programme and to obtain improved genetic gain is selection of best populations and best individuals within the populations. Hence present study was undertaken to study variation in qualitative characteristics among and between different populations to select plus trees of *H salicifolia*. Nursery raising, plantation technology, fruit harvesting methodology and other biochemical aspects have been already worked out for *H rhamnoides* but this species is still lacking information, being its restricted and scattered distribution in patches. With this concept and idea in mind, this species has been preferred to work on qualitative parameters so that complete package of practices of this particular species is developed. The study may help in identification of discriminating morphological descriptors to know the extent of variation and variability among populations and within individuals of the populations. Finally, development of morphological descriptors of this species may certainly help in the preparation of DUS guidelines at later stage.

MATERIAL and METHODS

The present investigations were carried out in the fields of Baspa valley of district Kinnaur and Spiti valley of district Lahaul and Spiti as well as in the laboratories of the Department of Tree Improvement and Genetic Resources, Department of Basic Sciences, Department of Environmental Science and Department of Silviculture and Agroforestry, College of Forestry, Dr YS Parmar University of Horticulture and Forestry, Nauni, Solan, Himachal Pradesh during 2018-2020. Baspa valley of Kinnaur and Spiti valley of Lahaul and Spiti districts of Himachal Pradesh were surveyed for the occurrence of *H salicifolia* plant species after proper identification of plants and populations with selecting three natural populations in each valley and from each population five plants were selected, marked and taken for further investigations and recording qualitative characteristics. Experimental sites/ populations were taken viz Kuppa, Batseri, Chitkul of Baspa valley in district Kinnaur and Mane, Shiego and Giu in Spiti valley in district Lahual and Spiti, Himachal Pradesh. Five female plants of *H salicifolia* at each site ie populations were selected at the time of fruit set ie during August-September when males and females could be differentiated. The selected plants were used for the assessment of qualitative variation of *H salicifolia* in Baspa valley of Kinnaur and Spiti valley of Lahaul and Spiti. Leaves and berries were taken and carried to the laboratories for further study of qualitative variation and preparation of morphological descriptors and fodder quality analysis. Altitude of populations ranged from 2,590 to 3,538 m amsl in the study area at different sites of Himachal Pradesh.

Observations on the characteristics were recorded on plant characters like sex, growth type, vigour, density of shoot, position of inflorescence, one-year old shoot thickness, number of thorns per shoot and length of thorn on shoot; leaf characters like leaf blade shape, size, margin ie undulation of margin, green colour and intensity of green colour of upper side and pubescence of the lower side; flower and fruit characters like time of beginning of flowering, time of beginning of fruit ripening, fruit skin colour, shape, pubescence, length of stalk and size (width); seed characters like colour and shape of seed tip from naturally occurring populations and individuals ie within populations (five individuals from each population). The qualitative characters observed and their expression with code/note are given in Table 1.

RESULTS and DISCUSSION

Qualitative characters

Growth habit and plant vigour: The growth habit among the populations studied was found to vary from small tree and shrub (Table 2). The KP3, SP1, SP2, SP3, SP4 and SP5 were shrub types whereas the other genotypes between populations were small tree type. The plant vigour was found to vary from weak, medium and strong. KP3, CP3 and MP1 were having weak plant vigour whereas KP1, KP2, KP4, KP5, BP1, CP4, GP2, GP4, GP5, MP2, MP3, MP4, SP1, SP2, SP3, SP4 and SP5 were medium type. On the other hand, BP2, BP3, BP4, BP5, CP1, CP2, CP5, GP1, GP3 and MP5 had strong plant vigour. From inclusive study, 60 per cent of the populations were found to be small tree type and rest 40 per cent were shrub type; however 56.6 per cent populations had medium vigour, 33.3 per cent had strong and only 10 per cent populations showed weak shoot vigour.

Density of shoot: The character density of shoot showed a wide variation between as well as among populations which varied from sparse, medium to dense (Table 2). The populations KP1, BP4, CP1, CP4, GP1, GP2, GP4, MP1, MP2, MP3, MP4, MP5, SP1, SP2,

Table 1. Observations recorded on qualitative characteristics of seabuckthorn and their expression

Characteristic	State	Code/note	Characteristic	State	Code/note
Plant sex	Female	1	Pubescence of lower side	Weak	1
	Male	2		Medium	2
Plant growth type	Tree	1		Strong	3
	Small tree	2	Fruit size	Small (5.29-6.07 mm)	1
	Shrub	3		Medium (6.07-6.85 mm)	3
Plant vigour	Weak	1		Large (6.85-7.63 mm)	5
	Medium	2	Fruit colour	Yellow	1
	Strong	3		Orange	3
Density of shoot	Sparse (1-7)	1		Red	5
	Medium (7-14)	2		Deep red	7
	Dense (>14)	3		Purple	9
Position of inflorescence	On one-year shoots	1		Other (specify)	99
	Both on one-year and older shoots	2	Fruit shape	Round	3
One-year old shoot thickness	Thin (1-2 mm)	1		Oval	5
	Medium (2.1-4 mm)	3		Long	7
	Thick (>4 mm)	5		Other (specify)	99
Thorniness	Absent (0)	0	Fruit pubescence	Weak	1
	Sparse/few (1-2)	3		Medium	3
	Medium (2-5)	5		Strong	5
	Abundant/dense (>5)	7	Fruit length of stalk	Short (up to 4 mm)	1
Length of thorn	Short (1-8 mm)	1		Medium (4-6 m)	3
	Medium (8-16 mm)	3		Long (>6 mm)	5
	Long (>16 mm)	5	Time of beginning of flowering	March	1
Leaf blade shape	Linear	1		April	3
	Lanceolate	2		May	5
	Ovate	3		Other (specify)	7
Leaf blade size	Small (1-3.82 cm^2)	1	Time of beginning of fruit ripening	August	1
	Medium (3.83-5.85 cm^2)	3		September	3
				October	5
	Large (>5.85 cm^2)	5		Other (specify)	7
Undulation of leaf margin	Absent	1	Seed colour	Light brown	1
	Present	2		Brown	3
Intensity and green colour of upper side	Light green	1		Dark brown	5
	Medium green	2	Seed tip shape	Pointed	1
	Dark green	3		Round	3
	Other (specify)	99		Depressed	5

SP3, SP4 and SP5 showed sparse shoot density whereas KP1, KP2, KP3, BP2, BP3, CP2, CP3, CP5, GP3 had medium shoot density. On the other hand, the populations KP5, BP1 and BP5 showed dense shoot density. Sixty per cent of the populations showed sparse, 30 per cent medium and 10 per cent dense shoot density.

Plant sex and position of inflorescence: All the populations had female type of plant sex (Table 2). On the other hand, the position of inflorescence in 100 per cent populations on one-year old shoot was recorded.

One-year old shoot thickness: The one-year old shoot hickness varied from thin, thick to medium among and between the populations as shown in Table 3. Among all the investigated populations, 30 per cent had thick, 56.6 per cent had medium and 13.3 per cent had thin one-year old shoot thickness. The shoots of populations KP1, MP4, SP4 and SP5 were thin whereas these were medium in populations KP2, KP2, KP3, KP4, KP5, BP2, BP3, BP4, BP5, CP3, CP4, CP5, GP1, GP4, GP5, MP1, MP3 and MP5 and thick in the populations BP1, CP1, CP2, GP2, GP3, MP2, SP1, SP2 and SP3.

Table 2. Variation in morphological descriptors in plant sex, growth habit, plant vigour, density of shoot and position of inflorescence among and between selected seabuckthorn populations

Population	Plant sex	Growth habit	Plant vigour	Density of shoot	Position of inflorescence
KP1	Female	Small tree	Medium	Sparse	On one year old shoot
KP2	Female	Small tree	Medium	Medium	On one year old shoot
KP3	Female	Shrub	Weak	Medium	On one year old shoot
KP4	Female	Small tree	Medium	Medium	On one year old shoot
KP5	Female	Small tree	Medium	Dense	On one year old shoot
BP1	Female	Small tree	Medium	Dense	On one year old shoot
BP2	Female	Small tree	Strong	Medium	On one year old shoot
BP3	Female	Small tree	Strong	Medium	On one year old shoot
BP4	Female	Small tree	Strong	Sparse	On one year old shoot
BP5	Female	Small tree	Strong	Dense	On one year old shoot
CP1	Female	Small tree	Strong	Sparse	On one year old shoot
CP2	Female	Small tree	Strong	Medium	On one year old shoot
CP3	Female	Small tree	Weak	Medium	On one year old shoot
CP4	Female	Small tree	Medium	Sparse	On one year old shoot
CP5	Female	Small tree	Strong	Medium	On one year old shoot
GP1	Female	Small tree	Strong	Sparse	On one year old shoot
GP2	Female	Small tree	Medium	Sparse	On one year old shoot
GP3	Female	Small tree	Strong	Medium	On one year old shoot
GP4	Female	Small tree	Medium	Sparse	On one year old shoot
GP5	Female	Small tree	Medium	Sparse	On one year old shoot
MP1	Female	Small tree	Weak	Sparse	On one year old shoot
MP2	Female	Small tree	Medium	Sparse	On one year old shoot
MP3	Female	Small tree	Medium	Sparse	On one year old shoot
MP4	Female	Small tree	Medium	Sparse	On one year old shoot
MP5	Female	Small tree	Strong	Sparse	On one year old shoot
SP1	Female	Shrub	Medium	Sparse	On one year old shoot
SP2	Female	Shrub	Medium	Sparse	On one year old shoot
SP3	Female	Shrub	Medium	Sparse	On one year old shoot
SP4	Female	Shrub	Medium	Sparse	On one year old shoot
SP5	Female	Shrub	Medium	Sparse	On one year old shoot

K- Kupa, B- Batseri, C- Chitkul, G- Giu, M- Mane, S- Shiego, P- Plant

Table 3. Variation in morphological descriptors of one year old shoot thickness and number and length of thorns among and between selected seabuckthorn populations

Population	One-year old shoot thickness	Number of thorns	Length of thorn	Population	One-year old shoot thickness	Number of thorns	Length of thorn
KP1	Thin	Few	Short	GP1	Medium	Dense	Medium
KP2	Medium	Few	Short	GP2	Thick	Medium	Medium
KP3	Medium	Few	Short	GP3	Thick	Dense	Medium
KP4	Medium	Few	Short	GP4	Medium	Few	Medium
KP5	Medium	Few	Short	GP5	Medium	Medium	Medium
BP1	Thick	Medium	Short	MP1	Medium	Medium	Long
BP2	Medium	Absent	Absent	MP2	Thick	Medium	Long
BP3	Medium	Medium	Short	MP3	Medium	Medium	Long
BP4	Medium	Absent	Absent	MP4	Thin	Medium	Long
BP5	Medium	Absent	Absent	MP5	Medium	Medium	Long
CP1	Thick	Medium	Long	SP1	Thick	Medium	Short
CP2	Thick	Absent	Absent	SP2	Thick	Medium	Short
CP3	Medium	Medium	Medium	SP3	Thick	Medium	Short
CP4	Medium	Medium	Medium	SP4	Thin	Medium	Short
CP5	Medium	Absent	Absent	SP5	Thin	Medium	Short

K- Kupa, B- Batseri, C- Chitkul, G- Giu, M- Mane, S- Shiego, P- Plant

Number of thorns: The range of the number of thorns varied as absent, few, medium and dense (Table 3). It was found that 16.6 per cent of populations showed absence of thorns, 56.6 per cent had medium number of thorns and few thorns were present in 20 per cent of populations. The said character was absent in BP2, BP4, BP5, CP2 and CP5; KP1, KP2, KP3, KP4, KP5 and GP4 had few number of thorns; BP1, BP3, CP1, CP3, CP4, GP2, GP5, MP1, MP2, MP3, MP4, MP5, SP1, SP2, SP3, SP4 and SP5 had medium number of thorns whereas it was dense in GP1 and GP3.

Length of thorns: Length of thorns (Table 3) ranged as short, medium, long and absent. The said character was absent in BP2, BP4, BP5, CP2 and CP5; it was short in KP1, KP2, KP3, KP4, KP5, BP1, BP3, Sp1, SP2, SP3, SP4 and SP5; medium in CP3, CP4, GP1, GP2, GP3, GP4 and GP5 and long in CP1, MP1, MP2, MP3, MP4 and MP5. Forty per cent populations had short and 20 per cent had long length of thorns.

Leaf blade shape, size and undulation of margin: The data on leaf blade shape, size and undulation of margin are given in Table 4. All populations showed linear leaf blade shape. The leaf blade size ranged as small, medium and large. Populations KP2, KP3, KP5, BP1, NP3, BP4, BP5, CP3, CP4, CP5, GP1, GP2, GP3, GP4, GP5, MP1, MP4, MP5, SP1, SP2, SP3, SP4 and SP5 showed small size of leaf blade and in KP1, KP4, BP2, CP2 and MP2 medium leaf blade size was recorded.

The large size leaf blade was noticed in CP1 and MP3. In overall 16.6 per cent populations were with small, 76.7 per cent with medium and 6.6 per cent with large leaf blade size. The undulation of margin was absent in all among and between studied populations.

Green colour intensity and pubescence on the lower side: The green colour intensity was medium, dark green and light yellow-green. In all 73.3 per cent populations showed medium green colour, MP1 showed dark green colour and MP4, MP5, SP1, SP2, SP3, SP4 and SP5 showed light yellow-green colour intensity which accounted for 23.3 per cent of the total populations. The character pubescence on lower side was present in all populations (Table 4).

Fruit size and fruit shape: The character fruit size and fruit shape are detailed in Table 5. The fruit size showed wide variation as small, medium and large. The fruit size was large in populations KP1, GP4, MP1, MP3 and MP4, medium in KP2, KP3, KP4, BP2, BP4, BP5, CP3, CP5, GP1, GP3, GP5, MP2, MP5, SP1 and SP5 and small in KP5, BP1, BP3, CP1, CP2, CP4, GP2, SP2, SP3 and SP4. In total 36.6 per cent had small, 46.6 per cent had medium and 16.6 per cent had large size fruits.

The character fruit shape varied from round to oval. All the studied populations had round fruit shape which accounted for 93.3 per cent of the populations except MP2 and MP3 which had oval fruit shape.

Fruit colour, pubescence and stalk length: The plants showed considerable variation for fruit colour, pubescence and stalk length (Table 5). The fruit colour was yellow-orange, orange-red and orange. The populations KP1, KP2, KP3, KP4, KP5, BP1, BP2, BP3, BP4, BP5, CP1, CP2, CP3, CP4 and CP5 had yellow-orange, GP1, GP2, GP3, GP4, GP5, MP2, MP3, MP4 and MP5 had orange-red and SP1, SP2, SP3, SP4 and SP5 had orange colour fruits. It was found that 53.3 per cent populations were with yellow-orange, 30 per cent with orange-red and rest 16.6 per cent with orange colour of fruits.

The fruit pubescence was recorded weak in all the individuals. The fruit length of stalk was short, medium and long. The short fruit stalk length was observed in populations KP1, SP1, SP2, SP3, SP4 and SP5 and medium in KP2, KP3, KP5, BP1, BP2, BP4, BP5, CP1, CP2, CP3, CP4, CP5, GP1, GP2, GP3 and GP4. In KP4, BP3, GP5, MP1, MP2, MP3, MP4 and MP5 long fruit stalk length was observed. In total 23.3 per cent of populations had short, 53.3 per cent had medium and 23.3 per cent had long fruit stalk length.

Time of beginning of flowering and time of beginning of fruit ripening: The characters, time of beginning of flowering and time of beginning of fruit ripening showed no variations (Table 6) as the flowering began in the month of April-May in all the populations and the fruit ripening began in the month of September in all of them except MP1 and SP1 where it started in the month of October.

Seed colour and shape of seed tip: The seed colour varied from brown to dark brown (Table 7). In all the studied populations, 90 per cent had brown seed colour except MP1, MP2, MP3, MP4 and MP5 which showed

Table 4. Variation in morphological descriptors in leaf blade shape, size, undulation of margin, green colour intensity and pubescence on lower side among and between selected seabuckthorn populations

Population	Leaf blade shape	Leaf blade size	Undulation of margin	Green colour intensity	Pubescence on lower side
KP1	Linear	Medium	Absent	Medium green	Present
KP2	Linear	Small	Absent	Medium green	Present
KP3	Linear	Small	Absent	Medium green	Present
KP4	Linear	Medium	Absent	Medium green	Present
KP5	Linear	Small	Absent	Medium green	Present
BP1	Linear	Small	Absent	Medium green	Present
BP2	Linear	Medium	Absent	Medium green	Present
BP3	Linear	Small	Absent	Medium green	Present
BP4	Linear	Small	Absent	Medium green	Present
BP5	Linear	Small	Absent	Medium green	Present
CP1	Linear	Large	Absent	Medium green	Present
CP2	Linear	Medium	Absent	Medium green	Present
CP3	Linear	Small	Absent	Medium green	Present
CP4	Linear	Small	Absent	Medium green	Present
CP5	Linear	Small	Absent	Medium green	Present
GP1	Linear	Small	Absent	Medium green	Present
GP2	Linear	Small	Absent	Medium green	Present
GP3	Linear	Small	Absent	Medium green	Present
GP4	Linear	Small	Absent	Medium green	Present
GP5	Linear	Small	Absent	Medium green	Present
MP1	Linear	Small	Absent	Dark green	Present
MP2	Linear	Medium	Absent	Medium green	Present
MP3	Linear	Large	Absent	Medium green	Present
MP4	Linear	Small	Absent	Light yellow-green	Present
MP5	Linear	Small	Absent	Light yellow-green	Present
SP1	Linear	Small	Absent	Light yellow-green	Present
SP2	Linear	Small	Absent	Light yellow-green	Present
SP3	Linear	Small	Absent	Light yellow-green	Present
SP4	Linear	Small	Absent	Light yellow-green	Present
SP5	Linear	Small	Absent	Light yellow-green	Present

K- Kupa, B- Batseri, C- Chitkul, G- Giu, M- Mane, S- Shiego, P- Plant

dark brown colour. The shape of seed tip was pointed in all populations.

Similar plant growth habit in seabuckthorn from shrub to tree and plant height up to 6 m was recorded by Yadav et al (2006). Medium to strong tree vigour was reported by Rati and Raducanu (2018). Nawaz et al (2018) also showed dark green colour intensity of leaf on ventral surface than dorsal surface. The linear shape of leaf blade was also reported by Mir et al (2018). In the present study, time of beginning of flowers was April to May in among and between the populations. Similar findings were also reported by Kaushal and Sharma (2012).

Similar variation in colour was also recorded in a study conducted by Nawaz et al (2018) who found strong orange-yellow colour in ripened berries of seabuckthorn. Yadav et al (2006) also reported round to ovate fruit shape. The variations in seed characters are in line with the findings of Mir et al (2018). Kaushal and Sharma (2012) reported that seed colour was greyish brown or dark brown in seabuckthorn.

CONCLUSION

On the basis of qualitative characters, the population of Batseri and Kupa sites were found more promising for growth habit, plant vigour, density of shoot, number of thorns and length of thorns. It is suggested that for further propagation programmes, gene pool from Sangla valley should be used. These characteristics will play important role in preparation of DUS guidelines for *Hippophae saliciflia* D Don.

Table 5. Variation in morphological descriptors in fruit size, fruit shape, fruit colour, fruit pubescence and fruit length of stalk among and between selected seabuckthorn populations

Population	Fruit size	Fruit shape	Fruit colour	Fruit pubescence	Fruit stalk length
KP1	Large	Round	Yellow-orange	Weak	Short
KP2	Medium	Round	Yellow-orange	Weak	Medium
KP3	Medium	Round	Yellow-orange	Weak	Medium
KP4	Medium	Round	Yellow-orange	Weak	Long
KP5	Small	Round	Yellow-orange	Weak	Medium
BP1	Small	Round	Yellow-orange	Weak	Medium
BP2	Medium	Round	Yellow-orange	Weak	Medium
BP3	Small	Round	Yellow-orange	Weak	Long
BP4	Medium	Round	Yellow-orange	Weak	Medium
BP5	Medium	Round	Yellow-orange	Weak	Medium
CP1	Small	Round	Yellow-orange	Weak	Medium
CP2	Small	Round	Yellow-orange	Weak	Medium
CP3	Medium	Round	Yellow-orange	Weak	Medium
CP4	Small	Round	Yellow-orange	Weak	Medium
CP5	Medium	Round	Yellow-orange	Weak	Medium
GP1	Medium	Round	Orange-red	Weak	Medium
GP2	Small	Round	Orange-red	Weak	Medium
GP3	Medium	Round	Orange-red	Weak	Medium
GP4	Large	Round	Orange-red	Weak	Medium
GP5	Medium	Round	Orange-red	Weak	Long
MP1	Large	Round	Yellow-orange	Weak	Long
MP2	Medium	Oval	Orange-red	Weak	Long
MP3	Large	Oval	Orange-red	Weak	Long
MP4	Large	Round	Orange-red	Weak	Long
MP5	Medium	Round	Orange-red	Weak	Long
SP1	Medium	Round	Orange	Weak	Short
SP2	Small	Round	Orange	Weak	Short
SP3	Small	Round	Orange	Weak	Short
SP4	Small	Round	Orange	Weak	Short
SP5	Medium	Round	Orange	Weak	Short

K- Kupa, B- Batseri, C- Chitkul, G- Giu, M- Mane, S- Shiego, P- Plant

Table 6. Variation in morphological descriptors in time of beginning of flowering and fruit ripening among and between selected seabuckthorn populations

Population	Time of beginning of flowering	Time of beginning of fruit ripening	Population	Time of beginning of flowering	Time of beginning of fruit ripening
KP1	April-May	September	GP1	April-May	September
KP2	April-May	September	GP2	April-May	September
KP3	April-May	September	GP3	April-May	September
KP4	April-May	September	GP4	April-May	September
KP5	April-May	September	GP5	April-May	September
BP1	April-May	September	MP1	April-May	September-October
BP2	April-May	September	MP2	April-May	September
BP3	April-May	September	MP3	April-May	September
BP4	April-May	September	MP4	April-May	September
BP5	April-May	September	MP5	April-May	September
CP1	April-May	September	SP1	April-May	September-October
CP2	April-May	September	SP2	April-May	September
CP3	April-May	September	SP3	April-May	September
CP4	April-May	September	SP4	April-May	September
CP5	April-May	September	SP5	April-May	September

K- Kupa, B- Batseri, C- Chitkul, G- Giu, M- Mane, S- Shiego, P- Plant

Table 7. Variation in morphological descriptors in seed colour and shape of seed tip among and between selected seabuckthorn populations

Population	Seed colour	Shape of seed tip	Population	Seed colour	Shape of seed tip
KP1	Brown	Pointed	GP1	Brown	Pointed
KP2	Brown	Pointed	GP2	Brown	Pointed
KP3	Brown	Pointed	GP3	Brown	Pointed
KP4	Brown	Pointed	GP4	Brown	Pointed
KP5	Brown	Pointed	GP5	Brown	Pointed
BP1	Brown	Pointed	MP1	Dark brown	Pointed
BP2	Brown	Pointed	MP2	Dark brown	Pointed
BP3	Brown	Pointed	MP3	Dark brown	Pointed
BP4	Brown	Pointed	MP4	Dark brown	Pointed
BP5	Brown	Pointed	MP5	Dark brown	Pointed
CP1	Brown	Pointed	SP1	Brown	Pointed
CP2	Brown	Pointed	SP2	Brown	Pointed
CP3	Brown	Pointed	SP3	Brown	Pointed
CP4	Brown	Pointed	SP4	Brown	Pointed
CP5	Brown	Pointed	SP5	Brown	Pointed

K- Kupa, B- Batseri, C- Chitkul, G- Giu, M- Mane, S- Shiego, P- Plant

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