International Journal of Science and Research (IJSR)
ISSN: 2319-7064
SJIF (2019): 7.583

Shashi Mountains - An unexplored Major Plant Biodiversity Hotspot of Trans-Himalayan Region of District Kargil (Ladakh)

Abul Qasim[1, 2]

[1]Department of Botany, Panjab University
[2]Defence Institute of High Altitude Research (DIHAR), Defence Research and Developmental Organization
Corresponding author- Abul Qasim - E-mail: *abulqasimmehdavi[at]gmail.com*

Abstract: ***Shashi is a mountainous region in the Kargil district of Ladakh, which is rich in medicinal plants. This paper is concerned with the exploration of the new major biodiversity hotspot of the Trans Himalayan region of district Kargil (Ladakh) and its ethnobotanical study. Among few biodiversity hotspots of Trans Himalayan Ladakh, Shashi mountains are the most important biodiversity hotspot which gives a lifeline to the region in the form of hundreds of medicinal plants having multi-usage like health tonic, a cure for digestive problems, leprosy, liver and kidney problems, cold cough, respiratory problems, etc; besides these, it can also be used asa vegetable, fuel, and fodder. In this research paper, we evaluate 50 genera of 24 families of medicinal plants from the Shashi mountain region. This research aimed to explore the new medicinal hotspot to minimize the stress of overharvesting and documentation of medicinal plants of this region.***

Keywords: Medicinal plant, Shashi Valley, Rhodiola, Trans-Himalayan Ladakh

1. Introduction

Ladakh, the "Land of high-rising passes" is a region directly administered by the central government as union territory since 31 October 2019 when it was separated from the erstwhile state of Jammu and Kashmir. Ladakh is divided into two districts Kargil and Leh. Kargil has the majority of its population practicing Islam while Lehhasa Buddhist majority when it comes to faith. It lies at a latitude of 31˚44'57"-32˚59˚57" in the North and longitude 76˚46'29"- 78˚41'34" in the East, covering a total area of more than 65,000 km^2 [1, 2]. It is bordered by Tibet in the East, Jammu and Kashmir and Gilgit-Baltistan in the West, Himachal Pradesh in the South, and the Karakorum range in the North at an altitude of 3000m- 8000m with habitation up to 5500m. The climate of Ladakh is often categorized as subarctic type marked by dry, hot, and short summers while winters are extremely cold with temperature constantly dipping below the freezing point for almost three months which is also manifested by the presence of second coldest place in the world known as Drass [3]. The summers experience scanty rainfall up to 15 centimeters only occasionally receiving precipitation from the South West monsoon as it falls in the rain shadow area. But in winter, it regularly receives precipitation from the western disturbances as snowfall in Kargil and Leh. Ladakh is the second largest desert in India after the Thar Desert in Rajasthan [4].It has an extremely rugged topography with mountains and valleys dominating the landscape of Kargil, while in Leh sandy plains and deep gorges make a good portion of its total area. Nature(texture) of the soil is classified as grey, light, and arid primarily lacking in humus content which makes it less fertile so Ladakh is confined to scanty vegetation[5]. The vegetation of Ladakh follows the alpine and high alpine zones and it is dominated by perennial and annual herbs followed by a few stunted shrubs and bushes. The growth of vegetation starts with the preceding of snow that marks the beginning of spring and most of the plants reach their reproductive stage in the month of august and almost disappear in October.

As people are getting more and more health-conscious they are increasingly relying on herbal products due totheir therapeutic benefits. Apart from that, plants provide us enormous socio-economic benefits in the form of timber for fuel and house construction, medicine, food, fiber, plant growth regulators, food flavor, and industrial enzymes [6]. The ethnobotanical usage of medicinal plants gained enough consideration in western countries because of the side effect of chemical drugs [7].The consumption of herbal medicine is becoming widespread as well as increased in recent years and for primary health care, 80% of the people are dependent on traditional medicine in developing countries[8,9,10]. The global market for herbal medicine is assumed to be worth the US $800 billion per year[11,12]. India is one of the leading countries in Asia in terms of the wealth of medicinal plants. The Trans Himalayan region of Ladakh is known for its rich biological diversity and is considered as a storehouse for valuable medicinal plants in the country. Above 1,180 vascular plant species were recorded in Ladhak by Klemesand Dickore in their floristic survey of the region [13] and the above-mentioned figure is assumed to bemuch greater than those reported by Kachroo *et al.* 611 plant species [14] and 880 plant species by Kachroo in his newly published volume of the area [15].

2. Study Area

Shashi, a valley stretching for three to four kilometers from North to South is formed by high mountain ranges that run parallel to each other and it is home to many important medicinal plants and these mountains are extensively used for

grazing purpose besides it also offers panoramic views of the valley in-between and a birds-eye view of dozen villages. An artificial lake named Shashi Lake occupies the northernmost part of this valley. The lake is recharged every year by snow melts and rainfalls, considered as the main water source for villages like Sandow, Kharboo, and Samuna. It extends between 34.56˚ N to 34.55˚ N latitudes and 76.64˚ E to 76.38˚ E. The altitude of the location is ranging from 11000ft to 16000ft above sea level. The area of study comes under village Sandow that is 105km from Kargil district.

These days it is attracting a great chunk of people making it a tourist hotspot in the Trans-Himalayan Ladakh under district Kargil for its unique beauty and floral wealth. The high pasturing mountains are bounded by villages from all sides like Lalungin in the North, Karithin in the West, Darchiks and Garkon (Aryan Village) in the East, and Sandow in the South. The climate of the region is the same as the rest of the Ladakh characterized by low precipitation (precipitation mostly occurs in the form of snow), low humidity, solar radiation with high UV, and high wind velocity. These herbs are the source of medicine for the indigenous people of the region but the new generation relies mostly on chemical drugs and is losing the indigenous knowledge of these herbs, as there is the unavailability of any written documentation. Medicinal plants of this region can boost the economy of the area as nature blessed these plants with potential bioactive molecules. The vegetation of the village Sandow near the water stream is dominated by *Salix* sp. *Populus*sp. *Hipphophae*sp, *Myricaria elegans, Rosa webbiana,* and commonly cultivated crops like *Triticumvulgare, Hordeum vulgare, Pisium sativum, Brassica nigra, Raphanus sativus, Allium cepa, and Daccuscarota* however in the high mountain pasturing land is dominated by desert vegetation like *Acantholimon sp*. *Rhodilasp*. *Thymus sp*. And*Bergenia sp*because of extreme dryness, diurnal temperature fluctuation, strong wind, and nutrient-poor soil. There are more than a hundred different plant species in the valley along that region and it also provides shelter for a numerous population of wild animals like Ibex (*Capra ibex*), Blue sheep (*Psedoisnayaur*), wolf (*Canis lupus*),and Snow Leopard (*Panthera unica*). Most of the area is available as grazing land for animals like sheep, goats, cows, donkeys, and horse throughout the summer season. As far as flora is concerned, the area is fully dominated by annual, perennial herbs and shrub of medicinal and commercial value but no research information is available of the **Shashi** high mountainous pasture land to date. In Ladakh certain regions like **Suru valley**, **Sapi village,** and **Nubra Valle**y are considered as important medicinal plant hotspots and a huge amount of medicinal herbs are harvested by local Amchis and indigenous people. The current rate of unchecked plucking, grazing, and lack of cultivation awareness can pose the threat of extinction due to over-harvesting. Considering the importance of herbal products and the demand for Himalayan herbs in the near future, the source of medicinal herbs is very important and it is essential to explore new medicinal hotspots. Therefore, the aim of this study is to offer a new hotspot of medicinal plants considering the number of medicinal plants in the region and their uses for different purposes in the traditional Amchi system of medicine and by the indigenous people. In this paper, few important plants that are used by the local people in Amchi system of medicine are mentioned along with their uses.

Amchi system of medicine in Ladakh

"Tibetan medicine" is known as "Amchi" in Ladakh and in general it is known as Sowa-Rigpa, which is considered as one of the oldest, living ways of medicine in the world. In the Kargil District of Ladakh, the system of medicine is commonly called "Aba". This practice is commonly followed in Tibet, Mongolia, Bhutan,some parts of China, Nepal, the Himalayan Region of India, and few parts of the former Soviet Union [16].In Ladakh, all practitioners of this system of medicine are Budha followers and highly respected, both socially and spiritually by every community in both the region (Kargil and Leh). According to the Four Tantras of Sowa-Rigpa, their principle of treatment is based on Jung-was-Lna (Five elements), and Nespagsum (three humors). All living organisms are formed of five elements as Sa (Earth), Chu (Water), May (Fire), rLung (Air or wind), and Nam-kha (Space) [17].The three humours- rLung (wind), mKris-pa (bile), and Badkhan (phlegm) [18].The origin of a disease is explained by ignorance drawing the person into desire, hatred, and obscuration, which brings imbalance into these three humours. Amchi makes the diagnosis by interview,pulse taking, and urinalysis. The treatment aim is to restore the balance by using diet, behavior, medicinal therapies, and accessory therapies like moxibustion, acupuncture, and surgery. The medicine used by the machines are formulated by the combination of various plants, rarely single plant is used but mostly it is composed of 3-40 plant ingredients.

3. Material and Methods

The area of study has been visited continuously during the period of the flowering and fruiting season in 2018-2019. Plants were collected from different sites of Shashi Mountain like **Shashila**, **Bringbring**, **Brakmundoro**, **Chumikchan**, **Sacer**, **Brakchikopochae,** and many other locations to cover maximum possible sites. Plants were photographed individually and collected, pressed, and made herbarium.

Identification of the medicinal plants were done by using all possible methods. Identification was carried out at DIHARherbarium by comparing the plant sample taken from the study area and the herbarium sheet. Some of them were identified with the help of various diagnostic keysand familiar Trans Himalayan floral published literature especially by Klimes and Dickore, Kachroo *et al.*, Steward, Chaurasia *et al*. During identification various plant taxonomist of the regions were consulted.

The uses and the indigenous knowledge about the medicinal plant species were obtained through questionnaires, direct interviews with the local people by showing pictures and using the vernacular names along this some practitioners also taken to the field during sampling where they narrated the uses of plants. The uses are also revealed from the published literature

on the "Amchi" medicine system. While doing questionnaires and interviews the number of the individual was 70. Out of these 50 were male and 20 were female. The minimum age was 32 and the maximum age was 87.The indigenous knowledge of the medicinal plants is very less to the young generation and females, but the old aged people have good knowledge about the uses of medicinal plant.

4. Result and Discussion

The study reveals that Shashi is the major biodiversity hotspot of trans-Himalayan Ladakh gifted by hundreds of important medicinal plants but less explored because of lack of heed from the concerned authorities and also remains away from the Botanist and herbal researcher. This survey to the valley brings some important medicinal plants for the researchers like *Aconitum heterophyllum, Rhodiola imbricate,Thymus serphyllum, Bergenia strachye*, etc. Several important medicinal plants that are used by the indigenous people of the surroundings are mentioned in the paper are divided into 24 families and 50 genera. Most of the plants are belonging to the Asteraceae family. All plants are collected from the mountains of Shashi at an altitude of 12000 to 16000ft above sea level. Different plants confined to different altitudes like *Cicer sp*. *Atremisia sp*. *Tanacetum sp.Chesneya sp*.etc are easily accessible at a low altitude of 1200 to 13000 ft above sea level, but some species like *Rhodiola sp.*, *Bergenia sp*. *Delphenium sp*. are present at a very high altitudeof 15000ft to 16000 ft above sea level.As we scale the high altitude the plants are tufted and leaves are spiny to protect themselves from the high speedy winds and snowavalanche[18][19].

Table: Ethnobotanical uses of medicinal plants, with their vernacular names and parts used

S.No.	*Botanical name*	*Vernacular name*	*Family*	*Parts used*	*Uses*
01	*Acantholimonlycopodioides* (Girard) Boiss.	Longzae	Plumbaginaceae	Whole plant	Plant ash with milk is considered to be useful in cardiac arrest. The fresh plant is used as fodder and the dried plant is believed to be super fuel.
02	*Aconitum heterophyllum* Wall. ex Royle	Bowakarpo	Ranunculaceae	Root	A root decoction is used for stomachache, intestinal worm, arthritis, body pain, swelling pain, inflammation, lymph fluid disease, gastric problems, vomiting, gout, leprosy, and paralysis.
03	*Aconogonum tortuosum* (D. Don)	Tsenalo	Polygonaceae	Whole plant	Blood purification and painful urination. Used as fodder for an animal in winter when there is no green grass to eat.
04	*Ajaniatibetica*(Hook.f. & Thomson) Tzvelev	Phae-burtsey	Asteraceae	Whole plant	During the end ofthe summer season, it is harvested and allowed to dry. Later it's used as a vegetable in winter when there is a shortage of fresh vegetables by the local inhabitant.
05	*Allium przewalskianum*Regel	skotchay	Alliaceae	Aerial part	Used as an alternative of onion in Ladakh for making special Ladakhi Dish Gangthor. Used to cure dysentery and stomach upset.
06	*Arnebiaeuchroma*(Royle) I.M.Johnst.	Zgremoks	Caryophyllaceae	Roots	The root is used in the treatment of burn areas. The nature of the root is red and it's used to dye nails, hair, and local food on some occasions.
07	*Artemisia maritima*L. ex Hook.f.	Burtse	Asteraceae	Leaves and stem	Skin disease and intestinal worm
08	*Artemisia absinthium*L.	Bos gar	Asteraceae	Whole plant	Used to cure malaria and rheumatism and also protection of clothes from insecticides.
09	*Artemisia brevifolia*Wall. Ex DC	Khampa	Asteraceae	Leaves	Used to cure abdominal worms, aphrodisiac, antiseptic, and also act as a blood purifier. The seed is considered best to cure obesity and also reduce fat from the stomach.
10	*Aster flaccidus*Bunge	Brangrgebs	Asteraceae	Flower and stem	Used in bronchitis cramps, common cold, and cough, fever and also help in relieving pain.
11	*Astragalus mu-nroi Bunge*	Dakchong	Fabaceae	Seed	Increase stamina, strength vitality, and increase immune functions.
12	*Biebersteiniaodora*Stephan ex Fisch	Poonar	Geraniaceae	Flower and leaves	A decoction of a flower is useful in the treatment of migraine and fever.
13	*Bergenia strachyei*(Hook. f. &Thoms) Engl	Shapur	Saxifragaceae	Leaves and roots.	Used for rheumatic, arthritic, and backbone pain, against contagious disease and influenza.
14	*Bistortaaffinis*	GyapoeMentok	Polygonaceae	Leaves and flower	Anti-inflammatory and antipyretic, cough, cold, and tonsillitis.
15	*Chesneyacuneata*(Benth.) Ali	B-gangbo	Fabeaceae	Fruit and root	The fruit is eaten raw. The root is antiseptic.
16	*Chrysanthemum pyrethroides* (Kar. &Kir.) B. Fedtsch.	serpan	Asteraceae	Leaves	Insecticide and mosquito repellent.
17	*Cicermicrophyllum*Benth.	Sari	Fabeaceae	Leaves,	Used to cure jaundice, sore throat, stress, fatigue, and

				flower, and fruit	tongue infection. Act as the best fodder in winter.
18	*Cirsium arvense (L.) Scop*	Zbeangtser	Asteraceae	Leaves	Headache and vomiting
19	*Clematis orientalis L*	rBisho	Ranunculaceae	shoot	Helpful in digestion.
20	*Codonopsisclematidea (Schrenk) C.B.Clarke*	Phaq-phaq	Campanulaceae	Shoot and leaves	Liver and lung problems, chest conjunction, and blood disorder.
21	*Corydalis govaniana*Wall	makshang	Fumariaceae	Root and Leaves	Muscular pain, gastric problems, diuretics, febrifuge, and antipyretic
22	*Cousiniathomsonii*C.B.Clarke	Go- tok	Asteraceae	Shoot and flower	Sprain and arthritis also relieve body pain.
23	*Crepisflexuosa* (Ledeb.) Benth. ex C.B.Clarke	Gulthak	Asteraceae	Whole plant	Fever, backache, urinary problems, and abdominal disorder
24	*Delphinium brunonianum* Royle	Ladar-Mentok	Ranunculaceae	Whole plant	Throat pain, malaria, and colic.
25	*Descurainiasophia (L.)* Webb ex Prantl	khampa	Brassicaceae	shoot	Chickenpox
26	*Echonopscornegerous* DC	Murkak	Asteraceae	Aerial parts	Used to cure a cold and cough. Food poisoning and jaundice. In ancient times it's the best fuel to ignite the fire.
27	*Ephedra gerardiana*Wall. ex Stapf	Tse-phat	Ephedraceae	stem	Used to cure bronchial or respiratory problems in high altitude, rheumatism, and heart stimulant. Ash is used as an alternative to tobacco and kept in the mouth by ancient people.
28	*Epilobiumlatifolium L.*	Shamalolo	Onagraceae	Flower	Used to cure skin diseases like pimples, inflammations, and also used to cure fever.
29	*Geranium wallichianum* D.Don ex Sweet	Spoldo	Geraniaceae	Flowers	Ancient people used to dye their local dress Goncha by boiling the flower.
30	*Heracleum pinnatum* C.B. Clarke	Spesio	Apiaceae	Shoot and root.	Used to cure irregular menstruation, hemorrhage, and abdominal cramps. Besides this, it's also said to cure leprosy, chickenpox, and smallpox.
31	*Hypecoumleptocarpum* Hook. f. & Thomson	parpata	Papaveraceae	Root	Acidity and stomach disorder
32	*Iris lactea*Pall	Tsema	Iridaceae	Flower and stem	Considered a suitable fodder to milking animals.
33	*Juniperousmercopoda*Boiss.	Shukpa	Cupressaceae	Stem and leaves	Used in the treatment of swelling, tumor, wart, colic, and cough and cold. Very best fuel along with that its used as a pillar while construction of houses by the ancient people. The most frequent use of the plant is its leaves are used as incense on many religious occasions.
34	*Lagotiskunawurensis* Rupr	Honglen	Scrophulariaceae	Root	Fever, blood purification, and bile disorder
35	*Lanceatibetica* Hook. F. & Thomson	Spang Ali	Scrophulariaceae	Whole plant	Extract of the whole plant is considered as a tonic, used against pus in the lung,cough. The fruit is used for heart problems and retention of menses.
36	*Leontopodiumhimalayanum* DC	Zima	Asteraceae	Whole plat	Wounds, septic, and headache.
37	*Meconopsisaculeata*Royle	Achak-sermum	Papaveraceae	Whole plant	The whole plant is used to cure ulcers,lung problems, backache, and disorders of the spinal cord.
38	*Nepeta longibracteata*Benth	Piangku	Lamiaceae	Leaves and Flower	It is believed to cure kidney and liver problems, acidity, and stomach complaints.
39	*Oxyriadigyna* (L.) Hill	Gra-Lhachu	Polygonaceae	Leaves and shoot	Gastric problems, appetizer, and indigestion.
40	*Pedicularisoederi*Vahl	Chondol	Scrophulariaceae	Whole plant	Stomachache and migraine
41	*Perovskiaabrotanoides* Kar	Burtsey	Lamiaceae	Leaves and flower	Constipation, burning sensation, cough, and painful urination.
42	*Plantagohimalaica*Pilg	Tharum	Plantaginaceae	shoot	Diarrhea
43	*Rheum spiciforme*Royle	Lhachu	Polygonaceae	Whole plant	Used to cure swellings, wounds, chronic bronchitis, constipation, rheumatism, and piles.
44	*Rheum webbianum*Royle	khakhol	Polygonaceae	Root	Purgative, astringent, and wounds.
45	*Rhodiolaheterodonta* (Hook.f., & Thomson) Boriss.	Shrolo	Crasulaceae		The root is considered to cure a disorder of the lungs, improves physical strength.
46	*Rhodiolaimbricata*Edgew	ShroloKarpo	Crassulaceae	Root	Health tonic and restore memory. can also cure a cold, cough, fever, loss of energy, and pulmonary complaints.

47	*Ribesorientale*Desf.	Askuta	Grossulariaceae	Fruits and stem	The stem is used for the construction of roof and fuel. The fruit is rich in vitamin C and is considered to cure abdominal pain.
48	*Stachystibetica*Vatke	Yakzas	Lamiaceae	shoot	Insecticides, mites, and lice control.
49	*Tanacetum gracile* Hook. F. & Thomson	Serpo-Burtsey	Asteraceae	Leaf and flower	Anti-intestinal worm
50	*Taraxacum officinale* Webb	Shantha	Asteraceae	Leaves and flower	Arthritis, headache, weak immune system, kidney disorder, and painful urination.
51	*Tribulus terrestris*L.	Coocoring	Zygophyllaceae	seeds	Urinary disorder
52	*Trigonellaemodi* Benth	Shamilik	Fabaceae	Leaves and shoot	Fever, anemia, and peptic ulcer.
53	*Thymus serphyllum* Benth	Tumburok	Lamiaceae	Whole plant	Used to cure stomachache, gastrointestinal problems, and also used in pregnancy by women.

5. Conclusion

After examining the Shashi Mountainous region it is concluded that it is rich in highly important medicinal plants and most of the plants are used by the inhabitants of the surrounding area. The studied area needs to explore more for the improvement of the socio-economy of the region. Because it tends upliftment of the socio-economy of the region, as nowadays most of the products are claimed to be herbal and most of the herbal product companies are interested in Himalayan-herbs. The local inhabitants can take plants from the wild and also can cultivate important plants like *Rhodiola*, *Aconitum*, *Thymus*, etc in their fields, and later they can distribute or supply the plants directly to the interested companies.

Future prospective:

This research opens a new research field for the researchers. The region is rich in important plants with medicinal value. The evaluation of phytochemical components of the region is needed in the future as it may contain various novel photychemical components. Another valuable work in the future can be done on the cultivation practices of above mentioned medicinal plants.

Reference

[1] Namtak S, Sharma RC (2018). Medicinal plant resources in Skuru watershed of Karakoram wildlife sanctuary and their uses in traditional medicines system of Ladakh, India. *Int J Complement Alt Med* **11(5):** 294–302
[2] Buth GM, and Navchoo IA (1988). Ethnobotany of Ladakh (India) Plants used in health care. *Journal of ethnobiology***8(2):** 185-194
[3] Basant B, Chaurasia OP, Ahmad Z & Singh S. (2008). Traditional medicinal plants of cold desert Ladakh-used against kidney and urinary disorders. *Ethnopharmacology**118***(2): 331-9.
[4] Juyal N (2014).The high-altitude Indian cold Desert, In book: Landscape and Landforms of India. 115-124
[5] Sharma GK (2002). Medicinal flora of Ladakh (Little Tibet). *Flora and Fauna***1(2):** 105-106.
[6] Abdul H and Raina KA (2014). Ethnobotanical uses of plants in and around Kanji wildlife sanctuary northwest Himalaya. *Journal of international journal of science and research* **3(11)** 538-545
[7] Kala CP (2005). Health traditional of Buddhist community and role Amchis in Trans Himalayan region of India. *Current science* **(89):**1331-1338.
[8] Olsen CS and Larsen HO (2003). Alpine medicinal plant trade and Himalayan mountain livelihood strategies. *The geographical journal***169(3)** : 243-254
[9] Fransworth NR, Akerle O, Bingel AS, Soejarto DD and Guo Z (1985). Medicinal plants in therapy. *Bulletin World health organization***63(6):** 965-981
[10] Dhyani P.P and kala C.P (2005). Current research on medicinal plant; five lesser known but valuable aspects. *Current science***(88):** 335-343
[11] Rajshekhran PE and Ganeshan S (2002). Conservation of medicinal plant biodiversity-an Indianperspective *journal of medicinal and aromatic plant science***(24):** 132-147.
[12] Raven PH (1998). Medicinal plants A global sustainability. *Science and education* 14-18
[13] Klimes L, and Dickore WB(2006) Flora of Ladakh (Jammu and Kashmir, India). A preliminary check list.
[14] Kachroo P, Sapru BL, Dhar U, (1977). Flora of Ladakh; an ecological and taxonomical Appraisal.Shiva printers, Dehradun, India.
[15] Kachroo P (1993).Plant diversity in North west Himalaya a preliminary survey. In: Dhar U, editor. Himalayan biodiversity; Conservation stratagies.Nanital Gyanodya Parakshan; 111-132.
[16] Gurmet P (2004). Sowa-Rigpa Himalayan art of healing. *Indian journal of traditional knowledge* **3(2):** 212-218.
[17] Gurmet P (2005). An introduction to Sowa-Rigpa; Himalayan art of healing. In. Gombu M, Singh Mk, Goyal DM, editior. Sowa-Rigpa; The science of healing. Himalayan Buddhist cultural association, Bela road, Delhi, 281-288.
[18] Chaurasia O P, Ahmad, Ballabh (2007) Ethnobotany and plants of trans-Himalaya, Field research laboratory (DRDO) Leh..
[19] Chaurasia, O.P., and Singh B (1996). Cold desert plants Leh, India: Field research laboratory, DRDO