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Effective Cultivation Aspect of Endangered Medicinal Plant in North Eastern Himalaya

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Abstract—*Medicinal plants offer alternative remedies with tremendous opportunities to generate income, employment and foreign exchange for developing countries. Many traditional especially high altitude temperate himalayan healing herbs and their parts have been shown to have medicinal value and can be used to prevent, alleviate or cure several human diseases. Present study has made an effort in order to explore and document cultivation and conservation aspect of high altitude valuable medicinal plant of Darjeeling hill with special reference to improved cultivation aspect of Swertia chirayita and Valerina Jatamansi. Studies were conducted during the year 2011-2014, under the Regional Research Station (Hill zone) of Uttar Banga Krishi Viswavidyalaya, Kalimpong. Main objective was to know the improved seed germination time of Swertia chirayita, and effect of organic source (FYM @ 2.5, 5.0, 7.5, and 10 tonn/ha; vermicompost @ 1, 2, 3, and 4 tonn/ha) of nutrient on economic yield of Valerina jatamansi. Information related to available medicinal plants in Darjeeling hill, four different region selected, which includes namely, Rimbhik, Lava, Algarah, Rishav, Phalut and Sandhapukh. Further, local people do not know exact time of chirayita sowing, as per our study revealed that first fortnight sowing failed to produce any response at January, February and March due to chilling condition and germination stage was ceased. However sowing in first fortnight of Aprils showed few percentage of germination. Experiment related to Valerina jatamansi , revealed that root and inflorescence length was significantly influenced by incorporation of vermicompost @ 3 tonn/ha, and was at par with the vermicompost @ 4 tonn/ha and FYM @ 7.5 tonn/ha. This treatment also gave more number of secondary inflorescence. Regular field trips to different areas of Darjeeling hills were conducted to know about the distribution pattern of high value medicinal plant in hill. Medicinal plants of this area are highly threatened due to various human related activities like deforestation, habit destruction, unsustainable harvesting of forest products etc. Because of the declining population of species like, Taxus baccata,* Rhododendron arboreum*, Pinus roxburghii, Swertia chirata etc, the area warrants conservation in order to preserve them from extinction. The important medicinal plants which are mainly confined in this part of Himalaya are Swertia chirata, Rubia cordifolia, Astilbe rivularis, Berginia spp, Acorus calamus, Kaempheria rotunda, Costus speciosus, Viscum articulatum, Rhus semialata, Phytolacca acinosa, Litsaea citrata, Drymaria cordata Artemisia vulgaris etc.*

Keywords*: Altitude, conservation, cultivation, medicinal plant, Swertia chirayita, Valeriana jatamansi.*

1. INTRODUCTION

Darjeeling himalaya harbours an enormous biodiversity of medicinal plants that occur right from the humid teesta river valleys to the cold trans-Himalayan desert. Also we have a vast repository of local health traditions and practitioners (*Baidya, Amji, Bongthing, Jhankri*, etc). This biodiversity of medicinal plants and its sustainable utilization sustains the health, medicinal, spiritual and other needs of most of us. High altitude medicinal plant greatly suffer from various kind of stress situation in hill[1]. This diversity of valuable medicinal plant such as *Sausarria lappa*, *Swertia chirayita*, is the treasure house from which future food needs, cures for deadly diseases and elements for knowledge and technology will be found. However, biodiversity is seriously threatened by human activities such as destructive harvesting, loss of habitat or degradation in its quality, leading to extinction of medicinal plants and also resultant dying out of our local traditional practices[2]. There is a need to prepare a detailed action plan to conserve and sustainably use these high value medicinal plants to protect the cultural, scientific, spiritual traditions and innovations related to it, and to equitably share the benefits arising from sustainable use. Darjeeling Himalaya fall under north Eastern Himalayan region in India which is situated between 87°59' - 88°53' E and 28°31' - 27°13' N in the northern part of West Bengal State of India. It has an area of 3,149 sq km. The annual mean maximum temperature is 14.9° C and annual mean minimum temperature is 8.9° C and average annual rainfall is 3092 mm[3]. The altitudinal range of this hilly region varies from 150 to 3636 meter resulting in a huge contrast and diversity in climate and vegetation[4]. The district is surrounded by Bhutan in the east, Nepal in the west and Sikkim of India in the north. Due to similar environmental and cultural conditions, the major inhabitants of Darjeeling hills and its surrounding areas are bonded together by Nepali language, the medium of communication among the different ethnic groups, *viz*. Lepchas, Bhutias, Rai, Sherpa, Tamang, Mangar, Gurung and Kagatay of the Nepali communities[5]. Traditionally, chief occupation of the people of Darjeeling had been agriculture, agro forestry, horticulture and animal husbandry. A wide range of microclimatic sites under a wide

array of climatic zones are available here, that allow growing more luxuriant biota in a proper naturally managed environment. The climates favour the luxuriant growth of diversified floral and faunal elements and make the vegetation as a climatic climax. Therefore, the gradient of this region is also diverse with gentle range of high altitude valuable natural flora. So, the area boosts luxuriant growth of ground vegetation of angiosperms along with different mosses, liverworts, lichens, fungi, algae and cyano-bacteria. The shrubby vegetation of different members aggregate the small patches along the dominant tree species there in a two or three layered canopy system, which have high coverage of litter fall. Not only the coverage of floral elements, there present many endemic, rare, threatened and endangered category. A good number of populates are present there in a remote village nearby and collecting plant material for their home garden. These also found in their homesteads, in crop fields and in communal lands. The exact situation about the position of plant and their uses are still not cleared due to landing a less number of biosocial research projects. So, practice and enumeration regarding the fate of plants of important groups are necessary to clarify the ecological problems in the said area and to draw a managerial line between the source and sink of the plants or the plant products in near future[6]. Darjeeling Himalaya has friendly ecosystem which boosts so many types of floral elements in varied ecosystems. A large number of plant species found here which have significant role to sustain the life-style of Darjeeling peoples in a need based way by different mode. The forests are dominated mostly by local tree species and other common plants *viz. Alnus nepalensis (Utis), Schima waliichii (Chilauney), Mallotus alba (Jogi Malata), M. roxburghianus (Fushrey Malata), Bischofia javanica (Kaijal), Bassia butyraceae (Chewri), Betula alnoides (Saur), Firmiana colorata (Firfiray), Ficus cunia (Khanew), Styrax serrulatum (Khanew), Sterculea villosa (Odal), Cephalostachyum capitatum (Payong), Brassiopsis mitis (Chulatro), Duabanga sonneratioides (Lampatey), Viburnum colebrookianum (Asaray), Cinelina arborea (Khamari), Ficus nemoralis (Dudalo), F. benjamina (Ber), Ficus religiosa (Pipal), Quercus lanceafolia (Katus), Morus indica (Kimbu), Fraxinus paxiana var. sikkimensis (Lakuri), Andromeda villosa (Angeri), Shorea robusta (Sal), Eupatorium cannabinum (Kalo banmara), Costus speciosus (Betlauri), Artemisia vulgaris (Titaypati), Laportea terminalis (Sisno), Heracleum walichii (Chimphing)* etc.[7]. Herbaceous medicinal plants are common one that has the potential for use value round the year in every part of the area. In a study Rai *et al.* (2013) studied 57 plat species belonging to 55 genera with their therapeutic values against different diseases occurring in Darjeeling Hills. They showed that, out of these plants studied, 38 species they used as herbs, 9 shrubs and 10 are trees[8]. They also showed that, herbs are more useful than the shrubs and trees and most of the plant species they used for more than one purpose. If above mentioned species are grown at commercial level in this Darjeeling and Sikkim hill, it will be a good source of income for local people[9]. There is a great scope for socioeconomic improvement of the rural masses through entrepreneurships development in the hilly tracts through judicious use of the medicinal plants found in these regions. This would require generating awareness among the local people and providing them with suitable agro techniques for cultivation of medicinal plants. Therefore, in this communication, an attempt has been made to document the high altitude valuable medicinal plant /along with few valuable plant improved cultivation measures in hilly region of Darjeeling Himalaya.

2. MATERIALS AND METHODS

An experiment was carried out from 2011 to 2014 at Regional Research Station (Hill Zone), under the aegis of Uttar Banga Krishi Viswavidyalaya, Kalimpong (1250 m asl). The study area includes higher hills of Darjeeling facing eastern part of hill and high altitude zone of Kalimpong Block II. Information related to available medicinal plant our focus on present study was mostly confined to Lava (2200 m asl), Rishav (2000 m asl), Rimbhik - Phalut (3000 m asl), Sukhiapokhri and Neora Valley of Darjeeling Himalaya, and part of Sikkim Himalaya includes Changu and its adjoining village area of Baba Dham. During our survey and day to day observation, remote far flung areas covering all the altitudinal ranges as low as Siliguri to the as high as phalut (3400 m asl). Activities included rapid surveys at block level, thematic workshops, interaction with farmer, scientist and other intellectuals at national and regional levels along with the individual experts in collaboration with institutions that synthesized the available information of the region. Two field experiments were conducted consecutively three year, by randomized block design with three replications. In first experiment seed of *Swertia chirayita* showed during first fortnight of January, February, March and April to know about the germination time. In second experiment with *Valerina jatamansi*, nine treatments combinations were tested, which include one control, four FYM levels viz. 2.5, 5.0, 7.5 and 10 , and four vermicompost level viz. 1, 2, 3 and 4 tonn/ha. The experimental data were analyzed statistically by applying the technique of analysis of variance (ANOVA) prescribed for the design to test the significance of overall difference among treatments by the F test and conclusions were drawn at 5 % probability level.

3. RESULT AND DISCUSSION

The soils of high altitude zone are mostly categorized as brown forest soil due to their characteristic reddish brown or brownish colour. This kind of soil is most preferred by *S.chirayita* and*Valeriana jatamansi*.

Table 1: Physico-chemical status of soil sample preferred by high altitude medicinal plant of Darjeeling hill (Average data of 32 selected places).

pH	ECE (mho/cm)	Available (kg/ha)			Total N (%)	Organic C (%)	Organic matter (%)	C/N ratio
		N	P_2O_5	K_2O				
5.4	0.25	278	23.9	241	13.25	2.98	3.09	10.25

A perusal of soil fertility classes suggest that soil of this zone are high in organic carbon and potassium content but deficient in available phosphorous. The soil reaction varies from highly acidic to neutral in nature. About 80% of soil are highly acidic (pH <4.9), 60% of soil are moderately acidic (pH 5.0-5.9) and rest are neutral (pH 6-6.5). The soil is mostly of light textured, highly porous and very low in water holding capacity. The average rainfall varies from 2500-3000 mm of which 80% is received during June to September. Snowfall during January to March is also very common in areas above 2200 m. The average maximum and minimum temperatures recorded round the year was 20º and 2ºC respectively. The temperature in this zone also varies from month to month due to altitude. The relative humidity also varies from 70 to 80% depending on the locality and season of the year. At higher altitudes humidity often causes accumulation of fog and thereby inhibiting the intensity of light

Studies conducted in this region revealed that few of the most valuable medicinal plant in this region, which need intense conservation right now for the future generation. The species of medicinal plants found in the hilly tracts Darjeeling were as follows : *Aconitum ferox, Acorus calamus, Artemisia vulgaris, Astilbe rivularis, Bergenia ciliate, Cephaelis ipecacuanha, Ceritella asiatica Clematis buchanaria Dioscorea composite, Dichroa febrifuga , Drymaria diandra, Digitalis purpurea , Eupatorium cannabinum, Ficus semicordatus, Fraxinus floribunda, Gentiana kurro, Heracleum wallichii, Litsaea cubeba, Nardostachys grandiflora, Oroxylum indicum, Panax pseudo-ginseng, Paederia foetida, Phytolacca acinosa, Picrorhiza kurrooa, Podophylum hexandrum, Przewalskia tangutica, Pteris biaurita, Rheum modi, Rhus semialata, Rumex nepalensis, Swertia chirata, Thysamolaena maxima, Urtica dioica, Viscum articulatum, Valeriana officinalis.*

Our field observation revealed that, Darjeeling range ($87^0$59' - $88^0$53'E and $28^0$31'-$27^0$13'N) was one of the native places of different kind of *Swertia* species. Out of various species, *Swertia chirayita* has long been used in the various treatments. The bitter infusion of the plant is used as a blood purifier, for skin disease and as a bitter tonic for fever and indigestion. The presence of xanthones in the species is reported to remedy tuberculosis. The bitterness, antihelmintic, hypoglycemic and antipyretic properties are attributed to amarogentin (most bitter compound till date). Reckless harvesting from its natural habitat created lot of pressure on their population. The practice of uprooting immature *chirayita* plants grown at their own in forests and farm land, for sale during the last 10 – 12 years, caused to disappear these valuable medicinal plants gradually and this has endangered its existence. As per our survey in Darjeeling hill, revealed that the farmers were interested in growing *chirayita* in their farm lands but they lack technological know how about its cultivation. *Chirayita* is a good income generating cash crop for the hill people[10]. As an item of export, it has high commercial value which is more important than its domestic use for various medicinal purposes. It has been seen that the hill farmers have benefited more by its export. It is said that about nine species of *chirayita* have commercial value but out of the total export the quantity of export of *Swertia chirayita* alone was 90-95%. Its price has also remarkably increased in the last two years. Seed germination is become one of the most important constraints for its mass production[11]. Hill people do not know exact time of its sowing, as per our study revealed that first fortnight sowing failed to produce any response at January, February and March due to chilling condition and germination stage was ceased (Table 3). However sowing in first fortnight of Aprils showed few percentage of germination.

Table 2: List of medicinal plant which has high value in Darjeeling Himalaya

Sl. No.	Scientific name
1	Alsophila costularis Bak
2	Angiopteris evacta Forst
3	Aralia sikkimensis Parry
4	Cinnamomum tamala Nees & Ebern
5	Cinnamomum obtusifolium Nees
6.	Dioscorea deltoidea Wall ex Kunth. Thunb
7	Gloriosa superba Linn
8	Pinus roxburghii Sargent
9	Rauvolfia serpentina (L) Benth ex Kurtz
10	Swertia chirata Buch Ham.
11	Taxus baccata Linn

Table 3: Effect of time of sowing on seed germination of *Swertia chirayity* (pooled data of three years).

Treatments	Germination (%)	Days require for onset of germination	Days required for completion of germination
First fortnight of January	Nil	-	-
First fortnight of February	Nil	-	--
First fortnight of March	Nil	-	-
First fortnight of April	12±6	18	79

First fortnight of May	14±3	22	82
First fortnight of June	9±2	29	74

Valeriana jatamansi is one of the most important medicinal herb of the western to eastern Himalayan grown at an altitude of 1200 - 2000 m[12]. Locally it is being used for medicinal purpose especially for headache and eye trouble. In Ayurvedic medicine, it is used as aromatic, stimulant, carminative, and antispasmodic. It is also used for the treatment of epilepsy and hysteria. Powdered drug, mixed with sugar is used in urinary troubles[13]. A decoction of the drug is reported to be given in Nepal to mothers after parturition, probably as a sedative. Although the economic value of the herb was reportedly unknown to the local people until recent past, the herb has now been widely known for its market potential. Thus, the exploitation of this plant is increasing leading to its rapid decline from its natural habitat in western Himalayan range. Sub-optimal and imbalanced disturbance of soil are the main reasons for low availability of this crop in Darjeeling hills. Rhizome is an item of commerce and is being sold to different trading centres in the region. Crude rhizome is banned to export without processing. Oil is used for perfumery and for other industrial products[3]. Experiment related to *Valerina jatamansi*, revealed that root and inflorescence length was significantly influenced by incorporation of vermicompost @ 3 tonn/ha, and was at par with the vermicompost @ 4 tonn/ha and FYM @ 7.5 tonn/ha. Number of secondary inflorescence was significantly vary with the FYM levels and it was more registered with the FYM @ 7.5 tonn/ha and was at par with the vermicompost @ 4 tonn/ha. Further studied revealed that fresh weight per plot showed different behaviour with various level of FYM and vermicompost application. More economic yield of root was found with the vermicompost @ 4 tonn/ha and showed parity with the FYM @ 10 tonn/h and FYM @ 7.5 tonn/ha. Rhizome yield was more registered with the FYM @ 10 tonn/ha and was at par with the vermicompost @ 4 tonn/ha, vermicompost @ 3 tonn/ha.

Table 4: Growth and economic yield of *Valeriana jatamansi* as influenced by various organic treatments under hill situation of Kalimpong (pooled data of three years).

Treatment	Root length (cm)	Length of inflore-scence (cm)	No. of secondary inflore-scence	Fresh weight per plot (g)	
				Roots	Rhizomes
FYM @ 2.5 tonn/ha	22	23	9	103	60
FYM @ 5 tonn/ha	35	29	19	141	75
FYM @ 7.5 tonn/ha	46	59	21	205	105
FYM @ 10 tonn/ha	39	52	24	230	117
Vermicompost @ 1 tonn/ha	29	40	15	125	74
Vermicompost @ 2tonn/ha	32	45	19	170	83
Vermicompost @ 3 tonn/ha	49	58	25	163	109
Vermicompost @ 4 tonn/ha	45	55	23	242	110
Control	18	33	8	79	43
CD (p=00.05)	4.78	5.98	2.11	13.66	9.87

4. MEDICINAL PLANT GENETIC RESOURCES AND ITS CONSERVATION

Plant genetic resources have made substantial contributions to the domestication, utilization and improvement of high altitude medicinal plants. Collection, characterization and their efficient utilization are keys to efficient management of any kind of genetic resource of medicinal plants. Modern techniques offer the opportunity for collecting, rapid propagation, medium and long-term storage and distribution of germplasm. Complementary strategies are significant for conservation, particularly of medicinal and aromatic plants as we come across a wide spectrum of species with orthodox or recalcitrant or intermediate seed storage behaviour or exclusively vegetatively propagated plants. Collections from different and widely placed areas will greatly enhance the existing collections in gene banks by providing back-ups in case of losses through diseases, insects and environmental stresses and weather changes. The major objectives of conservation programmes are to provide safety against loss of genetic resources and to make these resources available for crop improvement at present and in the future. Each strategy for conservation has to offer relatively greater safety and cost effectiveness. Any useful plant can be considered for conservation but medicinal plants with known biological activities and chemical constituents responsible for such activities if influenced by agro-ecological situations needs to be conserved in ideal situations to avoid loss of essential compounds responsible for biological actions. However, prioritization of species is essential to make full use of any particular strategy with justification. The conservation of the wild medicinal plants or any other such threatened species can be tackled by scientific techniques as well as social actions. There are basically two scientific techniques of conservation of genetic diversity of these plants.

1. Legislation
2. *In-situ* conservation
3. *Ex-situ* conservation

Few of the high value temperate (Coptis teeta, Geranium nepalensis, Panax pseudoginseng, Swertia chirata, Picrorrhiza kurooa, Satyrium nepalensis Rubia cordifolia Taxus baccata, Orchis latifolia) and alpine plant (Aconitum ferox, A. heterophyllum, Podophyllum hexandrum, Delphinium subulatum), which need intense attention, either for in-situ and ex-situ conservation (Mukherjee, 2014). Conservation practice become more easier if farmer know about the propogating part of planting. Medicinal plant which propagate via seed such as Albizia procera, Ophiorhiza mungos, Artemisia maritime Linn., Plantago erosa, Bixa orellana, Bridelia stipularis, Picrorhiza kurrooa, Taxus baccata. Few of the high altitude medicinal plant propagate through some specialized structure, such as Caladium bicolor Vent. (suckers), Potentilla sundaica (suckers) , Alpinia galanga (rhizome), Coptis teeta (rhizome), Dioscorea alata (tubers), Campylandra aurantiaca (bulb) .

5. CONCLUSION

Medicinal plants occupy a vital sector of health care system in Indian hill, and represent a major national resource. The dedicated medicinal plants are used by various tribal's and local people to cure different ailments ranging from simple injuries, wounds, cuts, fever, diarrhoea, ulcers, swelling, bone fractures, potency, antidote, skin care, night blindness, toothache, asthma, cough & cold. Hence, there is an immense need for conservation of diversity of medicinal plant wealth (*Swertia chirayita*, *Valeriana jatamansi* etc.) for the present and fore coming generations, by adapting the suitable strategy with most appropriate method of conservation.

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