HIMALAYAN SILVER BIRCH *(BETULA UTILIS* D. DON*)*: A MULTIPURPOSE AND CRITICALLY ENDANGERED TREE SPECIES FOR BIOPROSPECTION

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ABSTRACT

Betula utilis is a multipurpose, broad leaved deciduous tree and native of the Himalaya region. It is one of the dominant tree species of the Himalayan tree line. In some places, it is also found in association with *Abies pindrow*, *A. spectabilis*, *Prunus cornuta, Acer accuminatum, Sorbus foliolosa, Pinus wallichiana* and *Rhododendron campanulatum*. The bark is the striking feature of *B. utilis* due to its shining, reddish-white or white with white horizontal smooth lenticels. *B. utilis* is a basis of many biochemical compounds which possesses anti-cancerous, anti-HIV, antioxidant, antimicrobial, and anti- fertility activities. The tree species exerts a suppressive effect on the microbial communities of the rhizosphere. Many endophytic structures have been observed in the roots of *B. utilis*. Anthropogenic pressure such as over exploitation, deforestation, overgrazing and natural calamities such as erosion, snow drift, forest fire and landslides are the factors that affect the regeneration of *B. utilis*. The Protected Area Network (PAN) has helped in the *in-situ* conservation of the species. In addition, development of conventional and *in-vitro* propagation protocols and establishment and maintenance of plantlets/seedlings of the species would help in *ex-situ* and *in-situ* conservation of the species.

Keywords: Himalayan silver birch, *Betula utilis*, Bioprospection, Rhizosphere, Anthropogenic pressure, Conservation.

INTRODUCTION

Betula utilis D. Don (common name: Himalayan silver birch, Hindi name: Bhojpatra; Family: Betulaceae) is the broadleaved deciduous angiosperm and native to Himalayan region (Nadakarni 1976). The birch forest is referred as primary vegetation due to being in original and natural state. It consist of three layers; birch trees as the main component (Fig.1 a), scattered conifers, singly or in small groups present in upper story layer (Fig. 1 b), and the under story may be formed by shrubs particularly evergreen *Rhododendron* species namely, *Rhododendron campanulatum*, *R. lapidotum*, *R. anthopogon*, etc (Fig.1 c). This species also forms treeline in the Himalaya due to its freezing tolerance (Zobel *et al.*, 1997). The growth appearance of birch trees is unique due to its typical bent like growth caused by snow weight that forms Krummholz (Fig.1 d). The name *B. utilis* is indicative of its various uses of different plant parts ranging from paper, textile, building construction to medicinal value. However, due to excessive exploitation of its multipurpose use, it is considered as Critically Endangered.

Fig. 1. *Betula utilis* population (a) Pure population (b) mixed population with *Abies pindrow* (c) mixed population with *Rhododendron campanulatum* (d) vent like growth of *Betula utilis* due to snow pressure

Ecology, distribution and economic importance

Himalayan birch is distributed in sub-alpine zone of Himalayan range between 2700m to 4500m (Zobel *et al.*, 1997). It forms treeline all alongside the Indian Himalaya as well as Afghanistan, Bhutan, China, Nepal and Pakistan (Shaw *et al.*, 2014). It is a moderate- sized deciduous tree that grows up to 20 m in height. Bark, the striking feature of the tree, is smooth, shinning and reddish white consists of numerous paper like layers with broad horizontal roll. The leaves are ovate-acuminate, elliptic and irregularly serrate. The flowering season is May–June. The flowers are monoecious; both sexes can be found on the same plant and pollination is carried by wind. The seeds are winged. The plants can grow in acidic, neutral and basic (alkaline) soils and in semi shade and moist soil. Bark, leaves and wood of birch are used in various ways. The bark is sold at good price (150 Rs. / kg to 300 Rs. / kg) in the market. Bark of the tree consisting of numerous paper like layers with broad horizontal roll used to be the substitute for paper in ancient times, mainly, for the inscription of religious texts. Nowadays, the paper like bark is used as packaging material for making umbrella cover, pipes, bandage, cigarette paper, etc., and as textile in the manufacturing of Russian leather in various religious ceremonies (Anonymous 1988). The wood is used as boards and beams for construction of buildings, bridges, rope bridges and fuel (Singh *et al.*, 2000).

Pharmacological properties

The bark is also used in Ayurvedic medicine for the treatment of various diseases like healing of wounds, leprosy, skin infections, bronchitis, convulsions, diseases of the blood and the ear (Chauhan 1999). Many biochemical compositions found in various parts of the tree are used for various pharmacological activities. The major biochemical compound is pentacyclic triterpene which are identified as betulin, lupeol, acetyloheanolic acid, betulitc acid, lupenone, β-sitosterol, methyl betulonate and methyl betulate, while the minor compounds reported are oleanolic acid, ursolic acid and betulinic aldehyde (Kumaraswamy *et al.*, 2008).

Antimicrobial properties

B. utilis is also a source of essential oil, which contains geranic acid, seleneol, linalool, sesquiphellendrene, champacol and 1, 8-cineol, with strong antimicrobial activity against the fungus *Candida albicans* and Gram (+) and Gram (-) human pathogenic bacteria (Pal *et al.*, 2015). The betulinic acid which is easily converted form of betulin also possesses the antibacterial activity against some important human pathogenic bacteria like *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, *Proteus mirabilis*, *Salmonella* sp., *Shigella* sp., *Staphylococcus aureus* and *Streptococcus faecalis* (Kumaraswamy *et al.*, 2008). Dried bark possess antifungal activity against fungi *Aspergillus niger* and *A. flavus* (Sareen *et al.*, 2010), anti-cancerous activity (Mishra *et al.*, 2016), anti-HIV activity (Fujoka *et al.*, 1994). Antimicrobial plants are now being recognized as alternate source of microbe based antibiotics that are well known for the development of drug resistance and the side effects (Pandey *et al.*, 2015).

Fungal outgrowth on Himalayan birch

The fungal outgrowth known as bhurja–granthi, observed in the form of lumps and identified as chaga mushroom (*Inonotus obliquus*), develops symbiotic relationship with birch trees. The symbiotic nature of chaga on birch is due to its healing properties. The damaged part is recovered and healed if a damaged and splintered birch is filled with chaga. The fungus has been reported for its uses in traditional medicine (Chauhan 1999; Faass 2012). It has been consumed by ancient people of China, Korea, Japan, Siberia, Russia and Eastern Europe in daily beverages and therapeutic agents for its cancer curing properties (Faass 2012). It has also been reported for antioxidant compounds (Sun *et al.*, 2008), stimulation of immune response such as activation of chemical messengers such as interleukins and tumor necrosis factor alpha (Won *et al.*, 2011), prevention of breakdown of cell walls (Nakajima *et al.*, 2009).

Microbial dynamics in birch rhizosphere

Himalayan birch has been reported to exert a suppressive effect on the microbial communities in the rhizosphere, mainly with respect to inhibition of bacteria and actinobacteria. This was calculated in terms of R:S (Rhizosphere: Soil) ratios that did not vary much with change in the altitude. Even lower R:S ratios were obtained from the regions where the roots of *B. utilis* and *Rhododendron campanulatum* were found to be entangled (Pandey *et al.*, 2007). A phosphate solubilizing and antagonistic (against pathogenic fungi) bacterium, identified as *Pseudomonas putida*, has been reported from *Betula-Rhododendron* association (Pandey *et al.*, 2006).

Birch roots are also getting attention in our ongoing studies with respect to the colonization of a range of endophytes, mainly bacterial and fungal (Fig. 2). Colonization of internal tissues of the plant (such as birch) by endophytic microorganisms may benefit the host with respect to plant growth, control of various diseases and improvement in the plant's ability to withstand the environmental stress. The rhizosphere of long lived tree species experience the climatic conditions, such as low temperatures and heavy rain and snow fall, and are likely to go through various successions. Higher colonization of endophytes in plant tissues with increasing altitude has been reported recently (Jain *et al.*, 2016).

The rhizosphere microbial communities are affected by many factors, like the quantity and quality of root exudates secreted by a particular plant species, in addition to prevailing edaphic and climatic conditions. These factors, in turn, will give a way to the colonization of the selected microbial communities mainly in the form of endophytes. This aspect needs advance studies in view of understanding the contributions of plant-microbe associations in the establishment of specific biodiversity under a set of biotic and abiotic climatic conditions. Temperature is one of the most important factors that govern the limits of microbial populations under natural environment. The larger part of microbial communities remains unseen and unexplored reservoir of biodiversity on the earth. Microbes perform numerous functions essential for the biosphere that include

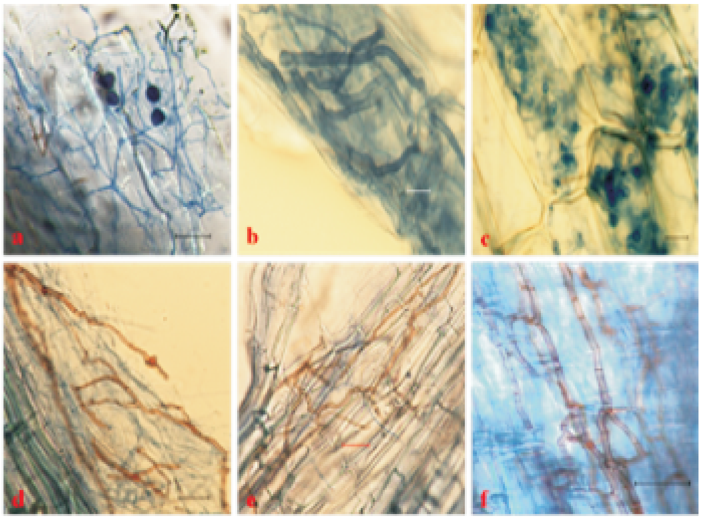

Fig. 2. Endophytes associations in *Betula utilis*
*(*a) Intercellular mycelium (b) Intracellular mycelium
(c) Intracellular spores (d-f) Dark septate mycelium
Bar = 5µm

nutrient recycling, environmental detoxifiers like biodegradation and bioremediation (Bhardwaj *et al.*, 2012). The plant associated endophytes carrying the traits for plant growth promotion and biocontrol are likely to be useful in propagation and conservation of the precious trees that grow under temperature stress (Pandey *et al.*, 2014).

Threats to Himalayan birch

Over exploitation for medicinal and fuel purposes, cutting of trees, overgrazing by all kinds of animals are considered the major threats faced by Himalayan birch. Other threats to birch are forest fire, snow drift, lighting, erosion and landslide. The demographic pressure, increase in demand of land for cultivation, livestock population and defoliation, Canker disease, Dieback due to the slow death of the branches caused by the attack of a pathogen are also the reasons for decline in the size of population of this precious tree. The only way of prevention of these diseases is keeping the tree healthy and wound free in absence of any chemical control. The above mentioned major and minor threats affect the regeneration of the Himalayan birch. Therefore, this species has been categorized as Critically Endangered (Ved *et al.*, 2003). The high altitude protected areas network have helped in the conservation of Himalayan birch, but ex-situ conservation of the species has not been attempted. Therefore, there is a need to develop conventional and *in vitro* propagation protocols, and establish and maintain the seedlings and plantlets in the *in-situ* and *ex-situ* conditions within the distribution range of the species.

CONCLUSION

Himalayan birch is unique species of the high altitude. Due to its religious and high medicinal values, susceptibility towards the climatic condition, no control over the seedling mortality due to fungal attack, lack of regeneration and no clear categorization of the threatened species are the limiting factors towards sustainable utilization of the species which can lead to species loss or extinction in near future. Proper survey and documentation will help in maintaining the growth and exploitation rate equal for the development of the conservation and management strategies. Literature on plant-microbe associations with respect to this high altitude tree is almost negligible and inclusion of studies on this aspect should be a major concern in future studies.

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