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Grewia optiva (Drumm. Ex Burr) - A Multi-Purpose Tree Under Agroforestry in Sub–Tropical Region of Western Himalaya

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ABSTRACT

The paper reveals review study on characteristics of a multi-purpose tree known as Bhimal *(Grewia optiva)* commonly grown under sub-tropical regions of western Himalaya on boundaries of farmers' land. It expresses the common characters of plant, habitat and distribution. A wide spectrum review has been made on its use as fodder for cattle, fiber for ropes, cloths and mats. The review also shows that *G. optiva* is saponin producing tree which is used for shampoo formation for hair wash. A light is also thrown on the status of tree under agroforestry and its impact on under storey agriculture crops, grasses and medicinal plants. Article also reflects volumetric aspect of the tree under rainfed and irrigated conditions. Studies suggest that *G. optiva* may be helpful in fulfilling the gap of demand and supply in case of fodder in sub tropical region of western Himalaya. Besides, being multipurpose tree, it may be a part of small scale industries for production of daily need items like, shampoo, ropes, mats, *etc.* The species should be widely adopted in agroforestry specially, on terraces as it is also has capacity to grow and survive in rainfed conditions. The review study reveals that *G. optiva* is a multipurpose species usually grown naturally on boundaries of farmlands in hilly areas. Keeping its multipurpose use, the species is required its in- situ and ex-situ propagation and also make people aware about its sustainable utilization.

Key Words:

Agroforestry, Farmers, Fiber, Fodder, *Grewia optiva,* Rainfed

INTRODUCTION

Grewia optiva locally Known as Bhimal or Beul is found in sub–tropical zone of Western Himalaya. Fairly well distributed from 500-2500 m in India, Pakistan and Nepal (Semwal et al. 2002). In North-West India, the species is common in the foot-hill and middle-hill regions of Jammu and Kashmir, Himachal Pradesh and Uttarakhand. Rather than in a forest area, it shows its existence on boundaries/terrace risers of farmland (Thakur et al. 2004 and 2005). *G. optiva* is a moderate size deciduous tree species, which belongs to the sub-tropical climate having maximum temperature 38^{0}C and minimum -2^{0}C,

where frost is common during autumn and winter season (Luna 2005). The species is common where annual rainfall varies from 1200 to 2500 mm mainly in the summer season. The tree has a capacity to grow in almost any type of soil but sandy loam with proper moisture is most suitable for its proper growth. Although the tree can grow and survive under rain-fed conditions but tree along with boundaries of irrigated lands grows much better than the tree growing in rain-fed lands. It is a strong light demander and requires complete light for its optimal growth. It can be easily propagated through seeds or cuttings. Its fully mature leaves are a very good fodder for cattle, especially in winter.

G. optiva is a small to medium-sized tree species, 9-12 m in height with a clear bole of 3 to 4 m and spreading crown. A full grown tree is moderate sized with spreading crown, reaching a height up to 12 m with a clear bole of 3-4 m and a girth of about 80 cm. Branches are smooth, pale silvery-brown; bark is dark brown, thick and roughish, exfoliating in small woody scales; blaze rather fibrous, pale yellow, often tinged pink towards the exterior and juice slimy. Leaves are opposite, 5-13 cm x 3-6 cm, ovate, acuminate and closely serrate; teeth are small, blunt; rough and hairy above, pubescent beneath, base rounded, slightly oblique, 3-nerved; petiole 0.3-1 cm long, stout, tomentose; stipules 0.5 cm long, linear subulate, caducous. Flowers are 1-8, together; peduncles solitary, leaves are opposite or exceptionally a few axillary; tomentose and 0.8-1.8 cm long. Sepals are 1-1.5 cm long, linear oblong, 3-ribbed, green outside, white, pale yellow or red inside; petals are white or pale yellow, shorter than the sepals, linear and claw distinct. The tree shades its leaves in March-April and bears new ones appear in April-May. Flowers appear with the new flush of leaves in April-May and soon after produce fruits. The fruits attain full size by September, ripening between October and December depending on climatic conditions of the locality. The immature fruit is olive green in color, turns black on ripening. Fruits are much liked by birds, the major dispersal agents. The fruits are borne on previous year's shoots. Fruit is a drupe, 1-4 lobed, each lobe about 0.8 cm in diameter, olive green then black in colour when ripe (Orawa et al 2009).

Bhimal is a wonder tree having many qualities which make it valuable for the local community. Leaves of the tree are very good fodder, the soft bark contains saponin which is used in shampoo and conditioner for hair wash (Luna 2005). The rich fiber of the bark hardens and then drenched bark is used to make strong ropes, Kurna (backpacks) and Kandi (baskets), bags, purses, chappals, mats, wall hangings, etc. Bhimal based feeding packages for goat production have been reported suitable, sustainable and beneficial to the farmers of mid and far Western hill region of Nepal (Pandey et al 2017). According to Sehgal et al. (2003) the species is one of the most important fodder trees of North-Western and central Himalaya and is found distributed throughout sub-Himalayan tract. The timber is used for shafts, shoulder poles, cot frames, paddles, tools, and axe handles. Its soft branches are used for making baskets (Gill et al. 2016). Overall, *G. optiva* is an important agroforestry species primarily grown for green fodder, fibre and small timber in the North-West Himalaya.

BHIMAL BASED AGROFORESTRY

Agroforestry is very common practices in the Central-Western Himalayan region of Uttarakhand. Trees under Agroforestry are deliberately retained/grown by the farmers in order to fulfill their multifarious need namely; fodder, fuel, fibre, fruits and small timber along with the agricultural produce. The story does not finish here with profits; there are some harmful aspect of the presence of trees like antagonism for light, water and nutrients between trees and crops which generally lower down the productivity of agricultural crops. For this, productivity assessment of agricultural crops in existing agri-horti-silviculture system with presence of G. optiva in the mid-hills of this region was done by Bijalwan

(2011). The findings showed that *G. optiva* was predominant tree species in the Northern and Southern aspect. He has reported, a reduction in both grain and biological yield of agricultural produces. Similarly, in mid hills of Himachal Pradesh, as many as 167, 33 and 533 trees/ha (of all ages) with importance value index (IVI) of 32.69, 9.91 and 53.64 under traditional agri-silviculture, silvi-pasture and horti-silvipasture systems, respectively, have been reported being deliberately retained/grown by farmers due its multipurpose nature (Thakur et al. 2004). Another study in same region reports *G. optiva* as one of the dominant tree under agri-silviculture with IVI of 101.55, second most encountered in silvi-pasture (IVI=75.30) and co-dominant in pastoral-silvi-horticulture system (Thakur et al. 2005).

As multipurpose tree species in agroforestry plantation, *G. optiva* is considered by many scientists as one of the most important tree species in Uttarakhand (Toky 1989; Tewari et al. 2007). *G. optiva* and fruit tree based traditional agri-horti-silvicultural model in mid elevations of the western Himalayas has been found to be sound and more ecologically than either agricultural monoculture or agri-horti-cultural systems (Toky, 1989). It is artificially propagated by seedlings or stumps. Seedlings are planted on farm bunds or terrace risers at spacing of 8m as a single row or in clumps around homesteads. In the sub–tropical zone, the number of trees/household varies (12-129) depending upon size of landholding. The general trend is that farmers with smaller landholdings plant or retain a larger number of trees than those of larger land holdings. The trees are lopped during winter when no other fodder or grass is available. *G. optiva* and other fodder tree models seem to be sustainable with low application of inputs. These species are native to the region. Although very few systematic studies have been conducted regarding the economics of *G. optiva* and other fodder species grown in different agroforestry models under rain-fed conditions, centuries-old uses of these models justifies their profitability (Azene 2007).

The traditional agroforestry practices are practiced by the local community since time immemorial. *G. optiva,* being a multipurpose tree species, is widely preferred in agroforestry systems in Garhwal Himalayan region of India. About 2/3rd of the cultivated area of Garhwal Himalayas is rain-fed and wheat is predominant crop cultivated on sloppy terraces in combination with *G. optiva* on terrace bunds. This wonder tree of western Himalaya, abundantly grown on the farmers' field under traditional agroforestry along with most of the agricultural crops like wheat, barley etc. The *G. optiva* based combination is commonly adopted by the local people. Farmers maintain trees of *G. optiva* on risers of terrace fields which is an age old common practice, seen in the hilly landscape. The importance of this tree species with other crop combinations is highly supported by Bijalwan et al. (2014).

In North-Western Himalaya, small and marginal farmers maintain livestock and traditional farming practices mainly for earning their livelihood. Since the hill farmers cannot afford to allocate their lands for fodder crops due to small land holdings and therefore, they depend mainly on multipurpose tree species for quality green fodder, fiber and fuel requirement. *G. optiva* is the most important and established multipurpose tree species in agroforestry practices. The species is considered as a boon for the region by several workers (Nautiyal et al. 1998, Bhatt and Pathak 2003, Bijalwan and Dobriyal 2007). Retaining large trees of *G. optiva* on farmland mainly for fodder and timber form integral parts of rural farmer community. While evaluating the effects of *G. optiva* trees planted on farm boundaries under rain-fed condition, Khybri et al. (1983) reported a more pronounced effect of boundary trees on winter wheat crop than on a rainy season crop of rice, perhaps due to the limitation of moisture availability during the winter season. Further, a study on tree-crop interaction for 13 years from 1977-1990 on (Khybri et al. (1992) tree crop interaction among

G. optiva, M. alba and Eucalyptus with paddy and wheat was conducted in Doon valley reported that all the tree species had depressing effect on the crop yield including *G. optiva*. In the findings, the species produced 1.09 t $ha^{-1}yr^{-1}$ of branch wood and 0.26 t ha^{-1} yr^{-1} of leaves. Least soil moisture was reported under Eucalyptus followed by *G. optiva* when grown with paddy and wheat. This was due to the fact that leaves of *G. optiva* remain green during growth period of wheat. In Himachal Pradesh mid hills, under *G. optiva* based agri-horti-silviculture (200 *G. optiva* trees/ha) and agri-silviculture (1000 *G. optiva* trees/ha)) systems with components as Peach+*G.optiva*+setaria +*Withania somnifera/Mcuna pruriens/Ocimum sanctum, G. optiva*+*setaria*+*Withania somnifera* / *Mcuna pruriens/Ocimum sanctum, G. optiva* (3-4 year old, pollarded at 1.5 m above ground) has been reported to provide green fodder ranging from 4.55 to 5.83 and branch wood 5.33 to 5.57 under former system and 7.40 to 11.40 and 9.20 to 11.20 q/ha under later agroforestry system (Verma and Thakur 2010 & 2011; Thakur and Verma 2012).

Biological and ecological characteristics of *G. optiva* with information on its multipurpose uses was given by Joshi and Narain (1992). They provided a detail on the nutritive value of lopped fodder, bark yield and wood uses. According to the study, this species can be grown with both; crops and grasses. By analyzing growth of tree species and combination crops namely; gorda grass (*Chrysopogon fulvus*) and bhabar grass (*Eulaliopsis binata*), the experiment established a better tree growth with gorda grass (*C. fulvus*); a less vigorously growing species. Considering its benefits, Prasad and Arya (1997) mentioned Grewia+crop as an example of traditional agroforestry practices in Himalayan zone of India. Later, Bisht et al. (2000) studied performance of ginger and turmeric under 10 year old *G. optiva* and *Bauhinia variegata*. The finding had shown that yield of turmeric and ginger was affected significantly with these fodder trees. They also reported highest forage yield from B. variegata.

Highlighting economics of *G. optiva* based agroforestry, Rana et al. (2000) did benefit-cost analysis of agroforestry trees including *G. optiva* in eroded soils in district Una, H.P. The results indicated that *G. optiva* being popular and useful fodder species of the area, yielded the highest NPV (Rs. 11,644) followed by *Dalbergia sissoo* (Rs. 5,611). However *G. optiva*, produced a lesser B:C ratio (2.35:1) compare to *D. sissoo* (2.59:1). In another study, an agrisilviculture system (*Triticum aestivum* and *G. optiva*) was established by Verma et al. (2002) in mid hills of Himachal Pradesh (Western Himalayan region) and it was reported that integration of *G. optiva* (tree density 666 trees/ha) pollarded at 1 meter height with wheat crop reduced wheat grain yield by 24%. They also reported an additional financial return of INR 2500 from *G. optiva* leaf and fuel-wood/ha.

Concentrating upon tree-crop interaction, Kaushal and Verma (2003) studied above and below ground interaction between *G. optiva* and wheat based agroforestry planted at different spacing towards the outer canopy of single scattered tree of Grewia. They found that growth and yield of wheat crop was influenced negatively below the tree crown, while it was increased with an increase in distance from the tree trunk. Further, *G. optiva* did not pose any competition to wheat for light at sowing and tillering. However, at panicle initiation, milking and harvesting of wheat, light was reduced considerably below *G. optiva*. The study concluded that *G. optiva* based agroforestry system creates competition for light, nutrient and moisture. In 2005, they further studied influence of *G. optiva* with Soybean intercrop, when planted in rows with emphasis on distance, plant height, number of plant/ha and number of branches/plant. A significant variation was recorded among different tree crop combinations as compare to sole crop, which was probably die due to competition for light, moisture and nutrients. Also, a higher yield of Soybean was recorded with *G. optiva* as compare to Morus alba.

G. optiva is an early succession species, which gains better height and diameter by exploiting the high light regime for growth. Experiments were conducted by Bijalwan and Dobriyal (2014) on productivity of wheat as intercrop under *G. optiva* based traditional agroforestry systems in Garhwal Himalaya. In findings, a drastic reduction in grain yield was reported by them. The study noticed decreased yield with increase of diameter and crown spread. However, evidence of winter lopping in *G. optiva* sometimes played a positive role in penetration of sunlight to the underlying wheat crop.

Patheria et al. (2003) mentioned Grewia spp. and Bauhinia spp. under agri-silviculture system of agroforestry predominant in Himalayan region. Bhatt et al. (2010) enlisted some major multipurpose tree species in Western Himalaya, Uttarakhand. The list included different species of Grewia like *G. asiatica, G. eriocarpa* and *G. oppositifilia* and Bauhinia spp. like *B. vahlii, B. racemosa, B, semla, B. variegata* and *B. purpurea*. Orwa et al. (2009) evaluated yield value of Bhimal (*G. optiva*). Their findings reported Bhimal yield as 11 ton/ha from 2 year old plants and the green fodder from mature trees was reported to be 12-30 kg. Gupta and Arora (2015) also elaborated these two species as major fodder tree species in the Himalayan region of India.

Investigations on the effect of tree-crop combinations (Peach+ *G.optiva*+Setaria+*W. somnifera*/*M. pruriens*/*O. sanctum* and *G. optiva*+*Setaria*+*W. somnifera*/*M. pruriens*/*O. sanctum)* and nitrogen on medicinal and aromatic plants as intercrops with *G. optiva* tree density of 200 to 1000 trees/ha in mid hills of Himachal Pradesh suggested that different tree-crop combinations had no significant effect on growth, economic yield and active principles (withanolides in *W. somnifera,* L-DOPA content in *M. pruriens* and essential oil yield in *O. sanctum*) but it was influenced significantly by application of Nitrogen (Verma et al. 2010; Thakur et al. 2011; Thakur et al. 2014; Thakur et al. 2015).

The interaction between tree-crop combinations was statistically non-significant. These combinations also did not bear any significant effect on above and below ground biomass yield. The reported variation in fodder, fuel wood, and grass production in tree-crop combinations was due to the difference in the magnitude of each component in respective combinations.

Mehta et al. (2015) monitored performance of three best provenances (Bhaintan, Chamba and Malas) of Bhimal planted on farmers field terrace at four locations comprising middle hill and valley locations lying in Tehri and Dehradun District of Uttarakhand. The study also analyzed the effects of these provenances on field crops. A reduction in the yield of the field crop was reported more towards tree canopy.

There are various multipurpose trees that are deliberately retained by the farmers on their agricultural fields, yet *G. optiva* being a multipurpose species is widely preferred in agroforestry systems as mentioned earlier by Rana et al. (2016) who studied floristic structure, composition and functional characteristics of home gardens and reported *G. optiva* as one of the major dominant tree species in home gardens in Garhwal Region, Uttarakhand.

Adding to its yield aspect, Mehta et al. (2008) documented high yielding provenances of Grewia spp. for North- Western Himalaya lying in Uttarakhand and Himachal Pradesh. Providing a detail on planting techniques, medicinal and other uses, they elaborated productivity and economics of this tree species. The average productivity green fodder, dry fodder and bark fiber was found between 131.77 to 135.7 kg for all three studied provenances which confirmed potential for fodder productivity to cover the north western Himalaya up to middle elevations in farm forestry. Exploring its nutritional content, Sankhyn and Bhagta, (2016) studied fodder quality and nutritional value from *G. optiva*. According to the findings, *G. optiva* contained 17.35-21% crude protein, 17-21.51% crude fiber and 10.42-21.50% total ash which established a high nutrient value of this tree species.

CONCLUSION

Bhimal (*G. optiva*) is an important tree under agroforestry practices in sub – tropical zone of western Himalaya. It is a multi-purpose tree which provides fodder, fiber and timber. The tree also provides raw material for shampoo and hair conditioner. The review gives an overview on cultivation of this species, its suitability in rain-fed agroforestry, its nutritive value of fodder content, suitable crops to be cultivated under this species and its wider applicability to those areas where socio-economic and agro-climatic conditions create a challenge before farmers. From this review however, it is understood that some gaps have been there in *G. optiva* based agroforestry studies. For example, compatibility of this species with agricultural crops, its relative economic viability to those areas where other agroforestry species are also prevailing such as Poplar and Eucalyptus and its wider suitability to major agroforestry systems and practices such as agri-silviculture and silvi-pastoral. Hence, to achieve successful agroforestry development in rain-fed areas, several steps should be considered while developing *G. optiva* based regional agroforestry models. The main focus should be given to selection of area and farming communities to encourage their participation at every stage of the programmes related to model development. For this purpose the present review of literature recommends that an approach to farmers and extension strategies as the most important element for a successful agroforestry model development. Besides this, in order to develop potential models for agroforestry, implementing agencies should be taken into account the existing farming systems, policy issues and the management option of government and private ownership there.

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