Management of bhimal (Grewia optiva) planted on terraced field bunds in North Western Himalayas

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In the Himalaya region animal population is high (214.51 lakhs) when compared to land resources available. As such the region is facing shortage of fodder round the year which becomes acute during winter season. Due to continuous increase in human population, there is a great pressure for cultivation of food and cash crops on these lands. Further, the cultivation of fodder crops on arable lands is restricted due to very small holdings. At present the forage production can be increased from the area which is not suitable for sustainable agricultural production, i.e., wastelands. Introduction of fodder trees can increase the productivity of these lands. This provides us an opportunity to exploit such lands for production of forage and fuel yield. Introduction of fodder trees can increase the productivity of these lands which can supply fodder during winter months. Several trees are recommended for the cultivation on these lands (Bisht et al. 1999 and Masoodi et al. 2003). Bhimal (Grewia optiva L.) is an important tree which provides nutritious fodder during winter months (Bisht et al. 2000, Bisht et al. 2004, Bisht et al. 2005 and Singh et al. 2004) and can be grown on wastelands and cultivated along agricultural fields (Bisht et al. 1998).

Fodder obtained from bhimal is much relished by animals and it is rich in protein and other materials (Singh et al. 2004, Singh and Sahoo 2004). Consequently, the trees are heavily lopped during winter months when green fodder is scarce. Cutting management is very important for the tree growing along the cultivated fields. The faster primary growth of plants can be used for optimizing biomass yields by cutting them regularly to enhance its fodder production. Therefore, the present experiment was designed to study the effect of cutting methods on the green and dry fodder, fuel wood and protein content and yield of bhimal grown along the cultivated terraces.

A field experiment was carried out from 1993 to 2002 at the research farm, Hawalbag of Vivekananda Parvatiya Krishi Anusandhan Sanshan, Almora, Uttarakhand, India. The site was located at 29°36' N longitude and 79°40' latitude at an elevation of 1 250 m above mean sea level. The climate of this region is sub-temperate. The average maximum temperature ranges from 17.6°C in January to 31.5°C in May and the average minimum from 0.2°C in December to 21.7°C in July. The average annual rainfall over a period of 10 years was 1 030.9 mm with 92.7 rainy days. About 67% of rainfall was received during June to September. The vegetative growth in most of the plants in hills takes place during the hot and rainy period, i.e., from May to September. April and May are having maximum moisture stress. Plant growth remains static from November to February due to low temperature.

The soil was silty loam soil with 25% silt and 56% sand having pH of 7. The soil contains high organic C (1.25%) low available N (225 kg/ha), medium P (15 kg/ha) and K (123.0 kg/ha). Experiment was carried out by planting the bhimal plants along the side of cultivated field terraces. The plant-to-plant distance was kept at 2 m. The experiment was conducted in randomized block design with 4 replications. Four cutting management treatments were imposed, i.e., (T1) Pollarding (tree cut back nearly to the trunk so as to produce a dense mass of branches) tree at 2 m height, (T2) Pollarding tree at 2 m height leaving main shoot intact (T3) local (removals of leaves and tender twigs at random just above the branches) and (T4) coppicing (whole tree was cutoﬀ close to ground level). The cutting treatments were applied on 8-year-old plants. At this time the trees were 2 to 3 m height. Cutting treatments to plant were imposed every year in December when other green forage is scarce in hills. Data on green and dry forage, fuel, protein yield and crude protein content were recorded every year.

These data were analyzed using standard analysis of variance techniques in randomized block design. Statistical analysis for the individual year for different parameters was done (Gomez and Gomez 1976). The mean effect of treatment variables was compared at 0.05 level of significance, nitrogen content of the leaves was estimated by microkjeldhal method (Jackson 1967). The crude protein content was calculated by multiplying leaf N with the factor 6.25. Dry matter yield was determined by sub sampling methods. One kg of green forage from each treatment was taken for the same. These samples were dried at 70°C, ±1°C for 48 hr in hot air oven until it attains constant weight and then dry weight was recorded. The crude protein yield was calculated by multiplying the crude protein...
Table 1: Effect of different cutting management on the green forage dry matter, fuel crude protein yield of bhimal plantation

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Green forage yield (kg/tree)</th>
<th>Fuel yield (kg/ha)</th>
<th>Dry matter yield (kg/ha)</th>
<th>Crude protein yield (kg/ha/tree)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₃, Local</td>
<td>9.73</td>
<td>9.00</td>
<td>10.55</td>
<td>8.60</td>
</tr>
<tr>
<td>T₄, Coppicing</td>
<td>11.87</td>
<td>14.67</td>
<td>16.79</td>
<td>9.95</td>
</tr>
<tr>
<td>CD (P=0.05)</td>
<td>NS</td>
<td>4.00</td>
<td>1.13</td>
<td>1.54</td>
</tr>
</tbody>
</table>

**Dry matter yield (kg/ha):**
- T₁, Pol.2m: 7.15, 7.70, 8.58, 8.55, 8.22, 7.93, 10.18, 8.09, 5.12, 5.12, 7.66
- T₂, T₁+LMSI: 5.56, 5.89, 8.45, 7.48, 7.93, 9.91, 11.73, 10.11, 8.25, 8.25, 8.36
- T₃, Local: 4.66, 4.76, 5.93, 3.69, 3.59, 3.72, 6.65, 6.69, 5.68, 5.68, 5.11
- T₄, Coppicing: 7.36, 7.82, 9.81, 5.22, 5.20, 3.56, 2.71, 3.47, 3.26, 3.26, 5.17
- CD (P=0.05): 0.84, 1.40, 0.56, 0.81, 0.90, 1.34, 1.34, 1.62, 1.31, 1.31, 1.14

**Fuel yield (kg/ha):**
- T₁, Pol.2m: 3.08, 8.83, 9.08, 12.5, 9.25, 9.35, 10.95, 10.93, 6.23, 4.03, 8.42
- T₂, T₁+LMSI: 6.42, 8.50, 8.93, 11.2, 6.10, 10.35, 12.18, 11.68, 9.88, 9.30, 9.46
- T₃, Local: 4.25, 6.17, 7.98, 7.23, 7.20, 4.73, 9.50, 7.61, 6.10, 5.00, 6.58
- T₄, Coppicing: 6.55, 10.33, 9.95, 8.88, 7.10, 5.75, 6.64, 5.76, 3.99, 4.03, 6.90
- CD (P=0.05): 2.73, 1.82, 0.83, 1.70, 1.76, 0.89, 1.95, 1.66, 1.70, 1.60

**Crude protein yield (kg/ha/tree):**
- T₁, Pol.2m: 1.31, 1.43, 1.57, 1.56, 1.50, 1.46, 1.92, 1.53, 0.95, 0.54, 1.38
- T₂, T₁+LMSI: 1.00, 1.06, 1.51, 1.35, 1.43, 1.77, 2.11, 1.81, 1.50, 1.28, 1.48
- T₃, Local: 0.83, 0.83, 1.02, 0.63, 0.62, 0.69, 1.25, 1.26, 1.06, 0.69, 0.89
- T₄, Coppicing: 1.37, 1.51, 1.87, 0.96, 1.01, 0.66, 0.52, 0.66, 0.63, 0.57, 0.98
- CD (P=0.05): 0.24, 0.37, 0.19, 0.22, 0.22, 0.27, 0.27, 0.37, 0.23, 0.23, 0.26

Effects of cutting methods on green forage yield were found significant in all the years of study except first year. During initial three years coppicing gave the highest green forage yield (11.9, 14.7 and 16.8 kg/tree respectively). But, fourth year onwards (Table 1) pollarding tree at 2 m height leaving main shoot intact produced the highest green forage yield except 1997 where it was lower than pollarding at 2 m height. Coppicing produce about 22, 63 and 59 % higher green biomass than local in 1993, 1994 and 1995 respectively (Table 1). The increase in green forage yield due to coppicing may be attributed to the hormonal suppression of lateral growth following due to which dormant buds on the side of the trunk begin to grow. Coppice growth is generally much more vigorous than normal growth and is characterized by both an up surge or vertical development and retardation of lateral branching. Immediately after cutting coppicing shoots usually produce abundance of leaves. However, even the most vigorous coppicing species has a limited life span. As a general rule, even the most popular agro-forestry species can be coppiced through 3 rotations after which their vigour declines and shoot growth is reduced sharply. In conformity of earlier findings, after 3 continuous coppicing in this study too production from coppiced treatment declined. Fourth year onwards pollarding at 2 m height retaining the main shoot (T₄) gave the highest green forage yield except in 1997 where it was lower than pollarding 2 m height and at par green forage yield (13.85 kg/ha) with pollarding tree at 2 m height in 1996. On mean basis T₁ produced the highest green forage yield (Table 1). Increase yield in this treatment is due to overall increase in plant growth with the age. Pollarding of tree resulted development of adventitious buds on each cut shoot within a fortnight leading to formation of sprouts.

Dry matter yield also followed the similar trend of green forage yield (Table 1). Effect cutting treatment on dry matter yield was found significant in all the year of study. Initial 3 years coppicing gave the highest dry matter yield (Table 1). On average basis T₄ gave 9.62 and 64 % higher dry matter over T₁, T₂ and T₃ respectively. Fuel wood yield/plant was affected significantly due to the application of different cutting treatments during different years of study (Table 1). Fuel wood yield did not follow a uniform trend with respect to different cutting treatments. On mean basis T₁ gave 1.04, 2.88 and 2.56 kg/tree more fuel yield than T₂ (8.42 kg/tree), T₃ (6.58 kg/tree) and T₄ (6.90 kg/tree) respectively.

Different cutting treatment could not significantly influence the protein content of bhimal tree fodder. In all the years coppicing produced the highest crude protein content, it varied from 18.63 in 1993 to 19.38% in 2001. In case of coppicing, every time fresh leaves are coming from the coppiced stem, however, in case of other treatments leaves are coming from old parts of the plants. In general, crude protein content decrease with maturity as the all content is...
diluted by structural component that is why in all the years coppicing produced the maximum protein content. Though the difference among treatment were non-significant but coppicing treatment showed the numerically higher protein content.

Crude protein yield differed significantly with the application of different cutting treatments (Table 1). It has followed the trend of dry matter and protein content. On mean basis, highest protein yield (1.48kg/tree) was recorded from T 2. During initial 3 cycles coppicing gave the highest protein yield. It varied from 1.37 kg/tree in 1993 to 1.87 kg/tree in 1995 and decreased later on.

Therefore, from the present study it can be concluded that the suitability of a particular cutting management was related to the age of the plantation. Coppicing of a tree can be done only for initial three cycles thereafter yield reduced. On the mean basis it can be said that the best lopping technique for bhimal is pollarding tree at 2m height leaving main shoot intact.

SUMMARY

Bhimal is an important tree which provides nutritious fodder during winter months and can be grown on wastelands. Cutting management is very important for the tree growing along the cultivated fields. Management of bhimal (Grewia optiva) planted on terraced field bunds in North Western Himalayas was studied at Research Farm of Vivekananda Parvatiya Krishi Anusandhan Sansthan, Harsil bag, Almora, Uttarakhand, (India). The experiment was laid out in randomized block design with 4 replications and 4 treatments. Effect of cutting methods on forage, dry matter, fuel and protein yield of bhimal was found significant expect first year green forage yield. Suitability of a particular cutting management was related to age of plantation. During initial 3 years coppicing gave the highest green forage yield (11.9, 14.7 and 16.8 kg/tree in 1993, 94 and 95 respectively). But, fourth years onwards pollarding at 2m height leaving main shoot intact gave the highest green forage yield except 1997 where it was lower than pollarding at 2 m height. Increase yield in this treatment is due to increase plant growth with the age. The highest protein content, i.e. 19% was found in the leaves of coppice treatment. Thus, from the study it was concluded that bhimal combination of coppicing at initial and pollarding at latter stage was found to be optimum cutting management.

REFERENCES


