Management strategies for rehabilitation of Lantana infested forest pastures in Shivalik foothills of Jammu & Kashmir

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ABSTRACT

A study on rejuvenation of wild sage (Lantana camara L.) infested forest pastures in Shivalik foothills of Jammu & Kashmir was conducted from April 2006 to December 2008. The study included manual cuttings of Lantana bushes; manual cuttings followed by application of 1% glyphosate on its regenerated growth of 30 cm in height; and manual grubbings. These were followed by either no plantation of grasses, planting either of hybrid napier and Setaria cuttings. Results of the study revealed that the fresh bio-mass of Lantana bushes recorded a sizeable reduction ranging from 66 to 99% under different treatments over its initial average fresh bio-mass value of 28 kg/25 m². Likewise, a significant reduction in the number of Lantana bushes per unit area to the extent of 67-99% over its initial average value of 6 bushes/25 m² was also recorded with grubbing and the herbicide applied treatments. Application of glyphosate 30 cm regenerated growth of Lantana bushes and grubbing treatments followed by planting either of hybrid napier and Setaria were found equally effective in rehabilitation of Lantana infested forest pastures as both of these grasses provided good soil cover and recorded higher forage yields under these treatments i.e. hybrid napier 1.81 to 2.07 t/ha and Setaria 0.98 to 1.02 t/ha. These two treatments were also found significantly superior to the repeated Lantana cutting treatments and decreased fresh Lantana bio-mass by 94.20 to 99.03% over its initial bio-mass value. However, between these two most effective treatments i.e. the management of Lantana bushes with the application of glyphosate followed by planting of either hybrid napier and Setaria grasses were found economically superior, with a net saving of rupees 6,640/ha, over the grubbings of Lantana followed by planting either of these grasses.

Key words: Economics, Forest pastures rehabilitation, Grubbing, Glyphosate, Lantana camara, Manual cutting, Perennial grasses

The expansion of human population has enforced man to exhaustively exploit the natural resources including forest pastures and grasslands. Over-exploitation of such valuable resources is rendering large area as wasteland year after year which is an alarming signal for the sustenance of these resources. These resources cater the fodder need of more than 90 per cent of the livestock population in India (Anonymous 1995). Among the various pests which affect the productivity of a land, weeds wage a hidden war for plant essentials and interfere with the growth of plants and obstruct the activities of animals and human beings. Perennial weeds because of their immense capacity of reproduction, higher rate of dispersal and adaptation to adverse conditions have invaded the land that are not under cultivation. Hilly regions which have more such land due to typical physiographic conditions are more infested by these weeds. The areas which used to support large livestock population have got invaded by uneconomic vegetation i.e. weeds. The perennial weeds infesting these lands resulted into shrinkage of the area for animal grazing and grass production (Angiras 1999).

Jammu & Kashmir, a North-Western hill state of India occupies 2, 22,236 sq km with an altitude range of 307 to 4,700 meter above mean sea level. The physiographic features of Jammu & Kashmir State can be compared to a threefold plateau on the basis of altitudinal variations for Shivaliks, middle Himalaya and the Greater Himalaya ranging from 307 to 615, 921 to 1,228 and 4,300 to 4,700 meters above mean sea level, respectively. The state is agrarian in character and about 75% of its population is engaged in various agriculture and live-stock related pursuits. However, the distribution of cultivable waste land and forest cover in the three regions vary. Out of a total sub-tropical area of about 585 thousand hectares in J&K around 268 thousand hectares are uncultivated (Anonymous 2008) and which probably has been under the threat by the invasion of aggressive native as well as exotic weed
species, particularly exotic Lantana camara which is making inroads in forest pastures and grasslands. Out of total weed invaded area of sub tropical belt of Jammu region, probably a sizeable portion is heavily infested with exotic weed species and amongst them Lantana has been found to take hold of most of the area under natural forests as under canopy weeds. The alarming situation arising out of such invasions particularly by the Lantana camara, an obnoxious weed which is a wild shrub and does not grow on lands which are under frequent tillage but establish itself on non-cultivated areas has almost dwindled the ecology of the forest ecosystems turning the lush green productive and economically viable forest pastures into unproductive degraded lands which needed a scientific intervention. Thus, keeping this in view, a study on the management of Lantana invaded forest pastures of Shivalik foot-hills was carried out from April, 2006 to December, 2008 with the objectives of finding out the most effective and economical technique for rejuvenation of these land pockets rendering their ability to at least provide some forage for local consumption and meanwhile not having much competition with native vegetation like those of the endemic types which face extinction due to biotic environmental stress.

**MATERIALS AND METHODS**

The study site falls in forest area near village Janglote 8 km away from district headquarter Kathua of Jammu & Kashmir state. The experimental study to restore the forage productivity of forest pastures was conducted from April, 2006 to December, 2008. The soil of the experimental site was sandy loam in texture (sand=49.02%, silt =22.08% and Clay =28.0%), acidic in reaction (pH=6.4) and high in organic carbon (9.0%), medium in available nitrogen (416 kg/ha), phosphorus (15.8 kg/ha) and potassium (152.5 kg/ha). The experiment consisted of nine treatments viz., T1= 3- Lantana cuttings during the year each at 4 months interval to allow the natural native flora to come up, T2= 3- Lantana cuttings during the year each at 4 months interval and planting of hybrid napier (NB-21) cuttings, T3= 3- Lantana cuttings during the year each at 4 months interval and planting of Setaria sphacelata cuttings, T4= 3- Lantana grubblings during the year each at 4 months interval and planting of hybrid napier (NB-21) cuttings, T5= 3- Lantana grubblings during the year each at 4 months interval and planting of Setaria sphacelata cuttings, T6= Cutting of Lantana bushes followed by application of glyphosate 1.0% just before rainy season on about 30 cm regenerated growth of Lantana to allow the natural native flora to come up, T7= Cutting of Lantana bushes followed by application of glyphosate 1.0% just before rainy season on about 30 cm regenerated growth of Lantana and planting of hybrid napier (NB-21) cuttings, T8= Cutting of Lantana bushes followed by application of glyphosate 1.0% just before rainy season on about 30 cm regenerated growth of Lantana and planting of Setaria sphacelata cuttings was laid out in a randomized block design in three repeats. For grubbing treatments, Lantana bushes were first cut near the ground level and then grubbing of its roots was done. In case of herbicidal treatments, the Lantana bushes were first cut just near the ground surface in the month of April, allowed its regrowth to occur up to about 30 cm in height and then herbicide (glyphosate 0.1%) was applied. About 15-20 cm deep holes were made with the help of screw auger at a spacing of 60 x 40 cm and stem cuttings of perennial grasses viz., hybrid napier (NB-21) and Setaria sphacelata were planted during the rainy season in the treatment plots where grass cover was to be provided to the soil to suppress the further reoccurrence of the Lantana bushes. A uniform dose of 40 kg of N/ha was applied to all the treatments as top dressing. Re-planting of grass cuttings was done in the gaps occurred due to mortality of grass cuttings in February. The grasses were allowed to grow and establish till rainy season of 2008 and thereafter they were harvested and recorded. Treatment wise study of fresh above ground biomass of the introduced grasses was carried out to evaluate their establishment and effectiveness in checking the reoccurrence of the Lantana bushes about two years after imposition of the treatments. The weight of above ground biomass of Lantana bushes per unit area was assessed by weighing total above ground biomass obtained after cutting from a unit area both at the start as well as completion of the study. Fodder estimation per unit area was also done to work out the fodder output of each grass under each treatment. The economics of all the treatments was worked out on the basis of total man days involved for their respective operations as well as costs of the inputs as given in Table 2. The identification of the effective technique for rejuvenation of Lantana invaded forest pastures was done on the basis of higher fodder output and grass cover to the soil with relatively less expenditure incurred for the management of this weed. Identification of grasses was done keeping in view their aggressiveness in establishment under the prevailing conditions by suppressing this weed.

**RESULTS AND DISCUSSION**

**Effect on forage yield**

The results of the study (Table 1) revealed that both the introduced grasses i.e. napier and Setaria as well as native regenerated flora differed significantly in their forage yield and hybrid napier recorded highest forage yield ranging from 1.21 to 2.07 t/ha under different treatments.
and this was followed by Setaria (0.62 to 1.02 t/ha) and natural native flora (1.68 to 2.10 t/ha). It was observed that all the treatments performed better in respect of their forage yields except natural flora under herbicidal treatment. The significant differences in production of different grasses were due to the differences in their respective potential of forage production. Moreover, the probable reasons for higher forage yield of napier and Setaria under grubbing and herbicidal treatments might be due to less competitive congenial conditions created under these treatments for the growth and establishment of these introduced grasses. Less forage production from natural native flora can be attributed to its slow growth and establishment as compared to hybrid napier and Setaria coupled with non-selective nature of the herbicide used which might have eliminated most of the native flora initially. Sood and Sharma (1993) also reported that the production of different forages was largely governed by their respective production potentials.

**Effect on Lantana plants**

Significant differences in fresh biomass production of Lantana bushes were recorded under various strategies adopted for management of this weed at the completion of the study. Treatment T₃, i.e. cutting of Lantana bushes followed by application of glyphosate 1% on about 30 cm regenerated growth of the weed and planting of hybrid napier thereafter was found to be significantly superior to all the other treatments and lead to almost complete eradication of Lantana plants as it recorded quite less biomass (1.12 kg/25 m²). Treatment T₁, i.e. only cutting of Lantana bushes to facilitate the natural native flora to come up and establishment, recorded the highest biomass of Lantana (3.22 kg/25 m²). Highest per cent fresh bio-mass reduction was recorded with herbicide applied treatments ranging from 98.17 to 99.03% followed by grubbing (97.80 to 98.17%) and cutting (66.0 to 75.83%) treatments, irrespective of whether the grasses are introduced or regenerated species of native grasses. A significant reduction to the tune ranging from 67-99% over the initial average values of number of Lantana bushes per unit area was also recorded in the treatments where Lantana was controlled either by grubbing or by the application of herbicides. Better control of Lantana under herbicidal treatments can be attributed to the potential efficacy of the applied herbicide in suppressing this weed. Significant superiority of the herbicidal treatments followed by napier planting over Setaria and natural native flora, however, shall be ascribed to the fact that napier grass was found to be more aggressive in growth which lead to its early establishment under the Shivalik foot-hill situations. Similar observations with regard to establishment of different grasses were also made by Thakuria and Singh (1990).

**Economics**

The economic analysis of various treatments as innovative interventions (Table 2) indicated that the herbicidal control was found economically superior than manual grubbing as well as cutting of the wild sage, irrespective of the agrostological interventions in these treatments. However, the application of glyphosate 1.0% on

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Fresh biomass kg/25 m²</th>
<th>% biomass reduction</th>
<th>Number of Lantana bushes/25 m²</th>
<th>Forage yield (t/ha)</th>
<th>Management cost (¥/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>T₁ = Three Lantana cuttings</td>
<td>3.20 (9.50)</td>
<td>66.0</td>
<td>2.971 (8)</td>
<td>0.21</td>
<td>10,500</td>
</tr>
<tr>
<td>T₂ = T₁ + Hybrid napier planting</td>
<td>2.77 (6.75)</td>
<td>75.8</td>
<td>2.426 (5)</td>
<td>1.25</td>
<td>18,300</td>
</tr>
<tr>
<td>T₃ = Three grubbing</td>
<td>1.58 (3.50)</td>
<td>94.2</td>
<td>1.715 (2)</td>
<td>0.23</td>
<td>15,010</td>
</tr>
<tr>
<td>T₄ = T₃ + Hybrid napier planting</td>
<td>1.22 (0.50)</td>
<td>98.2</td>
<td>1.414 (1)</td>
<td>1.81</td>
<td>22,850</td>
</tr>
<tr>
<td>T₅ = T₄ + Setaria planting</td>
<td>1.27 (0.60)</td>
<td>97.8</td>
<td>1.000 (0)</td>
<td>0.98</td>
<td>22,850</td>
</tr>
<tr>
<td>T₆ = Lantana cutting + 1% glyphosate on 30 cm regrowth</td>
<td>1.23 (0.50)</td>
<td>98.2</td>
<td>1.414 (1)</td>
<td>0.17</td>
<td>7,460</td>
</tr>
<tr>
<td>T₇ = T₆ + Hybrid Napier planting</td>
<td>1.12 (0.25)</td>
<td>99.0</td>
<td>1.414 (1)</td>
<td>0.21</td>
<td>16,210</td>
</tr>
<tr>
<td>T₈ = T₇ + Setaria planting</td>
<td>1.31 (0.47)</td>
<td>98.6</td>
<td>1.244 (0.67)</td>
<td>0.10</td>
<td>16,210</td>
</tr>
<tr>
<td>LSD (P=0.05)</td>
<td></td>
<td></td>
<td>0.51</td>
<td>9.7</td>
<td>0.61</td>
</tr>
</tbody>
</table>

Data are subject to square root transformation \( \sqrt{x+1} \) and original values are given in parenthesis.

Initial population of Lantana bushes = 6 bushes/25 m²; Fresh biomass of Lantana before imposition of treatments = 28 kg/25 m².
about 30 cm regenerated growth of Lantana followed by the planting of either hybrid napier and Setaria cuttings were found to be economically better with a net saving of about ₹ 6,640 over all the others similar treatment combinations of grubbings of Lantana bushes, respectively.

The results are in conformity with the findings of Kumar and Sood (1998). They have also reported relatively differential response of such like treatments with respect to their economics.
The introduction of improved grass species like napier and Setaria after herbicidal (glyphosate 1.0%) control of Lantana had a pronounced effect on the elimination of this hardy obnoxious weed. The present study thus envisages that the Lantana infested forest pasture land pockets can be successfully and economically rejuvenated and converted into highly productive pastures through cutting of Lantana followed by application of 1% glyphosate at about its 30 cm regenerated growth and planting either of napier and Setaria cuttings.

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