Integrated nutrient management for natural grasslands of mid-hills of Himalayas

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Introduction Livestock rearing is an important pursuit in mountain farming in India and plays a crucial role throughout the country. The preponderance of marginal and small landholdings (about 82%) in hilly regions does not allow the farmers to allocate even a small part of their land exclusively for forage production. In Himachal Pradesh state of India about 1.16 m ha (20% of the total area) is under permanent pastures and other grazing lands and none of the natural grasslands are fertilised in any form. Existing grasslands have deteriorated to such an extent that their carrying capacity is only 1.05 ACU (Adult Cattle Unit, with an average body weight of 350 kg)/ha (Vashist *et al*., 2000). Biofertiliser-based technologies could be appropriate and cost effective approaches that are easy to adopt and eco-friendly. Response may arise from increased populations of phosphate solubilisers in the rhizosphere in P- deficient soils resulting in mobilisation of insoluble phosphorus (Raghu & Mac Rac, 1967). The study was undertaken with the main objectives of assessing the effects of biofertilisers on productivity and quality of natural grassland and the level of N and P substitution by biofertilisers.

Materials and methods The study was undertaken at a community natural grassland in the mid-hills of Himachal Pradesh state (1300 m altitude, 32^0 6' N-latitude and 76 3' E- longitude in north western Himalaya) in India during 2001and 2002. Thirteen treatments comprised a control (no application); recommended application of N and P (60 and 40 kg /ha); sole application of Azotobacter, Phosphobacteria; Azotobacter + Phosphobacteria; nine combinations of 50, 75 and 100% of the full N rate with 50, 75 and 100% P along with Azotobacter + Phosphobacteria. The trial had a randomised block design with three replicates.

Results *Heteropogon contortus* (62.89 %), *Eulalia* sp (15.34%), *Chrysopogon fulvus* (11.96), *Arundinella nepalensis* (3.37%) and *Cyperus deformis* (1.53%), were the dominant species in the grassland. Sole application of Azotobacter produced 0.27 t/ha of herbage dry matter (DM) compared to the control and the combined use of the two bacteria produced a further response of 0.36 t DM/ha (Table 1). Application of 50, 75 and 100% N and P along with Azotobacter and Phosphobacteria as well as the treatment with the recommended application of N and P produced more herbage biomass compared to no application of fertilizers or the sole application of Azotobacter and Phosphobacteria. Application of 75 % of N and P with Azotobacter + Phosphobacteria gave significantly higher herbage production compared to the sole bacterial applications, control and 50% N and P application. The herbage yield from the treatments with the bacterial additions together with 75% N and 100% P or 100% N and 75% P were similar to that with full application of 100 % N and P. Chemical analysis did not indicate any significant differences in crude protein content.

Table 1 Impact of biofertilsers on herbage production (t DM/ha) (average of two years)

Treatments	
T1- Control	2.07
T2- Azotobacter	2.34
T3- Phosphobacteria	2.04
T4- Azotobacter + Phosphobacteria	2.70
T5- 50% N + 50% P + Azotobacter + Phosphobacteria	2.90
T6- 50% N + 75% P + Azotobacter + Phosphobacteria	2.96
T7- 50% N + 100% P + Azotobacter + Phosphobacteria	2.98
T8- 75% N + 50% P + Azotobacter + Phosphobacteria	3.05
T9- 75% N + 75% P + Azotobacter + Phosphobacteria	3.08
T10- 75% N + 100% P + Azotobacter + Phosphobacteria	3.35
T11- 100% N + 50% P + Azotobacter + Phosphobacteria	3.02
T12- 100% N + 75% P + Azotobacter + Phosphobacteria	3.33
T13- 100% N + 100 % P + Azotobacter + Phosphobacteria	3.45
T14- Recommended N and P	3.29
SE of mean values	0.06
CD	0.17

Conclusions Azotobacter and Phosphobacteria could substitute about 25 % of the requirement for N and P, presumably through N fixed by Azotobacter and P solublised by Phosphobacteria.

References

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