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Effect of integrated nutrient management on nutrients availability and uptake by black henbane (*Hyoscyamus niger* L.) in *Tarai* region of Uttarakhand

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Abstract

Experiments were conducted to quantify the effect of integrated nutrient management on soil health and black henbane (*Hyoscyamus niger* L.). The treatments were, no chemical fertilizer and organic manure (control) [T_1], recommended (rec.) NPK (i.e. 100:50:50 kg ha^{-1}) [T_2], 75% rec. NPK +2.5t vermicompost (VC) [T_3], 50% rec. NPK + 5.0t VC (T_4), 25% rec. NPK + 7.5t VC (T_5), VC 10t (T_6), rec. NPK + Biofertilizers (BF) [T_7], 75% rec. NPK + 2.5t VC + BF (T_8), 50% rec. NPK + 5.0t VC + BF (T_9), 25% rec. NPK + 7.5t VC + BF (T_{10}), 10t VC + BF (T_{11}) and BF [*Azotobacter* & Phosphorus Solublizing Bacteria (PSB)]. Highest herbage yield was obtained with application of T_8 during both the years. Integrated application of inorganic fertilizers and organic sources of nutrients increased the N, P, K content and their uptake. Highest available N and K content in soil was observed with T_2 during 2008–09, while during 2009–10, the maximum available N content in soil was observed with T_8. Highest N uptake was observed with T_6, while highest P and K uptake was recorded with T_8 during both the years.

Keywords: black henbane, biofertilizer, *Hyoscyamus niger*, nutrient uptake, vermicompost

Introduction

Black henbane (*Hyoscyamus niger* L.) is an important medicinal plant grown in India and distributed mainly in the sub-tropical to temperate regions up to altitudes of 1500-3000 m above MSL. It is valued for its alkaloid hyoscyamine (0.041%- 0.081%) and hyoscine (scopolamine) (Maheshwari *et al.* 1998). Organic manures and biofertilizers can replace around 25% to 50% of chemical fertilizers (Manjunath *et al.* 2002). The basic concept of INM is to maintain soil fertility and soil productivity at optimum level. Integration of chemical fertilizers with organic manures helps in not only maintaining higher productivity but also in providing great stability in crop production and sustainability (Jeyabal *et al.* 2000).

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Materials and methods

The experiment was carried out in randomized block design at Medicinal Plants Research and Development Centre of GBPUAT Pantnagar (29°N, latitude, 79.29°E longitude and 243.8 m above the MSL), Uttarakhand. The *Tarai* region experiences sub-humid and sub-tropical climate with hot dry summers and cool winters. The soil of the experimental plot was sandy loam in texture having high organic carbon, low available N, medium available P and available K with neutral soil reaction. Seeds were sown during October 2008 and 2009 in raised beds and transplanting was done after one month. Application of *Azotobacter* and phosphate solubilizing bacteria (PSB) was ensured by dipping seedling roots in biofertilizer solution @ 0.5% for 30 minutes. The treatments included no chemical fertilizer and organic manure (control) [T_1], recommended (rec.) NPK (i.e. 100:50:50 kg ha^{-1}) [T_2], 75% rec. NPK + 2.5t vermicompost (VC) [T_3], 50% rec. NPK + 5.0t VC (T_4), 25% rec. NPK + 7.5t VC (T_5), VC 10t (T_6), rec. NPK + Biofertilizers (BF) [T_7], 75% rec. NPK + 2.5t VC + BF (T_8), 50% rec. NPK + 5.0t VC + BF (T_9), 25% rec. NPK + 7.5t VC + BF (T_{10}), 10t VC + BF (T_{11}) and BF (*Azotobacter* & PSB, T_{12}). Soil samples were collected from top 15 cm soil depth at 4 places from each plot after the harvest of crop to determine pH and organic carbon (Jackson 1973), available N (Subbaiah & Asija 1956), available P (Olsen *et al.* 1954) and K (Jackson 1973). The experimental soil had pH of 6.81 and organic carbon of 0.92% and available N, P, K of 225.46, 23.41 and 214.42 kg ha^{-1}, respectively. The chemical composition of vermicompost used in the experiment was N 2.14%, P 0.97% and K 1.21%. The experimental data were analyzed by using analysis of variance (ANOVA) technique for each character as prescribed for a randomized block design. The interpretation of data was done on the basis of "F" test. The critical differences (CD) at 5% level of probability were calculated for testing the significance of difference between two treatment means (Snedecor & Cochran 1967).

Results and discussion

The result indicated that the variation in soil pH was significant between the treatments during 2009–10, while the effect was non-significant during 2008–09 (Table 1). Organic carbon (OC) content ranged between 0.83%-1.1% and 0.80%-1.2% during 2008–09 and 2009–10, respectively (Table 1). In both the years, INM had significant effect on OC. Highest OC was observed with application of 10t VC + Biofertilizers [T_{11}] during both the years. Similar findings were also reported by Jat & Ahlawat (2006). Highest available N content in soil was observed with the application of recommended NPK during 2008–09, while during 2009–10, highest available N content was observed in T_8 (Table 1). The available N content was lowest in control during both the years. Plots treated with inorganic fertilizer alongwith VC and BF showed higher availability of N. Yaduvanshi (2001) also reported that combined use of urea and organic manure decreased NH_3 volatilization losses in comparison to urea alone. Thus integrated nutrient management could save 5.0-6.0% of fertilizer N (Bhardwaj & Omanwar 1994). The treatments also influenced the availability of P significantly. Higher available P was recorded with the use of 75% rec. NPK + 2.5t VC + BF during 2008–09, while during 2009–10, higher available P was observed with the application of 10t VC + BF (Table 1). During both the years, the use of INM influenced availability of P significantly. The available P increased with the combined application of organic and inorganic source of nutrients (Chadha & Prabhaker 1997). Available K was highest with the application of recommended NPK (T_2). All the treatments recorded higher available K than BF alone and control during 2008–09 while, highest available K was found with the application of 10t VC in 2009–10. FYM with or without N enhanced available K in soil by promoting the buildup of K level in soil (Bhardwaj & Omanwar 1994).

The highest herbage yields were recorded with the application of 75% rec. NPK along with 2.5t VC and BF followed by 75% rec. NPK along with 2.5t VC (Fig. 1). Application of 10t VC along with BF recorded significantly high herbage yield than control during 2009–10. The maximum N (Fig. 2a) and P (Fig. 2b) content

Table 1. Effect of integrated nutrient management on fertility status of soil under Black henbane in *Tarai* region of Uttarakhand

Treatment	pH		Organic carbon (%)		Available N (kg ha^{-1})		Available P (kg ha^{-1})		Available K (kg ha^{-1})	
	2008–09	2009–10	2008–09	2009–10	2008–09	2009–10	2008–09	2009–10	2008–09	2009–10
T_1	6.8	6.8	0.8	0.8	193.7	185.2	18.2	16.3	186.5	183.2
T_2	7.0	7.0	0.9	0.9	221.1	219.2	21.2	21.0	210.8	210.2
T_3	6.9	7.0	1.0	1.0	219.5	219.1	21.1	21.4	209.0	209.5
T_4	6.9	6.8	1.0	1.1	213.9	216.9	20.5	21.3	207.5	209.1
T_5	6.8	6.8	1.0	1.1	208.8	213.8	19.8	20.1	203.1	208.3
T_6	6.8	6.7	1.0	1.1	204.4	213.3	19.9	22.3	202.8	210.3
T_7	7.0	7.0	1.0	1.0	219.1	218.5	22.1	22.2	210.2	210.1
T_8	6.9	6.9	1.0	1.0	220.0	220.5	22.3	22.2	209.9	210.2
T_9	6.9	6.9	1.0	1.0	213.9	215.4	20.2	20.7	209.3	209.6
T_{10}	6.9	6.9	1.1	1.1	211.2	214.5	20.2	20.4	203.1	209.1
T_{11}	6.8	6.8	1.1	1.2	205.2	214.1	21.0	22.5	203.1	210.3
T_{12}	6.9	6.9	1.0	1.0	199.3	195.6	19.5	19.3	192.8	191.8
SEm±	0.049	0.067	0.023	0.025	5.43	6.38	0.57	0.65	4.03	4.50
CD (P<0.05)	N.S	0.20	0.07	0.08	15.92	18.72	1.68	1.92	11.81	13.19

T_1=(control); T_2=recommended (rec.) NPK (i.e. 100:50:50 kg ha^{-1}); T_3=75% rec. NPK + 2.5t vermicompost (VC); T_4=50% rec. NPK + 5.0t VC; T_5=25% rec. NPK + 7.5t VC; T_6=VC 10t; T_7=rec. NPK + Biofertilizers (BF); T_8=75% rec. NPK + 2.5t VC + BF; T_9=50% rec. NPK + 5.0t VC + BF; T_{10}=25% rec. NPK + 7.5t VC + BF; T_{11}=10t VC + BF; T_{12}=BF (*Azotobacter* & PSB).

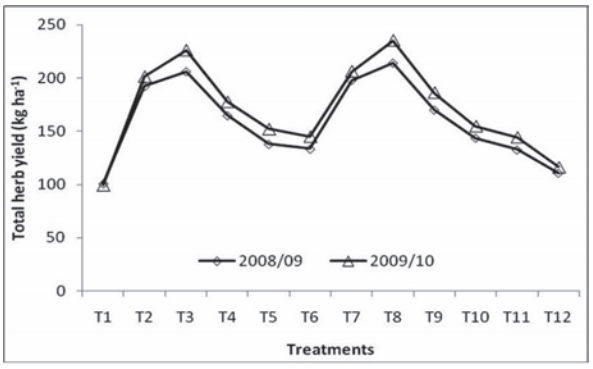

Fig. 1. Effect of various treatments on total herb yield of black henbane in *Tarai* region of Uttarakhand

in plant was recorded with rec. NPK along with BF, while K (Fig. 2c) content was minimum with the application of rec. NPK only. This was probably due to more N fixation by the bacteria resulting in better utilization of the nutrients by plants, resulting in more N and P contents in seed and straw (Shelke *et al.* 2001).

INM significantly influenced N uptake by black henbane during both the years (Fig. 3a). Significantly higher N uptake was observed with the application of 75% rec. NPK + 2.5t VC + BF (T_8) during both the years. Moreover, the application of VC 10t with or without BF significantly influenced N uptake over control during both the years (Dashora 1980). The treatments influenced P and K uptake significantly during both the years. Highest P uptake was recorded with the application of 75% rec. NPK + 2.5t VC + BF (T_8) during both the years while minimum P uptake was found in control as well as BF alone in both the years (Fig. 3b). Highest K uptake was recorded with the application of 75% rec. NPK along with 2.5t VC and BF during both the years (Fig. 3c). Application of 75% rec. NPK along with 2.5t VC and BF, 75% rec. NPK along with 2.5t VC, rec. NPK along with BF and rec. NPK recorded significantly higher K uptake during both the years. Application of 10t VC with or without BF influenced K uptake significantly over control during both the years (Fig. 3c).

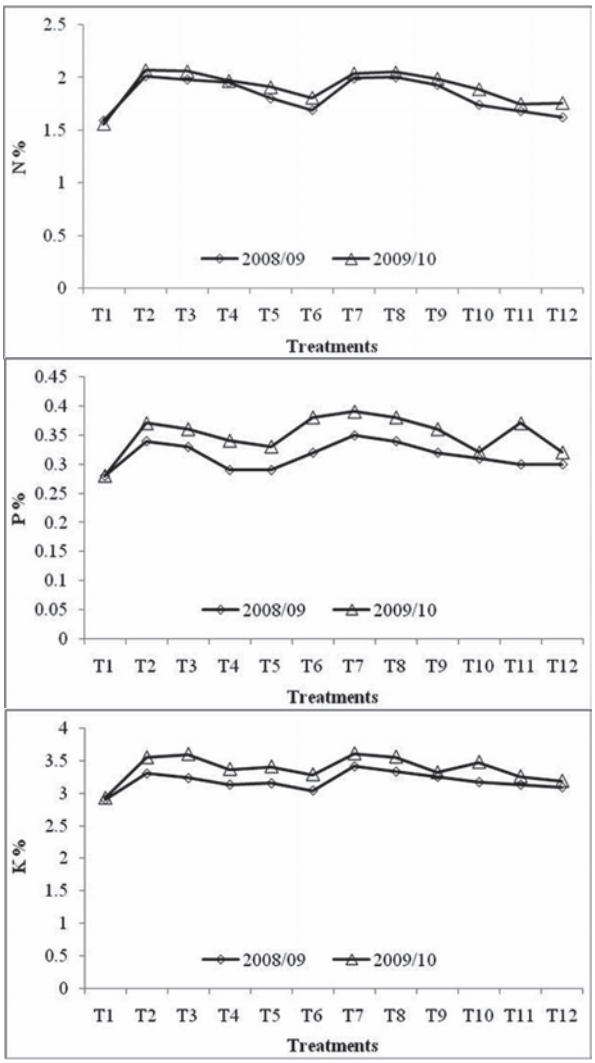

Fig. 2. Effect of integrated nutrient management on (a) N, (b) P and (c) K content (%) in black henbane grown in *Tarai* region of Uttarakhand

Highest total herbage yield was observed with application of 75% rec. NPK along with 2.5t VC and biofertilizer (T_8) during both the years. Integrated application of inorganic and organic sources of nutrients increased the NPK contents and their uptake by crop. Biofertilizer inoculation also increased the NPK contents and their uptake. Generally the highest NPK availability in soil and their uptake in black henbane were recorded with the application of 75% rec. NPK alongwith 2.5t VC and BF during both the years, followed by 75% recommended NPK along with 2.5 t ha^{-1} VC (T_3) and recommended NPK with biofertilizers (T_7). Therefore, application of 75% recommended

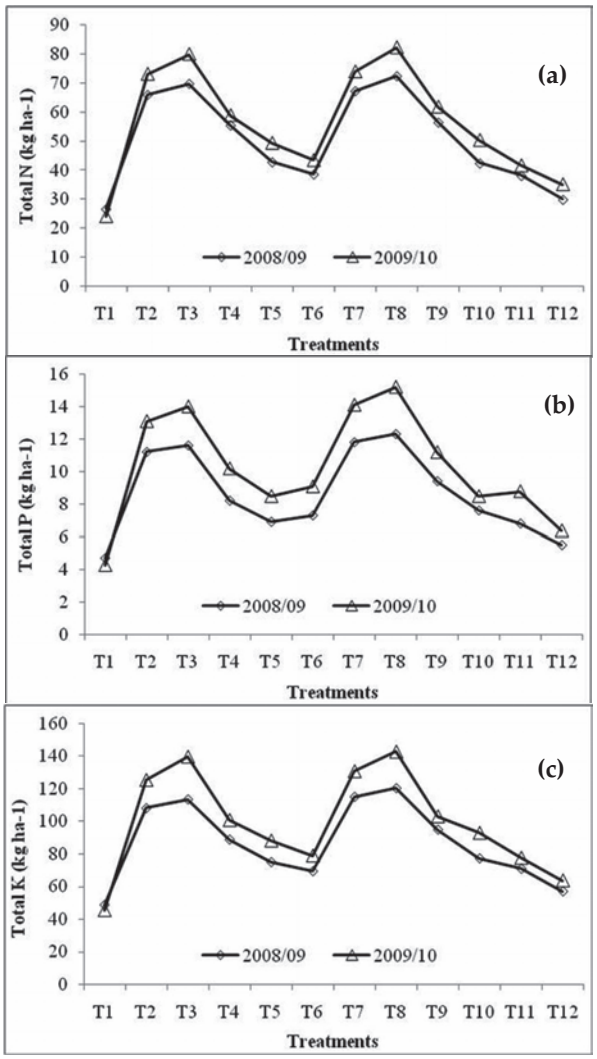

Fig. 3. Effect of integrated nutrient management on (a) total N (b) total P and (c) total K uptake by black henbane grown in *Tarai* region of Uttarakhand

NPK along with 2.5 t ha^{-1} VC with or without BF is recommended to get enhanced black henbane yield.

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