Indian J. Hort. 68(2), June 2011: 235-239

Influence of organic manures on growth, yield and quality of *makoi* (*Solanum nigrum* L.)

K. Umesha, S.P. Soumya, G.R. Smitha* and B.S. Sreeramu
Department of Horticulture, University of Agricultureal Sciences,
Gandhi Krishi Vignyan Kendra, Bengaluru 560 065

ABSTRACT

An investigation was conducted to find out the effect of different organic manures on growth, yield and quality of *makoi* (*Solonum nigrum* L.). The experiment comprised of 13 treatments consisting of different combinations of organic manures (FYM @ 10, 15 and 20 t, vermicompost @ 0.5 and 1.0 t and neem cake @ 0.5 and 1.0 t ha^{-1}) and FYM 10 t + NPK @ 100:50:50 kg ha^{-1} through inorganic fertilizers. Maximum plant height, number of branches per plant, plant spread, number of leaves per plant, leaf area and total dry matter accumulation were recorded with the application of FYM 20 t + vermicompost 1.0 t + neem cake 1.0 t ha^{-1}. Fresh and dry herbage yield were also maximum with the same treatment. However, application of FYM 20 t + vermicompost 1.0 t + neem cake 0.5 t ha^{-1} resulted in maximum alkaloid content and alkaloid yield, whereas, the highest net returns of Rs. 34,000 ha^{-1} and benefit to cost (B:C) ratio of 1.80 was recorded with the application of FYM 20 t + vermicompost 1.0 t + neem cake 1.0 t ha^{-1}.

Key words: *Makoi*, FYM, vermicompost, neem cake, alkaloid content.

INTRODUCTION

Solonum nigrum L. (commonly known as 'Black night shade" in English and '*Makoi*' in Hindi) belonging to the family Solanaceae is an important upcoming medicinal plant which has tremendous medicinal value. The economic parts of the plant are leaves, berries and even the whole herb. The plant contains alkaloids like solamargine, solanigrine and solasonine (Ridout *et al.,* 9). The herb has anticeptic, anti-dysenteric properties and used against abdominal upsets. The plant is also credited with emollient, diueretic, anti-spasmodic and laxative properties. It is used in heart disease, fever, pains, leucoderma, piles, ulcers, vomiting, *asthama* and eye troubles. *Makoi* leaves are also known to suppress carcinogenesis. Although, some work on standardization of agro-techniques in *Solanum nigrum* L. has been done in India, but no attempts have been made any where on organic farming practices in this crop as there is growing demand for organically grown herbal products in national and international markets. Therefore, an attempt has been done to assess the effect of different organic manures on the growth, yield and quality of *makoi*.

MATERIALS AND METHODS

The experiment was conducted at Division of Horticulture, University of Agricultural Sciences, GKVK, Bengaluru. The treatments comprised of three levels of Farm Yard Manure (FYM @ 10, 15 and 20 t ha^{-1}), two levels of vermicompost (VC @ 0.5 and 1 t ha^{-1}) and two levels of neem cake (NC @ 0.5 and 1 t ha^{-1}) in different combinations and a combination of FYM 10 t + NPK at 100:50:50 kg ha^{-1} through inorganic fertilizers which served as control. The experiment was laid out in a Randomized Complete Block Design (RCBD) replicated thrice. The soil of the experimental site was red sandy loam with a pH of 6.7 and organic carbon 0.61%. The available NPK content of soil was 216.8, 35.7 and 176.5 kg ha^{-1}, respectively. The organic manures were applied fifteen days in advance to facilitate their easy decomposition and early availability to the crop. The nutrient composition of the organic manure used in the experiment is presented in Table 1. In control treatment, half of N and full dose of P and K were applied at the time of transplanting while, remaining half dose of N was top dressed at 30 days after transplanting. The bio-fertilizers *viz., Azotobacter* and PSB @ 10 kg ha^{-1}, respectively were applied uniformly to the planting holes (except in control, T_1) at the time of transplanting of the seedlings. *Trichoderma viride* @ 6 kg ha^{-1} was also applied twice alongwith bio-fertilizers, at the time of planting and after a month of transplanting. *Makoi* seeds were soaked in GA_3 (500 ppm) for 12 h to break the seed dormancy and were sown in the raised nursery beds of row spacing 10 cm. One month old, uniform seedlings were transplanted in the main field at a spacing of 45 cm x 30 cm. During the period of experiment, the insects pests (ants, aphids and stem borers) were controlled by applying

*Corresponding author's present address: Directorate of Medicinal and Aromatic Plants Research, Boriavi, Anand 387 310, Gujarat; E-mail: smithagingade@yahoo.com

Table 1. Nutrient composition (%) of different organic manures used in the experiment.

Organic manure	Nutrient content (%)		
	N	P	K
FYM	1.76	0.24	1.50
Vermicompost	1.00	0.16	1.45
Neem cake	1.97	0.15	1.05

neem based insecticides while, the bacterial wilt was managed by drenching with streptocycline (500 ppm). The plants were harvested at mature green berry stage by cutting the whole plant at a height of 10 cm above the ground level. The freshly harvested plants were cut into pieces of convenient length and dried in hot air over at 70°C till a moisture level 8% was obtained. The total alkaloid content in the dried herb was estimated by following the procedure outlined by Harborne (4). The B:C ratio was worked out as per the prevailing market prices of inputs and dry herb of *makoi*. The data was analyzed statistically using standard statistical procedure (Gomez and Gomez, 3).

RESULTS AND DISCUSSION

The growth, yield and quality parameters of *makoi* were significantly influenced by the application of different levels of various organic manures (Table 2; Fig. 1). Application of 20 t of FYM + 1 t vermicompost + 1 t neem cake per hectare (T_{13}) resulted in maximum plant height, number of branches, plant spread, number of leaves, leaf area and total dry matter accumulation per plant. This treatment was *on par* with the control (T_1) in respect of plant height and number of branches per plant, while, it differed significantly from other treatments except T_{12} for plant height. However, T_{13} was significantly superior to all other treatments for plant spread, leaf area and dry matter accumulation. The data also clearly indicates that the good plant response to increased doses of organic manures. Lowest values in respect of all these growth parameters have been recorded with the application of 10 t of FYM + 0.5 t vermicompost + 0.5 t neem cake per hectare (T_2). FYM (20 t ha^{-1}) being a bulky organic manure, reduces the soil compaction and improves the aeration in addition to the supply of essential plant nutrients, thereby increases the soil biological activities (Hayworth *et al.*, 5). Alongwith FYM, application of vermicompost resulted in addition of some growth regulating substances excreted by earthworms in

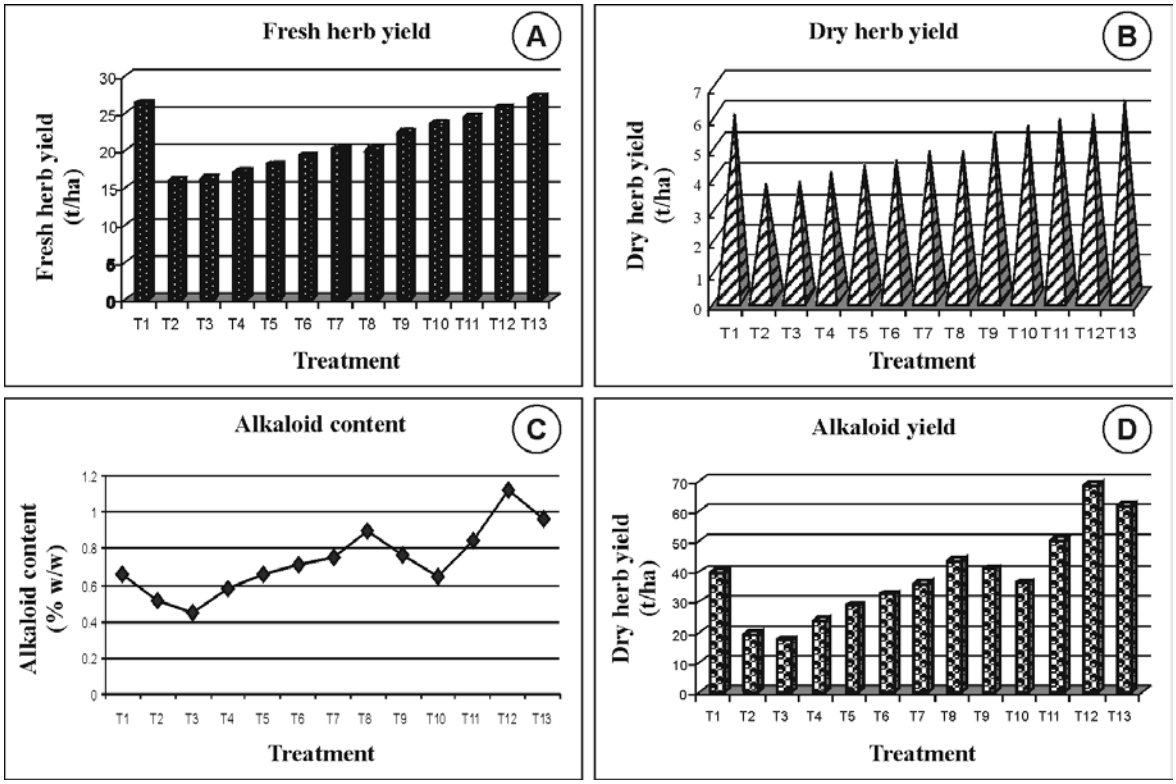

Fig 1. Fresh and dry herb yield (t ha^{-1}), alkaloid content (% w/w) and alkaloid yield (kg ha^{-1}) of *makoi* (*Solanum nigrum* L.) as influenced by different levels of organic manures.

Table 2. Effect of different organic manures on growth and flowering of *makoi* (*Solanum nigrum* L.).

Treatment		Plant height (cm)	No. of branches per plant	Plant spread (cm^2)	Leaf area per plant (cm^2)	No. of leaves per plant	Dry matter accumulation (g $plant^{-1}$)	Days taken for first flower appearance	Days taken for 50% flowering
T_1	FYM 10 t ha^{-1} + NPK @ 100:50:50 kg ha^{-1}	92	18. 0	3324	4145	576	28.6	34.6	102.10
T_2	FYM 10 t ha^{-1} + VC 0.5 t ha^{-1} + NC 0.5 t ha^{-1}	85	14. 1	1919	1934	192	37.3	39.3	57.10
T_3	FYM 10 t ha^{-1} + VC 0.5 t ha^{-1} + NC 1.0 t ha^{-1}	85	14. 6	2115	1976	193	34.6	39.3	59.30
T_4	FYM 10 t ha^{-1} + VC 1.0 t ha^{-1} + NC 0.5 t ha^{-1}	86	15. 5	1979	2177	246	37.3	39.3	67.70
T_5	FYM 10 t ha^{-1} + VC 1.0 t ha^{-1} + NC 1.0 t ha^{-1}	87	15. 7	2311	2387	287	36.3	39.0	71.60
T_6	FYM 15 t ha^{-1} + VC 0.5 t ha^{-1} + NC 0.5 t ha^{-1}	88	15. 5	2465	2639	291	33.6	37.0	73.30
T_7	FYM 15 t ha^{-1} + VC 0.5 t ha^{-1} + NC 1.0 t ha^{-1}	88	16. 0	2580	2786	303	30.0	37.0	77.70
T_8	FYM 15 t ha^{-1} + VC 1.0 t ha^{-1} + NC 0.5 t ha^{-1}	89	16. 6	2614	2694	468	33.3	38.0	80.90
T_9	FYM 15 t ha^{-1} + VC 1.0 t ha^{-1} + NC 1.0 t ha^{-1}	89	16.5	2759	3358	413	28.6	35.3	88.80
T_{10}	FYM 20 t ha^{-1} + VC 0.5 t ha^{-1} + NC 0.5 t ha^{-1}	91	17. 3	2818	3677	376	31.3	35.0	92.80
T_{11}	FYM 20 t ha^{-1} + VC 0.5 t ha^{-1} + NC 1.0 t ha^{-1}	91	17. 0	3041	3931	507	28.6	34.0	94.80
T_{12}	FYM 20 t ha^{-1} + VC 1.0 t ha^{-1} + NC 0.5 t ha^{-1}	92	17. 6	3381	4217	553	28.0	33.6	102.10
T_{13}	FYM 20 t ha^{-1} + VC 1.0 t ha^{-1} + NC 1.0 t ha^{-1}	95	19. 6	4253	5013	614	27.6	34.0	110.60
CD at 5%		4	1.8	590	661	201	7.93	5.7	2.3

to their casts (Senapathi *et al*., 10) and neem cake has nitrification regulative property (Singhal and Mudgal, 11).

Significantly highest leaf area was recorded with the application of 20 t FYM + 1 t VC + 1 t NC per hectare (T_{13}) helped in the production of more photosynthates and their accumulation. These results are in line with Subba Rao and Ravishankar (13) in brinjal and Renuka and Ravishankar (8) in tomato. Generally, flowering was early in plants applied with higher doses of organic manures. Similar response was observed when plants were supplied with combination of organic manures and inorganic fertilizers. Earliest flowering was observed in T_{13} followed by T_{12} and T_1 which were *on par* with each other. Delayed flowering was noticed in T_2 and T_4 which comprised of lower doses of organic manures. The trend remained almost same with respect to days taken for 50% flowering. This may be attributed to sufficient vegetative growth with higher doses of organic manures (T_{13}), which made the plants to enter into reproductive phase early. Whereas, plants supplied with lower doses of organic manures suffered for want of nutrients for their growth, resulted in reduced growth and delayed flowering. Days taken for fifty per cent flowering also followed the similar trend. The results are in agreement with the findings of Renuka and Ravishankar (8) in tomato.

Fresh herb yield was significantly influenced by different levels of organic manures wherein the highest fresh herb yield was registered in plot supplied with 20 t of FYM + 1 t vermicompost + 1 t neem cake per hectare (Fig. 1). It was *on par* with T_1 and T_{12} but significantly higher than the lower levels of FYM and vermicomost. Similar trend prevailed in respect of dry herb yield (Fig. 1). The increased fresh and dry herb yield with the application of 20 t FYM + 1 t VC + 1 t NC per hectare (T_{13}) could be attributed to increased plant height, number of branches, plant spread, number of leaves, leaf area and dry matter accumulation with this treatment. Higher doses of organic manures not only supply major nutrients but also sufficient quantity of required micronutrients such as Zn, B, Fe, Cu, Mn etc. Besides, bio-fertilizers are agriculturally important beneficial micro-organisms, which have ability to mobilize the nutritionally important elements from non-usable to usable form through biological processes (Anant Bahadur *et al*., 1). It has been reported that the microbial population increased at tremendous rate as the organic matter decomposed in the soil with the subsequent release of nitrogen for the growth (Pavan Yadav *et al*., 7). The results are in agreement with the findings of Kumarvel (6) in *Artermissia annua* and Chand *et al*. (2) in *Mentha arvensis*. Highest total alkaloid content (Fig. 1) was recorded with T_{12} (1.12%) while, T_3 recorded the lowest (0.45%). T_1 comprised of combination of organic manures and inorganic fertilizers without bio-fertilizers recorded considerably lower alkaloid content (0.66%). The alkaloid content was higher with high levels of FYM. Plants can perform its biochemical and physiological functions better when all nutrients are available in required quantity and in optimum proportion. The treatment T_{12} could provide sufficient quantity of organic manures which also comprised of bio-inoculants like *Azotobacter* and PSB and was favourable for multiplication of beneficial microbes which might have secreted growth promoting substances like IAA, GA and cytokinins which are responsible for the increased concentration of alkaloid. This may be due to availability and uptake of required nutrients in sufficient quantity and also improved physical, chemical and biological properties of the soil as reported by Smitha (12) in long pepper and stevia, and Sudhakara (14) in medicinal coleus.

Maximum alkaloid yield (68.3 kg ha^{-1}) was recorded in T_{12} and was *on par* with T_{13} and differed significantly with all other treatments (Fig. 1). This is due to the comparatively higher dry herb yield coupled with highest alkaloid content. Maximum net returns of Rs. 34,000 ha^{-1} was realized in T_{12} and T_1 and it was minimum (Rs. 9,050 ha^{-1}) in T_3. The B:C ratio also followed the similar trend wherein, highest B:C ratio of 1.80 was obtained in T_{13} (Table 3). The highest net return was in T_{13} as the pricing is based on yield but not on alkaloid content. If the price offered is based on alkaloid content, T_{12} is the best which gives maximum net returns because of higher alkaloid yield per hectare. Now a days the organically produced products fetches premium price in the market. If such price is offered to this crop, it would also significantly increase the net returns as well as the B:C ratio.

From the present investigation it can be concluded that the application of FYM, vermicompost and neem cake at 20, 1.0 and 0.5 tonnes per hectare along with bio-fertilizers is optimum for better growth, yield and quality of *makoi*, besides realizing maximum net returns.

REFERENCES

1. Anant Bahadur, Jagdish Singh and Singh, K.P. 2004. Response of cabbage to organic manures and biofertilizers. *Indian J. Hort*. **61**: 278-79.

2. Chand, S., Anwar, M. and Patra, D.D. 2001. Influence of combined application of farm yard manure and inorganic fertilizers on herb, essential oil yield and nutrient accumulation in menthol mint (*Mentha arvensis*). *J. Med. Aromat. Pl. Sci*. **23**: 29-33.

3. Gomez, A.A. and Gomez, K.A. 1984. *Statistical*

Table 3. Economics of m*akoi* (*Solanum nigrum* L.) cultivation as influenced by different organic manures.

Treatment		Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B:C ratio
T_1	FYM 10 t ha^{-1} + NPK @ 100:50:50 kg ha^{-1}	40,722	72,000	31,278	1.76:1
T_2	FYM 10 t ha^{-1} + VC 0.5 t ha^{-1} + NC 0.5 t ha^{-1}	34,050	44,400	10,350	1.30:1
T_3	FYM 10 t ha^{-1} + VC 0.5 t ha^{-1} + NC 1.0 t ha^{-1}	36,550	45,600	9,050	1.24:1
T_4	FYM 10 t ha^{-1} + VC 1.0 t ha^{-1} + NC 0.5 t ha^{-1}	35,800	49,200	13,400	1.37:1
T_5	FYM 10 t ha^{-1} + VC 1.0 t ha^{-1} + NC 1.0 t ha^{-1}	38,300	51,600	13,300	1.34:1
T_6	FYM 15 t ha^{-1} + VC 0.5 t ha^{-1} + NC 0.5 t ha^{-1}	36,550	54,000	17,450	1.47:1
T_7	FYM 15 t ha^{-1} + VC 0.5 t ha^{-1} + NC 1.0 t ha^{-1}	39,050	57,600	18,550	1.50:1
T_8	FYM 15 t ha^{-1} + VC 1.0 t ha^{-1} + NC 0.5 t ha^{-1}	38,300	57,600	19,300	1.50:1
T_9	FYM 15 t ha^{-1} + VC 1.0 t ha^{-1} + NC 1.0 t ha^{-1}	40,800	64,800	24,000	1.58:1
T_{10}	FYM 20 t ha^{-1} + VC 0.5 t ha^{-1} + NC 0.5 t ha^{-1}	39,050	67,200	28,150	1.72:1
T_{11}	FYM 20 t ha^{-1} + VC 0.5 t ha^{-1} + NC 1.0 t ha^{-1}	41,550	69,600	28,050	1.67:1
T_{12}	FYM 20 t ha^{-1} + VC 1.0 t ha^{-1} + NC 0.5 t ha^{-1}	40,480	72,000	31,520	1.77:1
T_{13}	FYM 20 t ha^{-1} + VC 1.0 t ha^{-1} + NC 1.0 t ha^{-1}	42,800	76,800	34,000	1.80:1

Procedures for Agricultural Research. John Wiley and Sons, New York.

4. Harborne, J.B. 1973. *Phytochemical Methods*, Champan and Hall, London, 191 p.

5. Hayworth, F., Cleawer, T.J. and Bran, J.M. 1996. The effect of manurial treatments on the yield and mineral composition of early potato. *J. Hort. Sci.* **41**: 225-41.

6. Kumaravel. 2003. Productivity and quality of *Artemisia annua* L. under organic cultivation. M.Sc. thesis, University of Agricultural Sciences, Bengaluru.

7. Pavan Yadav, Singh, P. and Yadav, R.L. 2006. Effect of organic manures and nitrogen levels on growth, yield and quality of okra. *Indian J. Hort*. **63**: 215-17.

8. Renuka, B. and Ravishankar, C. 2001. Effect of organic manures on growth and yield of tomato. *South Indian Hort*. **49**: 216-20.

9. Ridout, C.L., Price, K.R., Coxon, D.T. and Fenwick, G.R. 1989, Glycoalkaloids from *Solanum nigrum* L. - alpha solamargine and alpha solasonine. *Pharmaize*, **44**: 732-33.

10. Senapathi, B.K., Kale, R.D. and Dash, M.C. 1984. Vermicomposting present state of art. **In**: *Souvenir National Seminar on Waste Utilization and Vermicomposting* (Ed.), pp. 33-36.

11. Singhal, K.K. and Mudgal, 1982, Versatile neem. *Agri. Rev.* **4**: 2-10.

12. Smitha, G.R. 2010. Standardization of organic cultivation and propagation techniques in long pepper (*Piper longum*) and stevia (*Stevia rebaudiana*). Ph.D. thesis, University of Agricultural Sciences, Bengaluru.

13. Subba Rao, T.S.S. and Ravishankar, C. 2001. Effect of organic manures on growth and yield of brinjal. *South Indian Hort*. **49**: 288-91.

14. Sudhakara, H.A. 2005. Standardization of organic farming practices in coleus (*Coleus barbatus* Benth.). M.Sc. thesis, University of Agricultural Science, Bengaluru.

Received: January, 2009; Revised: October, 2010;
Accepted : January, 2011