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Effect of different bio-organic inputs on growth, yield and economics of turmeric grown as intercrop in arecanut plantation

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ABSTRACT

An experiment was carried out with two bio-fertilizers (*Azospirillum* and AM arbuscular mycorrhizal fungi and four organic manures (compost, vermicompost, phosphocompost and mustard cake) in comparison with inorganic management at Horticultural Research Station, Mondouri, BCKV, West Bengal to identify the suitable bio-organic combination for production of organic turmeric cv. Suguna grown as intercrop in six years old arecanut cv. Mohitnagar plantation. The plants grown under bio-organic management exhibited better growth and yield as compared to inorganic management. The maximum projected yield (28.94 t/ha) was observed with vermicompost + *Azospirillum* + AM, followed by compost + *Azospirillum* + AM (26.93 t/ha) as compared to 24.11 t/ha under inorganic management. Economic assessment of different treatments revealed that maximum return was realized from vermicompost + *Azospirillum* + AM (Rs. 1,79,712/-) followed by compost + *Azospirillum* + AM (Rs. 1,64,571/-) as compared to Rs. 93,808/- under inorganic management. The B:C ratio of the above three treatments were 1.86, 1.89 and 1.14, respectively.

Key words: Arbuscular mycorrhiza, *Azospirillum*, compost, intercropping, oil cake, organic, turmeric.

INTRODUCTION

Turmeric (*Curcuma longa* L.) is one of the important spices grown and used in India from time immemorial. India is the world's largest producer, consumer and exporter of turmeric. Indian turmeric is considered to be the best in the world market because of its high curcumin content. India accounts for bout 80 per cent of the world turmeric production and is maintaining its monopoly in production and export of turmeric. Currently, India exports to 100 countries all over the world. UAE is the major importer of turmeric from India followed by USA, Japan, UK, Iran, Singapore, Sri Lanka and South Africa. The international community is becoming more and more conscious about health and environment issues and government policies in industrialized as well as developing countries increasingly encourage organic and other forms of sustainable agriculture (ITC, 3). Growing of turmeric in arecanut plantation is a profitable combination. Keeping in view the benefits of bio-organic management system and intercropping in arecanut plantation, the present investigation was undertaken to identify the suitable bio-organic inputs for turmeric production.

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MATERIALS AND METHODS

The experiment was conducted in a 6-year-old arecanut cv. Mohitnagar plantation at Horticultural Research Station, Mondouri, BCKV during 2005 and 2006. The arecanut plants were spaced at 3.0 m × 3.0 m. Beds of 1.5 m x 1.5 m for turmeric cv. Suguna were prepared in the interspaces of four areca palms leaving 75.0 cm radius from the base of each palm and turmeric var. Suguna was planted at 25.0 cm × 25.0 cm spacing.

Two biofertilizers namely *Azospirillum brasilense* and arbuscular mycorrhiza (*Glomus fasciculatum*) and four organic manures (compost, vermicompost, phosphocompost and mustard cake) were included as bio-organic inputs. The biofertilizers were applied singly and in combination with organic manures. There are altogether 13 treatments including 100% recommended inorganic NPK. The experiment was laid out in RBD with three replications. The organic inputs namely compost, vermicompost, phosphocompost and mustard cake were applied basally during final land preparation @ 20, 5, 10 and 3 t per hectare, respectively. The mean nutrient content (N, P and K%) of different manures were: 0.75, 0.20 and 0.50% in compost; 3.00, 1.00 and 1.50% in vermicompost; 1.36, 1.80 and 1.20% in phosphocompost; 5.20, 3.00 and 0.65% in mustard cake and 5.20, 1.00 and 1.40% in neem cake, respectively (Reddy and Reddi, 10; Joshi and Prabhakar Setty, 5). Mycorrhiza was applied @ 65 kg/ha directly to the soil and *Azospirillum*

was incorporated through seed treatment @ 5 g/kg seed rhizome. Biofertilizers were collected from Nodule Research Laboratory, BCKV, Mohanpur. Healthy seed rhizomes (30-35 g) were treated with *Trichoderma viride* @ 5 g/kg seed rhizome and *Acacia* gum was used as sticker. Seed rhizomes were soaked in biofertilizer mixture for 30 min. and stirred thoroughly 4-5 times to confirm uniform soaking. After soaking, rhizome bits were dried under shade.

For inorganic treatment, turmeric was fertilized @ 150:60:150 kg NPK per hectare in 3 splits. Full P and 1/3rd N were applied as basal. 1/3rd N and ½ K were applied at 45 and 90 days after planting. Urea, single super phosphate and muriate of potash were used as inorganic source of N, P and K, respectively. Rhizomes of turmeric were planted to a depth of 3-4 cm, in the middle of April during both the years. Crops were mulched immediately with paddy straw at the rate of 10 t/ha immediately after planting and 5 t/ha at 45 and 90 days after planting. Earthing up was done before second and third mulching. On average 3-4 hand weedings were done. Irrigation was given as per requirement. Recommended dose of compost, *i.e.*, 25 kg/palm/year along with neem cake @ 3.0 kg/palm/year were applied during pre-monsoon (June) and post-monsoon (September), respectively.

The crop was harvested eight months after planting. Observations on different growth (at 180 days after planting) and yield attributing parameters were recorded from five randomly selected plants per replication. Rhizome yield was taken on net plot basis at harvest and the projected yield was calculated on the basis of yield per plot, considering the 60% area occupied by intercrop in the present investigation. The benefit : cost ratio of different treatment combinations were calculated on the basis of cost of cultivation, gross return and net return. The cost of different compost and cake were: Rs. 600 t^{-1}, Rs. 5.50 kg^{-1}, Rs. 8.30 kg^{-1} and Rs. 14.0 kg^{-1} for compost, vermicompost, phosphocompost, mustard cake and neem cake, respectively. The selling prices of turmeric under organic and general management were Rs. 900 and 700 kg^{-1}, respectively.

RESULTS AND DISCUSSION

The experimental results (pooled data) presented in Tables 1 & 2 revealed details on growth, yield and economics of turmeric production with various treatment combination. Among different treatments, maximum weight of clump/plant (326.15 g), weight of primary finger/clump (173.24 g) and yield per plot (11.51 kg/2.25 m^2) were noticed in vermicompost + *Azospirillum* + AM combination. Application of compost along with *Azospirillum* and AM recorded maximum plant height (171.86 cm) and number of leaves per clump (24.86) at 210 days after planting. Maximum tiller number (4.39) was noticed with phosphocompost + *Azospirillum* + AM, but maximum weight of secondary finger was found in plants raised with recommended inorganic NPK. Considering the projected yield per hectare, the most effective treatment was vermicompost + *Azospirillum* + AM (28.94 t/ha) followed by compost + *Azospirillum* + AM (26.93 t/ha).

The positive influence of biofertilizers on the various growth and yield parameters observed in the present study might be due to enhanced uptake of nutrients by the plants (Borea, 1). *Azospirillum* aid in increased plant growth due to their nitrogen fixing capacity and also they are known to help in the synthesis of growth promoting substances like IAA and GA (Jackson and Brown, 4). AM fungus increases the plant growth by increasing the uptake of P and other minor elements like Zn, Cu and Mn (Borea, 1). Further, AM are known to influence the water uptake (Tinker, 16). Turmeric responds well to the application of organics and biofertilizers (Srinivasan *et al*., 15). In turmeric 10% yield increase was reported with the inoculation of *Azospirillum* (Santhanakrishnan and Balashanmugam, 13). Application of vermicompost at 10 t ha^{-1} increased the rhizome yield from 6.7 - 25.5% (Vadiraj *et al*., 17). The mycorrhizal inoculation is advantageous in improving plant growth and plants inoculated with different spices of VAM fungi recorded a significant increase in growth compared to uninoculated plants (Kumar, 8).

A possible explanation for the beneficial effect of vermicompost may be due to the accumulation of mobile substances in earthworm casts as reported by many workers (Lunt and Jacobson, 9; Dash and Patra, 2; Senapati *et al*., 14). Kale *et al.* (6) observed that vermicompost application enhanced the activity of beneficial microbes like N_2 fixers and colonization by mycorrhizal fungi and hence play a significant role in N_2 fixation and phosphate mobilization leading to better uptake by the plant. Thus, the increased availability of nutrients and uptake by the plants would have resulted in better growth and yield in plots treated with vermicompost.

The maximum cost of cultivation (Rs. 109,744/-) was observed with phosphocompost + *Azospirillum* + AM, followed by phosphocompost + AM (Rs. 1,09,428/-) and phosphocompost + *Azospirillum* (Rs. 1,09,179/-), as compared to minimum cost of cultivation (Rs 82,405/-) with recommended NPK (inorganic). In respect of gross return, application of vermicompost + *Azospirillum* + AM recorded highest return (Rs. 2,76,120/-), followed by compost + *Azospirillum* +

Table 1. Effect of organic manures and biofertilizers on growth and yield of turmeric.

Treatment	Plant height (cm)	Number/clump		Weight (g)			Yield	
		Tiller	Leaves	Clump	Primary finger	Secondary finger	Plot (kg/ 2.25 m^2)	Projected (t/ha)
C + Azos.	154.40	3.78	21.50	256.16	125.65	98.35	8.80	22.06
C + AM	158.55	3.65	23.82	232.45	142.16	56.12	8.03	20.12
C + Azos. + AM	171.86	3.85	24.86	302.80	153.40	114.70	10.49	26.93
VC + Azos.	152.70	3.76	21.50	237.20	128.34	76.53	8.29	23.59
VC + AM	158.20	3.67	21.92	275.62	151.45	89.62	9.57	24.75
VC+ Azos. + AM	170.94	4.12	23.76	326.15	173.24	115.65	11.51	28.94
PC + Azos.	140.87	3.34	21.23	242.31	105.16	104.26	8.37	24.01
PC + AM	146.82	3.41	21.11	225.26	87.26	102.61	7.90	22.66
PC + Azos. + AM	149.63	4.39	21.44	259.17	152.12	68.35	8.95	24.56
MC + Azos.	147.34	3.25	19.41	194.53	94.16	65.18	6.80	17.10
MC + AM	151.08	3.43	24.53	219.72	102.52	82.30	7.60	20.00
MC + Azos. + AM	161.82	3.92	21.49	246.57	89.34	122.67	8.45	23.28
Recommended NPK	160.91	3.52	22.59	284.28	117.32	137.45	9.44	24.11
CD (P = 0.05)	7.579	0.192	NS	11.020	3.255	2.759	1.048	3.028

C = Compost, VC = Vermicompost, PC = Phosphocompost, MC = Mustard cake, Azos. = *Azospirillum*, AM = Arbscular mycorrhiza, NS = Non-significant.

Table 2. Effect of organic manures and biofertilizers on economics of turmeric production.

Treatment	Cost of cultivation (Rs. ha^{-1})	Gross return (Rs. ha^{-1})	Net return (Rs. ha^{-1})	Benefit : cost
C + Azos.	86,570	2,11,200	1,24,630	1.44
C + AM	86,738	1,92,600	1,05,863	1.22
C + Azos. + AM	87,069	2,51,640	1,64,571	1.89
VC + Azos.	95,776	1,98,840	1,03,064	1.08
VC + AM	96,053	2,29,560	1,33,508	1.39
VC+ Azos. + AM	96,409	2,76,120	1,79,712	1.86
PC + Azos.	1,09,179	2,00,880	91,702	0.84
PC + AM	1,09,428	1,89,600	80,173	0.73
PC + Azos. + AM	1,09,744	2,14,800	1,05,056	0.96
MC + Azos.	94,064	1,63,200	69,137	0.74
MC + AM	94,223	1,82,280	88,058	0.93
MC + Azos. + AM	94,512	2,02,680	1,08,168	1.14
Recommended NPK	82,405	1,76,213	93,808	1.14
CD (P = 0.05)	816.9	2,5157.7	24,772.5	0.25

C = Compost, VC = Vermicompost, PC = Phosphocompost, MC = Mustard cake, Azos. = *Azospirillum*, AM = Arbscular mycorrhiza.

AM (Rs. 2,51,640/-) and vermicompost + AM (Rs. 2,29,560/-). The lowest return was associated with mustard cake + *Azospirillum* (Rs. 1,63,200/-). In case of net return also, first and second position were occupied by vermicompost + *Azospirillum* + AM (Rs. 1,79,712/-) and compost + *Azospirillum* + AM (Rs. 1,64,571/-), followed by recommended NPK (Rs. 93,808/-). Application of mustard cake + *Azospirillum* showed minimum net return (Rs. 69,137/-) among different treatments.

Maximum magnitude of benefit : cost was observed with compost + *Azospirillum* + AM (1.89),

followed by vermicompost + *Azospirillum* + AM (1.86) and recommended NPK (1.14) though they are statistically at par. The cost of production and net return in compost + *Azospirillum* + AM were Rs. 87,069/- and Rs. 1,64,571/- as compared to Rs. 96,409/- and Rs. 1,79,712/-in vermicompost + *Azospirillum* + AM. If we consider the yield, cost of production and net return, then the best treatment was vermicompost + *Azospirillum* + AM, followed by compost + *Azospirillum* + AM. The lowest B:C ratio was noticed in phosphocompost + AM combination (0.73). Intercropping in arecanut plantation is a profitable proposition, was reported earlier by several workers. Korikanthimath *et al.* (7) obtained net profit of Rs. 45,004/- from arecanut with mixed cropping of ginger, turmeric and coffee. Sannamarappa (12) obtained a net profit of Rs. 1,71,734/- from mixed cropping of one hectare arecanut + cocoa + pepper plantation. Another high density multispecies cropping model consisting of arecanut + pepper + banana + pineapple + turmeric generated a net return of Rs. 1,85,520/- per hectare (Roy *et al*., 11). Hence, under intercropping in arecanut, for organically turmeric production the treatment combination of vermicompost + *Azospirillum* + arbuscular mycorrhiza is recommended.

REFERENCES

1. Borea, J.M. 1991. Vesicular arbuscular mycorrhizae as modifiers of soil fertility. **In**: *Advanced Soil Science*-Vol. 15, Springer-Verlag, New York, pp. 2-31.
2. Dash, M.C. and Patra, V.C. 1979. Worm cast production and nitrogen contribution to soil by a tropical earthworm population from a gravel and site in Orissa, India. *Rev. Zool. Biol. Soil*, **16**: 79-83.
3. International Trade Centre (ITC). 1999. *Organic Food and Beverages : World Supply and Major European Markets.* International Trade Centre, Geneva. Palais des Nations, 1211 Geneva 10, Switzerland, 271 p.
4. Jackson, K.M. and Brown, M.E. 1966. Behaviour of *Azotobacter chroococcum* introduced into the plant rhizosphere. *Ann. Inst. Pastenr* Paris, **3**: 108-12.
5. Joshi, M. and Prabhakarsetty, T.K. 2005. *Sustainability through Organic Farming*, Kalyani Publishers, pp. 119-314.
6. Kale. R.O., Mallesh, B.C., Bano, K. and Basvaraj, D.J. 1992. Influence of vermicompost application on the available micronutrients and selected microbial population in a paddy field. *Soil Biol. Biochem.* **24**: 1317-20.
7. Korikanthimath, V.S., Hegde, Rajendra, Sivaraman, K. and Hegde, R. 1995. Integrated input management in coffee based spices multi-storeyed cropping system. *Indian Coffee*, **59**: 3-6.
8. Kumar, G.S. 2004. Association of VAM fungi in some spices and condiments. *J. Ecobiol*. **16**: 113-18.
9. Lunt, H.A. and Jacobson, G.M. 1994. The chemical composition of earthworm casts. *Soil Sci.* **58**: 367-75.
10. Reddy, T.Y. and Reddi, G.H.S. 2002. *Principles of Agronomy*. Kalyani Publishers, pp. 200-53.
11. Roy, A.K., Srinivasa Reddy, D.V. and Sairam, C.V. 2000. Performance of areca based high density multispecies cropping system under different levels of fertilizers. *J. Plant. Crops*, **28**: 110-16.
12. Sannamarappa, M. 1993. Arecanut-based cropping system in *Maidan* parts of Karnataka. *J. Plant. Crops*, **21**: 3-6.
13. SanthanaKrishnan, P. and Balashanmngam, S. 1993. *Paper presented in All India Tuber Crops Meet at TNAU*, Feb, 1993, Coimbatore.
14. Senapati, B.K., Dash, M.C., Rana, A.K. and Panigrahi, B.K. 1980. Observation on the effect of earthworm in the decomposition process in soil under laboratory conditions. *Comp. Physiol. Ecol.* **5**: 140- 42.
15. Srinivasan, V., Sadanandan, A.K. and Hamza, S. 2000. An IPNU approach in spices with special emphasis on coir compost. **In**: *Int. Conf. on Managing Natural Resources for Sust. Agril. Prodn. In the 21st Century*. Feb. 14-18, 2000, New Delhi, pp. 1363- 65.
16. Tinker, P.B. 1975. Effect of VA mycorrhiza on higher plants. 29th *Symp. Expt. Biol*. D.G. Jennings and D.L. Lee (Eds.). Cambridge Univ. Press, London, pp. 325-49.
17. Vadiraj, B.A., Siddagangaiah and Poti, N. 1998. Effect of vermicompost on the growth and yield of turmeric. *South Indian Hort*. **46**: 176-79.

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