Studies on bio-organic inputs for production of organic turmeric grown as intercrop in arecanut plantation

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ABSTRACT

An experiment was conducted to find out the suitable bio-organic inputs for production of organic turmeric cv. Suguna grown as intercrop in six years old arecanut cv. Mohitnagar plantation. Four organic manures viz., compost, vermicompost, phosphocompost and mustard cake and two biofertilizers (Azospirillum and Arbuscular mycorrhiza) were applied singly or in combination. There are altogether 13 treatments including recommended NPK (inorganic). The seed rhizomes were treated with Trichoderma viridae and no chemical pesticide was used. The arecanut palms were also manured with compost (25 kg/palm/year) and neem cake (3 kg/palm/year). Plants grown under bio-organic inputs exhibited maximum values in most of the growth and yield parameters as compared to inorganic inputs. The highest projected yield 28.94 t/ha was recorded with vermicompost + Azospirillum + Arbuscular mycorrhiza, followed by compost + Azospirillum + Arbuscular mycorrhiza (26.93 t/ha) as compared to 24.11 t/ha under inorganic management.

Keyword: Arecanut, biofertilizers, intercropping, turmeric and vermicompost.

Turmeric (*Curcuma longa* L.) is one of the ancient and sacred spices of India. India enjoys monopoly in the production of turmeric. The demand for turmeric is increasing due to its wide utility as spice, dye in textile industry and as cosmetics (Shah, 1997). Consistent and indiscriminate use of chemical fertilizers has caused serious damage to the soil and ecology. Organic manures and biofertilizers offer a viable alternative to chemical inputs and are being increasingly used in spice production today. There is a demand for organically produced spices in developed countries like Europe, USA, Japan and Australia.

Growing turmeric in arecanut plantation proved profitable without hampering the performance of main crop (Sannamarappa and Shivashankar, 1988, Roy *et al*, 2000). Hence the present investigation was undertaken to select suitable bio-organic inputs for production of organic turmeric grown as intercrop in arecanut plantation.

MATERIALS AND METHODS

The experiment was conducted in 6 years old arecanut cv. Mohitnagar plantation at Horticultural Research Station, Mondouri, BCKV during April, 2005 and December, 2006. The arecanut plants were spaced at 3.0 x 3.0 m. Beds of 1.5 x 1.5 m for turmeric cv. Suguna were prepared in the interspaces of 4 areca palms leaving 75.0 cm radius from the base of each palm. Turmeric was planted at 25.0 x 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 were altogether 13 treatments including 100% recommended inorganic NPK. The experiment was laid out in RBD with 3 replications.

The organic inputs namely compost, vermicompost, phosphocompost and mustard cake were applied as basal during final land preparation @ 20 t, 5 t, 10 t and 3 t/ha respectively. AM was applied @ 65 kg/ha directly to the soil and *Azospirillum* was incorporated through seed treatment @ 5 g/kg seed rhizome. Healthy seed rhizomes (30-35 g) were treated with *Trichoderma viridae* @ 5 g/kg seed rhizome and *Acacia* gum was used as sticker. Seed rhizomes were soaked in biofertilizer mixture for 30 minutes and stirred thoroughly 4-5 times to confirm uniform soaking. After soaking, rhizome bits were dried under shade in airy place. For inorganic treatment, turmeric was fertilized @ 150:60:150 kg NPK per hectare in 3 splits. 1/3rd N and full P were applied as basal, rest nitrogen and potassium were applied in 2 equal split at 45 and 90 days after planting (DAP). Urea, single super phosphate and Muriate of potash were used as inorganic source of N, P and K respectively. Rhizomes of turmeric were planted at a depth of 3-4 cm, in the middle of April during both the years 2005 and 2006. Crops were mulched with paddy straw at the rate of 10t/ha immediately after planting and 5 t/ha at 45 and 90 days after planting. Three to four hand weedings were done. Irrigation was given as per requirement. Earthing up was done before second and third mulching.

As the experiment was conducted under complete bio-organic management, the scheduled nutrient management practices could not be followed in arecanut under both intercropped and monocropped

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block. 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.

RESULTS AND DISCUSSION

The pooled data presented in table 1-3, revealed a number of interesting features of growth and yield of turmeric with various combinations of organic manures and biofertilizers. The bio-organic combinations performed better over recommended dose of fertilizers in most of the cases. Among the different treatments, maximum plant height (157.89 cm), number of tiller (3.89), weight of clump (326.15 g), length of clump (18.24 cm), weight of primary finger (173.24 g), breadth of primary finger (2.23 cm) 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 number of leaves per clump (22.56), breadth of clump (13.24 cm) and length of primary finger (7.68 cm). The plants raised with recommended NPK showed highest magnitude in the characters related to secondary finger *i.e.,* number (13.85), weight (137.45 g), length (5.28 cm) and breadth (2.08 cm) of the same. 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) and vermicompost + AM (24.75 t/ha), as compared to lowest yield (17.10 t/ha) in mustard cake + *Azospirillum* combination. Application of recommended NPK recorded yield of 24.11 t/ha which is lower than the treatments with organic manures combined with both *Azospirillum* and AM.

The positive effect 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, 1991). *Azospirillum* aided in increased plant growth due to their nitrogen fixing capacity and also they might have helped in the synthesis of growth promoting substances like IAA and GA. (Jackson and Brown, 1966). VAM fungus increases the plant growth by increasing the uptake of P and other minor elements like Zn, Cu and Mn including water absorption capacity (Borea, 1991). 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, 1994, Dash and Patra, 1979, Senapati *et al.*, 1980 and Bano *et al.*, 1984). Earth worms are reported to excrete plant growth promoting substances into castes (Nielson, 1965). Kale *et al.* (1992) 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. Thomas (1965) obtained higher rhizome yield with the application of 10 t of organic manure and 5 t of green leaf as mulch, without any fertilizer application. The results of the present investigation are also in agreement with the findings of Reddy *et al.,* 2003. The experimental results clearly indicate the superiority of bio organic combination (Vermicompost+ *Azospirillum* + AM) over full inorganic for production of turmeric grown as intercrop as arecanut plantation.

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Table 1: Effect of organic manures and biofertilizers on vegetative growth of turmeric (Pooled of 2 years)

Treatments	Plant height (cm)			No. of tillers/clump			No. of leaves/clump		
	60 DAP	120 DAP	180 DAP	60 DAP	120 DAP	180 DAP	60 DAP	120 DAP	180 DAP
Compost + Azos.	57.59	95.72	141.95	1.31	2.19	3.54	4.94	13.77	19.65
Compost + AM	54.47	97.87	145.49	1.54	2.20	3.46	5.60	13.46	20.24
Compost + Azos. + AM	60.65	101.21	154.18	1.65	2.39	3.64	6.06	15.82	22.56
Vermicompost + Azos.	52.53	95.72	140.28	1.38	2.24	3.75	5.12	13.94	18.28
Vermicompost + AM	54.24	99.18	142.16	1.49	2.23	3.52	6.08	14.49	19.35
Vermicompost + Azos. + AM	63.56	113.27	157.89	1.77	2.44	3.98	6.11	15.62	21.75
Phosphocompost + Azos.	52.48	94.38	128.69	1.14	1.68	3.11	5.54	14.03	19.66
Phosphocompost + AM	50.70	95.44	131.99	1.23	1.99	3.23	4.71	13.66	19.32
Phosphocompost + Azos. + AM	56.08	95.90	138.57	1.55	2.15	4.12	5.59	14.88	19.72
Mustard cake + Azos.	52.77	93.77	129.79	1.34	2.06	3.17	5.08	13.84	17.45
Mustard cake + AM	51.82	89.10	140.15	1.31	2.00	3.28	5.19	12.69	18.26
Mustard cake + Azos. + AM	55.35	98.29	148.39	1.54	2.15	3.65	6.06	13.69	19.32
Recommended NPK(Inorganic)	69.43	120.68	151.43	1.79	2.60	3.36	7.08	15.12	20.36
SEm(±)	**1.870**	**2.150**	**2.092**	**0.134**	**0.053**	**0.038**	**0.335**	**0.912**	**0.437**
LSD(0.05)	**5.319**	**6.083**	**5.919**	**0.381**	**0.152**	**0.109**	**0.949**	**NS**	**1.236**

Table 2: Effect of organic manures and biofertilizers on clump and primary finger of turmeric (Pooled of 2 years)

Treatments	Clump / plant			Primary fingers / plant			
	Weight (g)	Length (cm)	Breadth (cm)	Number	Weight (g)	Length (cm)	Breadth (cm)
Compost + Azos.	256.16	16.72	12.32	6.72	125.65	6.86	1.92
Compost + AM	232.45	16.58	12.58	6.25	142.16	7.24	2.01
Compost + Azos. + AM	302.80	18.06	13.24	7.38	153.40	7.68	2.14
Vermicompost + Azos	237.20	17.28	11.58	6.92	128.34	6.52	1.96
Vermicompost + AM	275.62	17.53	11.53	6.45	151.45	7.27	2.16
Vermicompost + Azos. + AM	326.15	18.24	13.06	7.85	173.24	7.45	2.23
Phosphocompost + Azos	242.31	15.31	11.75	5.92	105.16	6.82	1.62
Phosphocompost + AM	225.26	15.84	10.90	6.05	87.26	6.53	1.73
Phosphocompost + Azos. + AM	259.17	16.59	12.52	6.49	152.12	7.16	2.12
Mustard cake + Azos.	194.53	14.86	11.16	6.31	94.16	6.63	1.85
Mustard cake + AM	219.72	15.64	10.80	6.15	102.52	6.84	2.13
Mustard cake + Azos. + AM	246.57	16.32	12.28	5.60	89.34	6.45	1.95
Recommended NPK (Inorganic)	284.28	17.93	12.84	6.32	117.32	6.94	2.04
SEm (±)	**3.875**	**0.355**	**0.320**	**0.274**	**1.145**	**0.189**	**0.152**
LSD (0.05)	**11.020**	**1.006**	**0.910**	**0.780**	**3.255**	**0.536**	**NS**

Azos : *Azospirillum*, **AM** : Arbuscular mycorrhiza, **NS** : Non-significant

Table 3: Effect of organic manures and biofertilizers on secondary finger and yield of turmeric (Pooled of 2 years)

Treatments	Secondary fingers / plant				Yield per plot (kg/2.25 m^2)	Projected yield (t/ha)
	Number	Weight (g)	Length (cm)	Breadth (cm)		
Compost + Azos.	8.96	98.35	4.83	1.83	8.80	22.06
Compost + AM	8.45	56.12	4.16	1.45	8.03	20.12
Compost + Azos. + AM	13.46	114.70	5.17	2.02	10.49	26.93
Vermicompost + Azos.	10.82	76.53	4.72	1.53	8.29	23.59
Vermicompost + AM	11.25	89.62	4.84	1.65	9.57	24.75
Vermicompost + Azos. + AM	12.38	115.65	5.02	2.05	11.51	28.94
Phosphocompost + Azos.	9.25	104.26	4.92	1.72	8.37	24.01
Phosphocompost + AM	8.75	102.61	5.06	1.69	7.90	22.66
Phosphocompost + Azos. + AM	9.47	68.35	4.65	1.55	8.95	24.56
Mustard cake + Azos.	7.35	65.18	4.72	1.75	6.80	17.10
Mustard cake + AM	8.26	82.30	4.85	1.66	7.60	20.00
Mustard cake + Azos. + AM	12.10	122.67	5.12	1.84	8.45	23.28
Recommended NPK (Inorganic)	13.85	137.45	5.28	2.08	9.44	24.11
SEm (±)	**0.113**	**0.970**	**0.269**	**0.341**	**0.370**	**1.070**
LSD(0.05)	**0.324**	**2.759**	**NS**	**NS**	**1.048**	**3.028**

Azos : *Azospirillum*, **AM** : Arbuscular mycorrhiza, **NS** : Non-significant

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