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Evaluation of Organic Management System for Sustainable Production of Turmeric

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INTRODUCTION

In India, the total production of spices is around 3.94 lakh tonnes among which, about 0.3 million tonnes (8–10%) is exported. The Indian share of the world trade in spices is 45–50% by volume and 25% in value. Turmeric is cultivated in more than 20 states with an area of 1.86 lakh ha with a production of 8.37 lakh tonnes during 2006-07 (DASD, 2008). Andhra Pradesh, Tamil Nadu, Orissa, Karnataka, West Bengal, Gujarat, Meghalaya, Maharashtra, Assam are some of the important states cultivating turmeric, where, Andhra Pradesh alone occupies 35% of area and 47% of production. The national productivity of the crop is 4501 kg ha^{-1} and wide variations in productivity are observed across the states. India exports only 6.48 % of its production of turmeric to more than 50 countries mainly as dry produce (63%) and powder (37%). The share of organic turmeric is only 11% compared to conventional turmeric. There is a great demand for organic turmeric in USA, Germany, France and Japan (ITC, 2004). Growing demand for natural colours in industry, fast food chains and pharmaceuticals offer a potential scope for organic production of turmeric.

Field experiments on turmeric cv. Alleppy Supreme were conducted in the experimental farm of Indian Institute of Spices Research at Peruvannamuzhi during 2004–06. Different management systems viz., fully organic (MP1) (with 20t FYM + 2t Neem cake + 1t Ash + 4t Vermicompost/ha, *Azospirillum* and Phosphate Solubilising bacteria, *Trichoderma* and *Pseudomonas* sp. as seed treatment and also as bimonthly soil application and spray of Bordeaux Mixture (1%) and neem oil (5 ml/l) for disease and pest control), fully inorganic

[MP2 with 100% inorganic recommended dose of fertilizers, seed treatment with Dithane M-45 at recommended dosage, spraying and drenching of mancozeb (0.3%) and spraying of malathion (0.1%) for control of pest and diseases] and Integrated system (MP3 with 20t ha^{-1} FYM + ½ N, P, K at the recommended levels of 60:50:120 kg/ha + P- Solubilising bacteria and spray with mancozeb and neem oil and malathion for disease and pest control). The experiments were laid out in blocks with an area of 75 m^2 each. Live fencing of the organic area with *Glyricidia* was maintained to avoid drift of chemicals between systems. Turmeric was planted in 3 × 1m^2 beds having 40 plants each. Full dose of organics were applied as basal and the application of bio-fertilizers and biocontrol agents were done at bimonthly intervals. The N (as urea) and K (as muriate of potash) were applied in two equal doses on 45 and 90 days after planting (DAP) in inorganic and integrated systems. The prophylactic spray of plant protection materials were done on 45 DAP and at monthly intervals after from June—September.

Results indicated that soil pH and organic carbon status did not differ significantly among the management systems at 120 DAP during 2004-05. The nitrogen content was the highest in integrated system and at par to organic management with the lowest under inorganic system. Potassium availability was significantly high under inorganic system. Significantly higher availability of phosphorus, calcium and magnesium was noticed in organic management. Among the micronutrients, the highest manganese and zinc availability was noticed in integrated system, whereas, iron and copper did not vary significantly among the treatments. In 2006-07, soil pH and organic carbon status did not differ significantly among the management systems at 120 DAP. The nitrogen content was the highest in integrated system at par to organic management with the lowest under inorganic system. Potassium availability was significantly high under inorganic system. Significantly higher availability of phosphorus, calcium and magnesium was noticed in organic management. Among the micro-nutrients highest manganese and zinc availability was noticed in integrated system where as iron and copper did not vary significantly among the treatments.

The soil nutrient availability after harvest of the crops showed increased soil pH to 5.4 under organic system (2004-05) compared to inorganic and integrated systems. Higher phosphorus, potassium, calcium and magnesium contents were noticed in organic and inorganic systems as compared to integrated system. Micro-nutrient availability got increased under all managements over the period. During 2005-06 also, the highest pH of 4.97 was recorded in the organic system which was on par with that of integrated system. Maximum phosphorus and potassium was recorded in the integrated system and the calcium availability was more in the organic system with the lowest in the inorganic system. Organic system recorded the maximum magnesium and copper availability. Similarly, during 2006-07 also the highest pH of 5.06 was recorded in the integrated system which was on par with that recorded in organic and inorganic system. Nitrogen content was more in the organic system and lowest in the inorganic system. Organic system recorded the maximum magnesium content. The iron content was higher in organic whereas integrated system showed highest copper content.

The overall comparison over years also showed that soil pH status did not differ significantly among the management systems at 120 DAP. But an increased soil pH under organic system compared to inorganic and integrated systems at harvest was noticed. Similar higher soil pH under organic farms over conventional management was observed in South Wales by Derrick and Dumaresq (2000). The organic carbon, nitrogen, phosphorus and potassium content were the highest in integrated system and on par to organic management at 120 DAP. Phosphorus and potassium followed the same trend during harvest also. Nitrogen did not vary significantly among the treatments. Significantly higher availability of calcium magnesium and zinc was noticed in organic management both during 120 DAP and harvest. Iron content did not vary significantly among the treatments (Tables 16.1 and 16.2).

Table 16.1. Overall comparison of soil status under different systems of turmeric (2004–07) at 120 DAP

Treatments	*pH (1:2)*	*OC%*	*N*	*P*	*K*	*Ca*	*Mg*	*Fe*	*Mn*	*Zn*	*Cu*
							ppm				
Organic	5.09	2.01	150.4	8.65	198	493.6	160.8	48.4	6.32	0.78	1.19
Inorganic	4.97	2.09	152.0	7.66	265	396.3	123.0	43.9	8.46	0.64	1.54
Integrated	4.82	2.15	168.7	10.3	273	426.7	140.8	49.1	8.96	0.78	1.35
CD(P = 0.05)	NS	0.11	11.3	1.8	33	62.5	21.7	NS	1.3	0.08	0.17

NS = Not Significant

Table 16.2. Overall comparison of soil status under different systems (2004–07) at harvest

Treatments	*pH(1:2)*	*OC%*	*N*	*P*	*K*	*Ca*	*Mg*	*Fe*	*Mn*	*Zn*	*Cu*
							ppm				
Organic	5.16	1.83	154.3	2.49	212	597.3	96.0	48.7	9.87	1.0	1.13
Inorganic	4.65	1.75	149.7	2.02	213	397.9	73.3	51.5	9.74	0.75	1.22
Integrated	4.80	1.93	146.5	2.68	231	431.6	83.3	48.6	9.77	0.85	1.17
CD(P = 0.05)	0.17	0.07	NS	0.53	NS	67.8	12.3	NS	NS	0.12	NS

NS = Not Significant

The overall data on microbial population showed that the total bacteria, *Azospirillum*, Pseudomonas, actinomycetes and trichodermal population was the highest in the organic system. The fungal population was lower in inorganic system, followed by organic system. The population of Phosphobacteria was the highest in integrated system and was comparable with that of organic system (Table 16.3). The presence of vermi-compost, neem cake and farmyard manure enhances the microbial population of organic system. The overall population dynamics under organic system was comparable with that of integrated system which contributes significantly to yield, nutrient and quality parameters. Application of coir pith compost, *Azospirillum*, Phosphobacteria and VAM induced maximum IAA oxidase and peroxidase activity in turmeric (Velmurugan *et al.*, 2002). Mohan *et al.* (2004) recorded a linear response of turmeric growth, yield and quality of turmeric with inoculation of *Azospirillum* in combination with N levels compared to that of *Azotobacter* under Karnataka conditions. No incidence of rhizome rot was observed in all the treatments over the years. The organic and integrated system showed only up to 2.5 % shoot borer attack as compared to chemical control.

During the first year (2004-05), the fresh rhizome yield was significantly highest in the integrated management system followed by inorganic system with the lowest yield in organic system. Yield reduction of 13.6 and 25.5% was observed under organic management as compared to inorganic and integrated systems, respectively. During 2005-06, significantly high fresh rhizome yield of 33.38 t/ha was noticed in the treatment where integrated management practices are followed (Table 16.3). This was followed by 23.68 t/ha in the organic treatment which was on par with inorganic treatment (22.44 t/ha). In 2006-07 also, significantly high fresh rhizome yield of 29.98 t/ha was noticed in the treatment where integrated management practices are followed. This was followed by 26.60 t/ha in the organic treatment on par with the yield recorded by inorganic treatment (26.22 t/ha) when repeated at the first years location after raising a legume. Living mulches of legumes as cover crops can fix atmospheric nitrogen and improve soil quality (Sjoerd *et al.*, 2004) and thereby yield. Application of FYM increases the organic carbon, available P and effective cation exchange capacity content in the soil thereby improving the fertility which inturn improves the fresh rhizome yield. Similar increase in plant height, number and weight of mother, primary and secondary rhizomes and fresh rhizome yield and increased nitrogen, phosphorus and potassium contents in leaves and rhizome with farmyard manure application was reported by Gill *et al.* (2004). The overall soil fertility build-up under organic system was comparable with that of integrated system. In turmeric, combined application of different organic sources like FYM + pongamia oil cake + Neem oil cake + Stera meal + Rock phosphate + wood ash has yielded on par to the conventional practice in addition with high quality (AICRPS, 2006). Application of vermi-compost at 10t ha^{-1} increased the rhizome yield from 6.7–25.5 % in small cardamom (Vadiraj *et al.*, 1998).

Table 16.3. Different management systems on yield of turmeric

Treatment	*Yield (t ha^{-1})*		
	2004-05	*2005-06*	*2006-07*
Organic	31.0	23.68	26.60
Inorganic	35.9	22.44	26.22
Integrated	41.7	33.38	29.98
CD (P=0.05)	3.09	3.99	2.02

Among the quality aspects, significantly highest oil content was recorded in organic system on par with integrated system in 2004-05, but during next years oil content did not vary significantly between treatments. Inorganic system recorded the lowest oil. Oleoresin content also followed the same pattern with the highest content in organic management. During 2005–07 also the oleoresin content was the high under organic management on par with that of integrated management. Curcumin content was highest under the integrated system (5.49%), on par with organic system during 2004-05 and in the following years also significantly highest curcumin levels were observed under organic system on par with that of integrated system. Significantly highest starch content of 43.9% was noticed in 2004-05 under the organic system and it was on par with that of integrated system (39.7%) during 2005-06 (Table 16.4). The application of groundnut cake (1.1 t/ha) significantly increased the dry yield and the highest curcumin production on par to neem cake application (2.5 t/ha) (Sadanandan and Hamza, 1998). The differences in the management of soil fertility also affects soil dynamics and plant metabolism which results in quality.

Table 16.4. Quality parameters as affected by different management systems over the years

Management	*2004-05*		*2005-06*		*2006-07*	
Quality	*Oleoresin (%)*	*Curcumin (%)*	*Oleoresin (%)*	*Curcumin (%)*	*Oleoresin (%)*	*Curcumin (%)*
Organic	19.46	5.39	15.26	5.40	12.67	6.15
Inorganic	16.50	4.56	12.79	5.09	11.65	5.55
Integrated	18.71	5.49	14.99	4.81	12.47	5.85
CD (P=0.05)	0.87	0.51	0.89	0.34	0.94	0.50

The economic evaluation of the various management systems revealed that the integrated and inorganic systems recorded the highest B:C ratio of 1.83 and 1.87 followed by the organic system recording 1.50, with the prevailing price of Rs. 50 per kg of dry produce. If a 20% premium price is considered for the organically grown produce, the B:C ratio of organic system will be 1.78. If the organic inputs like FYM, vermi-compost and coir compost are internally produced within the farm itself, the B:C ratio will become 1.79 in the case of organic system. A case study on the sustainability of three apple production systems showed price premiums of 12% for the organic system to match the break-even point of the conventional system (John *et al.*, 2001).

Organic farming is an alternative agriculture to conventional methods of crop production for sustaining soil productivity and ecological balance. The overall results showed the positive influence of organic cultivation on the quality aspects of turmeric and also on the soil fertility build-up, even though the yield returns were higher under integrated management. An increased yield from third year of conversion and quality and microbial abundance reflects better nutrition of the crop under organic mode. Our results showed that organic and integrated systems are not only better for soil and the environment than their conventional counterpart but have comparable yields and quality. Premium price is the major constraints for marketing of organic turmeric. Currently, growers of more sustainable systems may be unable to maintain profitable enterprises without economic incentives such as price premiums for organic products. The organic turmeric cultivation will be a sustainable venture when a premium price for the product is assured.

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