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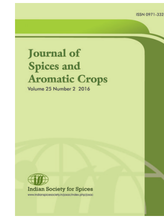

Nutrient management in turmeric (*Curcuma longa* L.) in an integrated farming system in southern Kerala

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Abstract

A field trial was conducted to assess the effect of different organic manures produced *in situ* in an integrated farming system at Farming Systems Research Station, Sadanandapuram during 2012–13 on the performance of turmeric, variety *Suguna*, grown as component crop in the system under nutrient recommendation of 30:30:60 kg NPK ha^{-1}. Higher plant growth was recorded in the treatment integrating 75% recommended dose nitrogen as organic manures and remaining 25% as inorganic fertilizers. Rhizome yields were significantly highest (42.71 t ha^{-1}) in the treatment receiving vermicompost along with chemical fertilizers followed by poultry manure substitution (33.08 t ha^{-1}) and sole organics - integration of vermicompost enriched with PGPR Mix I with poultry manure and goat manure (31.61 t ha^{-1}). Net returns per ha ranged between Rs. 1.82 lakh (inorganic fertilizers alone) and Rs. 5.8 lakh (vermicompost + inorganic fertilizers) and benefit cost ratios between 1.76 and 3.19.

Keywords: integrated, *in situ*, nutrients, turmeric, vermicompost, yield

Turmeric (*Curcuma longa* L) is a suitable intercrop for coconut gardens and is considered a component crop in integrated farming systems. Peter *et al*. (2000) have reported turmeric to be an exhaustive crop that responds well to judicious application of fertilizers and manures. Under integrated systems, the use of organic manures assumes importance as these systems have ample scope for organic recycling of biowastes that are produced *in situ* (Jayanthi *et al.* 2009). Application of organics improves physical, chemical and biological properties of the soil and maintains favourable environment for the growth of the crop, but when used alone these cannot meet the nutrient requirement of the crop (Singh 2007), while chemical fertilizers are crippled with the disadvantages of high acid contents and depletion of soil productivity. Hence, conjunctive use organic and inorganic fertilizers becomes indispensable in crop production. It is in this background that a field experiment was attempted to assess the effect of application of organic manures produced *in situ* in the farm in combination with inorganic fertilizers sources on growth, and yield of turmeric.

The field experiment was conducted in the integrated farming system unit at Farming Systems Research Station, Sadananapuram, Kottarakkara, Kerala. The site lies in Vettikavala

Block, Kollam district, Kerala State (latitude 9°16'N, longitude 76°37'E, altitude 91.44 m above MSL) and enjoys a warm humid tropical climate with mean maximum temperature 35.13°C and minimum temperature 23.13°C. Soil chemical analysis revealed an initial pH of 4.1, available N, P and K, 128.5, 12.82 and 212.16 kg ha^{-1}, respectively. The turmeric variety, *Suguna* was raised during June 2012–January 2013 in randomized block design with six treatments of different combinations of nutrient sources. The sources used in the experiment included chemical fertilizers (urea, rajphos, muriate of potash) and organic manures produced *in situ* in the farm (vermicompost -1.84% N, goat manure-5.93% N, poultry manure-4.97% N). The Kerala Agricultural University package of practices NPK recommendation of 30:30:60 kg ha^{-1} was the nutrient dose adopted for the study. The treatment combinations were T_1: 25% recommended dose nitrogen (RDN) as inorganic fertilizers + 75% RDN as vermicompost, T_2: 25% RDN as inorganic fertilizers + 75% RDN as goat manure, T_3: 25% RDN as inorganic fertilizers + 75% RDN as poultry manure, T_4: 50% of RDN as organic manures + 50% RDN as inorganic fertilizers, T_5: 100% recommended dose NPK as organic manures, T_6: 100% recommended dose NPK as inorganic fertilizers. Phosphorus and potassium were supplied through inorganic sources in all the treatments except for T_5. Basal dose of organic manure was applied in the pits prepared at 25 cm × 25 cm spacing along with the full dose of phosphorus and half potassium. Nitrogen application was done after sprouting (8-10 days) as per treatments fixed (organic nutrients in four splits at fortnightly intervals) and remaining K, one month after sprouting. Need based plant protection measures were adopted and observations recorded at periodic intervals. The crop was ready for harvest in seven months and yield data recorded. The tabulated data were subjected to statistical analysis (Gomez & Gomez 1984), interpreted and conclusions drawn.

The results of the study are presented in Tables 1 & 2. Perusal of the data revealed that the initial growth in turmeric was not influenced by the sources used, but significant variations were recorded in the later stages, 5 and 6 months after planting. Taller plants were recorded in the treatments including goat manure (108.3 cm) and poultry manure (105.93 cm) and were on par, but, significantly greater than the inorganic treatment. The number of tillers ranged between 2.7 and 5.0, higher values being recorded for vermicompost application along with chemical fertilizers on par with poultry manure application. Growth of turmeric was found to better in the combined application of organic manures (75% N) and inorganic fertilizers (25% N) than the sole use of inorganic fertilizers. Significant variations were noticed only in the 5th month after planting which can be attributed to the slow but steady availability of nutrients in the treatments including organic manures which would have enhanced plant growth in terms of height and tiller production.

The effect of different nutrient sources on the yield was significant, and the inclusion of organic manures recording the higher yields per plant and per hectare compared to use of inorganic fertilizers alone. Chemical fertilizers contain higher amounts of nutrients and are sources of readily available form of nutrients, but, the fertilizers use efficiency is often low due to the inherent soil characters, losses and low uptake. It is documented that application of the inorganic fertilizers in conjunction with organic sources stimulates the mineralization of N and S and diminishes the fixation of P and K in acidic soils (Kamat *et al*. 1982; Singh *et al*. 2001) thus improving the nutrient use efficiencies. The integration, in addition to the improvements in nutrient availability and uptake influences the soil physical and biological properties favourably, which reflects positively on the growth and yield of crops.

The yield attributes, number of fingers/ rhizomes, length and girth of fingers were highest in the treatment receiving vermicompost as nutrient source, fresh weights per plant and per hectare correspondingly recording highest yields in this treatment. This was nearly 33.6% greater than yield per plant in the inorganic fertilizers applied treatment. Significant variations noted in the vermicompost treated

Table 1. Effect of various nutrient source combinations on growth of turmeric

Treatments	Height (cm)				No. of tillers plant^{-1}
	2 MAP	3 MAP	5 MAP	6 MAP	
T_1	14.53	35.73	87.10	99.67	5.0
T_2	15.76	38.23	91.67	108.63	4.0
T_3	14.60	37.10	86.80	105.93	4.7
T_4	15.83	36.50	81.90	93.90	3.3
T_5	13.93	35.40	76.00	92.50	2.7
T_6	13.17	34.00	64.10	81.00	3.7
SE	1.57	6.25	7.72	6.08	0.724
CD	NS	NS	17.2	13.55	NS

T_1=25% RDN (inorganic fertilizers) + 75% RDN (vermicompost); T_2=25% RDN (inorganic fertilizers) + 75% RD N (goat manure); T_3=25% RDN inorganic fertilizers)s + 75% RDN (poultry manure); T_4=50% of RDN (organic manures) + 50% RDN (inorganic fertilizers); T_5=100% recommended NPK dose (organic manure); T_6=100% recommended NPK dose (inorganic fertilizers); MAP=months after planting

Table 2. Rhizome yield, yield attributes and economics of turmeric cultivation with different nutrient sources

Treatments	No. of fingers/ rhizome	Length of finger (cm)	Girth of finger (cm)	Fresh weight of rhizomes/ plant (g)	Rhizome yield (tha^{-1})	Cost of cultivation Rs. ha^{-1}	Net returns Rs. ha^{-1}	B:C
T_1	14.0	6.8	2.63	456.67	42.71	268050	586150	2.42
T_2	11.0	5.1	2.33	362.43	33.08	256300	263900	3.19
T_3	13.7	6.0	2.37	405.87	26.01	256900	404700	2.32
T_4	10.3	5.7	2.90	388.83	31.61	272875	359325	2.03
T_5	9.0	4.4	1.93	341.68	26.18	216025	307642	2.31
T_6	7.0	5.4	2.17	291.80	21.22	241825	182708	1.76
SE	1.01	0.58	0.60	37.59	4.88	-	-	
CD	2.25	1.31	NS	83.74	10.87	-	-	

T_1=25% RDN (inorganic fertilizers) + 75% RDN (vermicompost); T_2=25% RDN (inorganic fertilizers) + 75% RD N (goat manure); T_3=25% RDN inorganic fertilizers) + 75% RDN (poultry manure); T_4=50% of RDN (organic manures) + 50% RDN (inorganic fertilizers); T_5=100% recommended dose NPK (organic manure); T_6=100% recommended dose NPK (inorganic fertilizers)

plants would be due to the beneficial effect vermicompost has in improving the soil environment which in turn encourages proliferous root growth resulting in better absorption of moisture, nutrients and thus produces higher biomass (Vadiraj *et al*. 1998). The easily available forms of nutrients besides growth stimulating substances (enzymes, antibiotics and growth hormones) present in vermicompost could be responsible for the better growth noticed. Integration of chemical fertilizers with vermicompost have been found to be superior in ginger (Vastrad 1999; Pradeepa 2003). However, in this study use of goat manure and poultry manure to meet 75% N requirement also recorded good yields. Patel *et al*. (2012) have reported that the application of recommended dose of N through poultry manure in combination with recommended dose of essential nutrients significantly improved the yield of turmeric. Channabasanagowda *et al*. (2008) reported the differential action of organic manures and attributed this to the slow release of N due to slow mineralization which helps in availability of nutrients to the plants throughout the growth of the plant and thus resulting in higher yields compared to usage of farm yard manure and glyricidia. Nadukeri & Kattimani (2012) opined that increased tuber yield in coleus might be due to the fact that vermicompost and FYM supplied higher amount of major and micronutrients and combined application resulted in higher uptake of the major nutrients.

Sole use of organic manures also recorded yields better than 50% and 100% inorganic fertilizers bringing to light the significance of organic nutrition in turmeric cultivation. It is interpreted that the different organic sources ensured a steady release and availability of nutrients throughout the growth period of turmeric (seven month duration) while in the 100% inorganic fertilizers treatment, the availability was confined to the first three months of the crop.

The economics of the cultivation are presented in Table 2. The slightly higher cost of cultivation in the organic treatment has been on account of the more labour needed for the application and incorporation of the manures compared to fertilizers use. Nevertheless, the cost of organic inputs in an integrated system may be ignored as these are available *in situ*. Analysis of the economics of using different nutrient sources in turmeric revealed highest benefit cost ratio of 3.19 with the use of vermicompost for 75% N substitution and least for the use of chemicals alone (1.76).

The study clearly brings to light the significant influence organic sources have on the growth and yields in turmeric. Of the integrations tried, use of vermicompost was found to be the best followed by poultry manure substitution of 75% N. Organic inputs produced *insitu* can be efficiently used as nutrient source in turmeric cultivation in an integrated farming system as this permits easy and safe recycling of the biowastes available and harvest of chemical free produce.

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