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Organic Production of Turmeric: A New Methodology to Improve Yield

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ABSTRACT: The trial has been conducted at the turmeric research station, kammarpally for the continuous of three years (2017-2020) to assess the potential of organic methodology developed by Indian Institute of Spices Research. The application of organic manures in the agricultural sector plays a key role in improving the quality of turmeric as well as improving the soil health. Turmeric helps in improving immunity and controls many diseases hence demand of organically grown turmeric is increasing tremendously. A field experiment has been conducted to study the organic cultivation of turmeric. In this trial a comparative study of organic cultivation over inorganic cultivation was undertaken with 3 varieties Prathibha, IISR-Pragathi (ACC-49) and Duggirala red to study the effect of different organic manures package in turmeric. Organic manures *viz.,* PGPR Stain of GRB-35, FYM, neem cake, vermicompost, sulphate of potash, IISR- turmeric booster used as organic source of nutrients formulated by Indian Institute of Spices Research, Kozhicode, Kerala for this trial. Maximum mean yield (44.18 t/ha) was observed from organic production with variety Prathibha followed by IISR-Pragathi (39.48 t/ha). Highest mean plant height (106.75), number of shoots (2.38), number of leaves (11.4), leaf length (50.1), leaf width (15.9) were recorded from the organic production module over traditional inorganic method of cultivation.

Keywords: Vermicompost, FYM, Fresh rhizome yield, Turmeric booster, GRB-35 strain.

INTRODUCTION

The turmeric (*Curcuma longa* L) is one of the important spice crops cultivating in India also known as golden spice. The use of turmeric for medicinal and cosmetic purposes increasing over the years in India. Due to increase in health consciousness most of the persons in the world consumes only organically grown products as daily consumption. As turmeric is exhaustive crop it requires high amount of nutrients for boosting the yield of the crop. Green revolution triggers the use of chemical fertilizers to great extent in India. Balanced use of organic and chemical fertilizers is much needed in this era. Heavy usage of chemical fertilizers harms the soil health and causes ecological imbalance. It is important to adopt the balanced use of organic manures and bio-fertilizers for the ecological balance and correct management of soil health. The use of organic manures and bio-fertilizers improve soil macro and micro flora and these are eco friendly.

Several researchers reported the importance of various bio-fertilizes and organic manures in turmeric relation to soil health, quality and productivity of the crop Velmurugan *et al.* (2009); Kumar *et al.* (2018). The concept of organic farming is gaining momentum in the world for sustainable production and enhancement of quality of the turmeric (Sadanandan *et al*., 1998). The continuous use of an heavy amount of chemical fertilizers badly affects soil health as well as causes soil and environmental pollution. Application of vermicompost to soil increase the availability of micronutrients to plants (Vasanthi and Kumaraswamy 1999). The judicious application of organic manures increase the porosity, water holding capacity and drainage which helps for better rhizome development in turmeric (Kale *et al*., 1991). It also improves soil micro and macro flora and enhances their activities in the soil. Various biological processes in the soil help for mineralization of organic carbon and recycling of nutrients (Kumar *et al.,* 2018). In Japan, similar study was conducted by Yokio (2002) on the policy development of organic agriculture and future perspectives. The study revealed that the public greatly concern about food safety issues owing to the recent incidents of mad cow disease (Bovine Spongiform Encephalopathy) and the detection of excess pesticide residues and the use of prohibited pesticides. Hence, policies on organic agriculture and organic food have been developed in terms of the "JAS Organic"

(Japanese Agricultural Standards) accreditation system and technological support of organic farming. Faidon *et al*. (2006) reported the critical and transparent overview of organic food safety to identify potential drawbacks in organic food production. The results revealed that food safety of organic verses conventional produce is difficult because of divergent conditions prevailing in terms of soil, water, climatic conditions. Organic food is not free from pesticides. However, fruits and vegetables are grown under organic farming can be found much less agrochemical residues than their conventional alternatives. Further, the health risk associated with dietary exposure to agrochemicals remains to be evaluated. Organically cultivated nitrophillic vegetables *viz.,* leafy root and tuber were found lower content than the respective conventional ones. Singh and Dinesh (2007) have explained organic farming vis-à-vis human health and environment. The study revealed that organic farming was superior to conventional farming or chemical farming in terms of pollution free environment, good quality of food and health: conventional farming was produced food and fodder by using chemical fertilizers and pesticides, which contaminated the food, health hazardous and environment pollution. Besides, organic farming produces good quality of food, by using different plant nutrition, weed management, pest and disease management so that eating of organic food considerably reduces the heart attacks, strokes, cancer, bowel cancer and many other diseases. Organic farming isn't necessarily the best option for long-term agriculture and food security, but judicious mixtures of organic and conventional practices could help boost global agriculture output (Meemken and Qaim 2018). Organic farming is one of the fastest-growing sectors in agriculture, contributing to 1% of the world's agricultural area. It is a farming system that uses fertilizers of organic origin such as compost manure, green manure, and bone meal and places emphasis on techniques such as crop rotation and companion planting (Seufert *et al.,* 2017).

Rajeev *et al.* (2013) reported that application of organic manures growth, yield and quality of turmeric (*Curcuma longa* L.) influenced by organic manures like cow dung, poultry manure, mustard cake and neem cake have significant influence on growth, yield, yield parameters and quality of turmeric. Sustainable farming is important because it offers solutions for the contemporary issues of traditional farming. Soil is considered a nonrenewable resource, sustainable farming promises to protect and preserve soil health. Furthermore, it addresses most of the public concerns, including corrective measures to continue health disparities among people of color, and reforming industrial practices, such as reducing the use of antibiotics where the production and processing conditions can be harmful to human as well as animal health (Ebitu *et al.,* 2021). Sharma *et al.* (2009) reported that increase in available nutrient content in soil with the use of organic manures. Akamine *et al.* (2007) reported that combined application of NPK will give 4 to 6 times greater shoot biomass and 8 to 9 times higher rhizome yield. The turmeric growing in north coastal hills of India is mainly cultivated as rainfed crop without any fertilizer application. The farmer in this area cultivates turmeric up to 2 to 3 years instead of 8 to 9 months got very low income with their produce. It is mainly due to lacking of proper knowledge in optimum use of nutrients and organic farming methods in turmeric cultivation. Hence, this trial has been conducted to study the effect of different organic manures on growth and yield of turmeric.

MATERIALS AND METHODS

The field trial has been carried out to study the effect of organic manures on growth and yield of turmeric on vertisols at Turmeric research station, Kammarpally, Nizamabad district, Telangana during three consecutive years from 2017-18 to 2019-20. The initial soil status of the experiment was less alkaline pH (7.65), electric conductivity 0.15 dS m^{-1}, low organic carbon with medium available nitrogen (250 kg ha^{-1}), high available phosphorus (32.57 kg ha^{-1}) and high available potassium (332.7 kg ha^{-1}).

Practice	T1- Organic production developed by IISR	T2- SAU recommendations
Pre sowing Rhizome treatment	Seed treatment PGPR Stain of GRB-35 Capsule in 100 lit of water Seed rhizomes dipped in PGPR Solutions	Seed treatment Ridomyla@ 0.2% and Imidacloprid @0.05 %
Basal application	Organic manures to be applied before last ploughing FYM 25 to 30 t/ha, Neem cake 2t/ha	Top dressing FYM 20 t/ha, Neem cake 0.6 t/ha, SSP- 0.38 t/ha, MOP- 0.18 t/ha
Top dressing	Organic manures top dressing at 45^{th} and 90^{th} DAP, Vermicompost 2 t/ha, Ash 0.5 t/ha, Sulphate of Potash 50 kg/ha	Neem cake 0.6 t/ha (200 gram/plot)
Micro nutrients application	Foliar spray at 60^{th} and 90^{th} DAP IISR- Turmeric booster @ 5 gr/lit of water (3-4 kgs /ha)	Formula-6@ 20 kg/ha
Pest & Diseases control	Neem oil @ 0.5% B.M @ 0.1%	Chemicals recommended as per the pest and disease incidence

This experiment has been laid out in a randomized block design with three replications. The treatments comprised general recommended T1-Organic package developed by IISR, T2-State Agriculture University package. The seed has been sown in the month of June and harvested at 8 months crop stage in the month of March during the experimental years.

This experiment conducted with two treatments (T1-Organic module developed by IISR; T2- Recommended practices of SAU) with three varieties V1-Duggirala Red, V2-IISR Pragathi and V3-ISSR Prathibha. All the treatments were replicated for three times. In this experiment growth, yield characters were recorded.

RESULTS

Vegetative characters. Significant differences were observed with all the growth parameters and the maximum mean plant height (106.75 cm), number of shoots (2.38), number of leaves (11.4), petiole length (24.4 cm), leaf height (50.5 cm), and leaf width (15.9 cm) were recorded with organic module developed by IISR. Among the varieties maximum mean plant height, number of shoots, petiole length, leaf height, and leaf width were recorded in IISR Prathibha variety followed by IISR Pragathi which cultivated in organic methodology. More number of leaves was observed in IISR Pragathi variety followed by IISR Prathibha with organic module method. All the growth parameters were differed significantly with the IISR organic module which comprises mainly FYM, vermicompost and turmeric micronutrient booster.

The increased vegetative growth in turmeric may be due to an increase in the activity of enzymes like chitinases and proteases that breaks down the organic-rich compounds. The availability of micro and macro nutrients were increased by the activities of micro flora and fauna with the application of vermicompost, FYM, organic and inorganic fertilizers (Kumar *et al.*, 2018). These results are in conformity with Poapst *et al.* (1970), who reported that earthworm castings from verimcompost shows hormonal activity and triggers plant nutrient uptake and plant metabolism resulted in increase of plant growth. Ganeshnauth *et al.* (2018) found the chlorophyll level increased by organic fertilizer in pepper plants. The vegetative growth of the turmeric crop is influenced by the use of organic manures like FYM and Vermicompost revealed an increase in turmeric crop yield as well as enhancement of the physical, chemical and biological properties of soils (Dudhat *et al*., 1997).

Yield characters: The maximum mean fresh rhizome yield per plot (16.59 kg/plot) and maximum mean fresh rhizome yield per hectare (44.18 t/ha) with organic module developed by IISR and among the varieties high fresh rhizome yield was observed with the IISR Prathibha variety followed by IISR Pragathi with organic cultivation methodology.

These results are in line with several workers (Roy and Hore 2011; Nanda *et al*., 2012). Balashanmugam *et al.* (1989) who enunciated that an increase in fresh turmeric rhizome yield from 25,550 kg ha^{-1} to 32,370 kg ha^{-1} with an increased dose of FYM from 0 to 25 tonnes ha^{-1} in CO-1 turmeric crop. Sadanandan *et al.* (1998) reported an increase of 37 per cent in the fresh rhizome yield of turmeric over control with 40 tonnes per hectare with the application of compost or cattle manure in the soil. The findings reported by Kushwah *et al*. (2016); Yadav *et al.* (2019) stated that It is possible due to combine application of NPK and Vermicompost may promoted the nitrogen content in the plant parts which pointers to the increased the chlorophyll content of leaf and ultimately increases the fresh weight of leaf. The field experiment has been conducted by Sharma *et al*. (2003) at Jabalpur, Madhya Pradesh and reported that effect of organic manures and chemical fertilizers alone and in combination with each other on the yield of turmeric. They noticed that the application of chemical fertilizers reduced the fresh rhizome yield in turmeric in succeeding years while application of organic manures in the form of vermicompost or FYM increased the fresh rhizome yield of turmeric by 7 to 10 per cent over the preceding year. The maximum amount of organic carbon (0.80 %) was observed in the application of FYM which was on par with press mud cake and sugarcane trash. Organic farming improves soil physic-chemical properties and increases nutrient availability, water retention, and phosphate solubilization. In addition, organometal fertilizer enhances plant agro-physiological traits. It increases plant biomass and yield, improves nutrient assimilations, and improves plants physiological metabolism (Atere and Olayinka 2012; Crusciol *et al*., 2020). It has been observed that improvement in available nutrients with vermicompost or FYM application due to mineralization of nutrients from organic manures in soil (Yaduvanshi, 2001). Sreenivas *et al.* (2000) reported that the use of vermicompost, FYM and biofertilizers enhance the soil health, nutrient reaction and their availability. Sharma *et al*. (2004) reported positive influence of vermicompost and organic manures on the availability of all essential plant nutrients during the crop period. The large increase in seed production caused by vermicompost mainly came through improved growth, which led to improvements in several yield metrics. It would involve better metabolite partitioning that is efficient and effective, as well as proper nutrient transformation to growing plant structures. The maximum amount of organic carbon (0.80 %) was observed in the application of FYM which was on par with press mud cake and sugarcane trash. Organic farming improves soil physic-chemical properties and increases nutrient availability, water retention, and phosphate solubilization. In addition, organometal fertilizer enhances plant agro-physiological traits. It increases plant biomass and

yield, improves nutrient assimilations, and improves plants physiological metabolism (Atere and Olayinka 2012; Crusciol *et al*., 2020). Yadav *et al*. (2019); Pradhan (2019) who reported that the integration of different sources of plant nutrients (e.g. FYM, vermicompost, other manures etc.) has a satisfactory role on all the yield attributes as a single sole crop or as a component crop of a cropping sequence of three or four crops. This may be due to the fact that a little bit substitution of chemical fertilizers through organic manures has been proved to be a better choice. This type of combined use generally keeps the physical condition of soil efficient besides providing nutrients to the plant progressively but in a steady manner along with the added advantage of rapid, bounty and easy nutrient supplying capacity of chemical fertilizer to the crops and ultimately results in yield escalation.

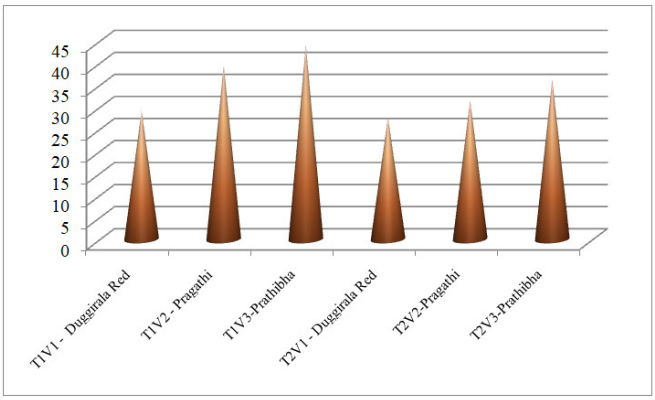

Fig. 1. Organic production of turmeric: A new methodology to improve yield.

Table 1: Organic production of turmeric: A new methodology to improve yield.

Treatments	Plant Height (cm)			Pooled mean	Number of shoots			Pooled mean	Number of leaves			Pooled mean	Petiole length (cm)			Pooled mean
	2017-18	2018-19	2019-20	Pool mean	2017-18	2018-19	2019-20	Pool mean	2017-18	2018-19	2019-20	Pool mean	2017-18	2018-19	2019-20	Pool mean
T1V1 - Duggirala Red	80.8	71.25	80.8	77.61	2.0	2.35	2.0	2.11	9.3	9.7	9.3	9.4	21.95	13.9	21.95	19.2
T1V2 - Pragathi	100.15	113.3	100.15	104.53	2.3	2.50	2.3	2.36	10.7	12.8	10.7	11.4	19.8	17.25	19.8	18.9
T1V3-Prathibha	106.55	107.15	106.55	106.75	2.4	2.35	2.4	2.38	8.4	14.95	8.4	10.5	28.25	16.85	28.25	24.4
T2V1 - Duggirala Red	83.75	72.15	83.75	79.88	2.0	2.10	2.0	2.03	7.2	9.25	7.2	7.8	20.45	12.7	20.45	17.8
T2V2-Pragathi	110.9	93.25	110.9	105.01	1.5	2.60	1.5	1.86	7.8	11.1	7.8	8.9	17.52	13.2	17.52	16.0
T2V3-Prathibha	108.85	93.9	108.85	103.86	1.7	2.35	1.7	1.91	6.7	37.65	6.7	17.0	21.95	14.8	21.95	19.5
SE(m)	5.201	5.92	5.201	3.85	0.193	NS	0.193	0.193	0.16	0.69	0.160	0.33	1.027	0.98	1.027	1.0
CD (5%)	15.82	18.01	15.820	12.29	0.587	NS	0.587	0.587	0.48	2.10	0.487	1.02	3.125	3.00	3.125	3.0
CV %	10.560	12.92	10.560	6.92	19.164	19.21	19.164	19.17	3.82	12.13	3.826	6.59	9.490	13.42	9.490	10.8

Table 2: Organic production of turmeric: A new methodology to improve yield.

	Leaf height (cm)			Pool mean	Leaf width (cm)			Pool mean	Fresh rhizome yield kg/plot			Pool mean	Fresh rhizome yield t/ha			Pool mean
Treatments	2017-18	2018-19	2019-20		2017-18	2018-19	2019-20		2017-18	2018-19	2019-20		2017-18	2018-19	2019-20	
T1V1 - Duggirala Red	46.2	37.35	46.2	43.25	12.3	13.15	12.3	12.58	9.61	13.6	9.61	10.94	25.62	36.27	25.62	29.17
T1V2 - Pragathi	44.7	47	44.7	45.46	14.5	13.45	14.5	14.15	13.14	18.15	13.14	14.81	35.03	48.40	35.03	39.48
T1V3-Prathibha	50.0	50.3	50.0	50.1	16.6	14.6	16.6	15.9	16.00	17.77	16.00	16.59	42.68	47.20	42.68	44.18
T2V1 - Duggirala Red	41.2	34.9	41.2	39.1	12.5	11.8	12.5	12.26	8.25	14.6	8.25	10.36	22.01	38.90	22.01	27.64
T2V2-Pragathi	43.1	44.9	43.1	43.7	10.6	13	10.6	11.4	9.0	17.55	9.0	11.85	23.99	46.8	23.99	31.59
T2V3-Prathibha	47.0	44.2	47.0	46.06	13.9	13.4	13.9	13.73	12.28	16.32	12.28	13.62	32.76	43.52	32.76	36.34
SE(m)	0.504	3.45	0.504	1.48	0.410	0.54	0.410	0.45	0.516	0.980	0.516	0.67	0.729	2.613	0.729	1.357
CD (5%)	1.535	7.43	1.535	3.5	1.246	1.66	1.246	1.384	1.568	2.981	1.568	2.039	2.219	7.94	2.219	4.126
CV %	2.223	11.42	2.223	5.28	6.104	8.333	6.104	6.847	9.061	12.81	9.061	10.31	4.807	12.81	4.807	7.47

CONCLUSIONS

The turmeric cultivated in organic module developed by IISR proved to be better organic methodology for organic cultivation of turmeric with IISR Pragathi and IISR Prathibha and Duggirala red varieties. The use of vermicompost, FYM and other inputs in this methodology improve soil condition, which is useful for higher net returns and maintenance of soil fertility in organic cultivation of turmeric.

FUTURE SCOPE

Further this study may be taken up with different organic manures, bio-fungicides and bio-pesticides to analyze the impact of these different organic components to improve yield and curcumin content of turmeric

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