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Productivity and Profitability of Tomato under Organic Nutrition in Wicking Bed System

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ABSTRACT

Tomato (*Solanum lycopersicum* L.), one of the most popular vegetables globally and rich in bio active compounds is an excellent model for studying under organic nutrition. There is need to evaluate the organic nutrition in wicking bed irrigation for the homestead cultivation of vegetables with tomato as a test crop using the liquid organic manures which are easy to prepare and affordable. A pot culture experiment was laid out in completely randomized design with three replications during summer season 2022. The treatments were soil application of cow's urine and vermiwash at weekly intervals along with foliar application of panchagavya at 3%, vermiwash at 3%, moringa leaf extract at 4% and water spray at 20, 40 and 60 DAT. Irrigation was provided by sub irrigation to tomato through wicking bed. The experiment results revealed that organic nutrition had a significant effect on growth, yield attributes and yield of tomato. Basal application of enriched farmyard manure supplemented with soil application of vermiwash or cow's urine at weekly intervals along with foliar application of panchagavya at 3% at 20, 40 and 60 DAT could be recommended for enhanced productivity and profitability of tomato under wicking bed system.

Key words: Foliar, Nutrition, Organic, Wicking bed, Yield.

The eco-friendly method of growing vegetables is a key focus globally in contemporary agriculture in order to increase nutritional security to the homesteads. Tomato (*Solanum lycopersicum* L.), one of the most popular vegetables worldwide, has many metabolites responsible for health and nutritional values thus making it as an excellent model for studying under organic nutrition. Kalpana and Aravinth (2022) reported the concerns about the safety and quality of food, as well as environmental preservation which led to a demand for organic products, which in turn propelled the expansion of organic agriculture.

The wicking bed system is a way of growing plants in which water wicks up from an underground water reservoir have been identified as a simple, water and labour efficient irrigation method. Capillary-wick irrigation employs capillary forces to supply the water, negating the need for irrigation apparatus which is labour and cost-effective.

Organic agriculture plays an important role in solving future challenges in producing food. The nutrients in the soil are continuously depleted during crop production when chemical fertilisers are used; however, by using organic manures, particularly affordable liquid organic manures that are easy to prepare and apply, it is possible to restore or improve the nutrients present in the soil. In order to increase the effectiveness of employing solid organic fertilisers in the growth of numerous vegetable crops, liquid organic fertiliser has been employed more and more recently (Rohmawan *et al*., 2020).

Foliar application of nutrients is an important crop management strategy which helps in maximizing crop yields by supplementing soil fertilization. The use of organic sources of nutrients has been reported to improve biological, chemical and physical properties of the soil and invariably increase plant growth and yield because of its high organic matter content due to high microbial activity (Mitran *et al*., 2017). The bio-waste, including crop residues and animal excreta, were potential sources of major plant nutrients and plant bio-stimulants and can be successfully recycled back into the agro-ecosystems. Natural plant growth bio-stimulants are intensively used currently for plant growth. *Moringa oleifera* is one of the natural bio-stimulants for plant growth, that play an important role in improving yields nutritional quality and tolerance in plants under adverse condition (Maishanu *et al*., 2017). Panchagavya can serve as a source of bio-organic plant growth-promoting nutrients for growing crops organically because it contains macronutrients and helpful microbes, thus improving the soil nutrient status (Somasundaram *et al*., 2021). Vermiwash, when managed efficiently, is a powerful biofertilizer that may

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help plants for an increased uptake of more beneficial nutrients (Vaikunthavasan *et al*., 2021).

There is need to evaluate the organic nutrition in wicking bed irrigation for cultivation of vegetables with tomato as a test crop using the liquid organic manures which are easy to prepare and affordable. Hence, a study was proposed under wicking bed system in tomato to evaluate the productivity and profitability.

The experiment was conducted during summer season 2022 in farmer's field at Southern coastal plain (AEUI), Thiruvananthapuram district, Kerala (8°43′11″N and 76°45′ 50″E longitude; 52 m above mean sea level). The experiment was laid out in completely randomized design with three replications. The treatments were T_1: soil application (SA) of cow's urine + foliar application (FA) of moringa leaf extract (MLE) at 4%, T_2: SA of cow's urine + FA of vermiwash at 3%, T_3: SA of cow's urine + FA of panchagavya at 3%, T_4: SA of cow's urine + FA of water spray, T_5: SA of vermiwash + FA of MLE at 4%, T_6: SA of vermiwash + FA of vermiwash at 3%, T_7: SA of vermiwash + FA of panchagavya at 3%, T_8: SA of vermiwash + FA of water spray. Soil application of liquid manures *viz*., cow's urine (1:10 v/v) and vermiwash (1:8 v/v) were applied at weekly intervals. Foliar application of MLE, vermiwash, panchagavya and water were applied at 20, 40 and 60 DAT. Irrigation was provided through wicking bed to all treatments. Moringa leaf extract was prepared by harvesting fresh leaves of moringa trees and extracted at the fully matured stage (Yasmeen *et al*., 2012). Panchagavya and vermiwash were purchased from Department of Organic Agriculture, College of Agriculture, Vellayani. Nutrient composition of on-farm liquid organic manures is given in Table 1. Tomato seedlings of bacterial wilt resistant variety Vellayani Vijai from KAU was used for planting.

Pots of dimension 45 cm were. used for planting tomato. Geotextile (900 GSM) was used as an interlining material for the wick bed system. Coconut shell halves were used for filling reservoir of water to a height of 15 cm. Soil bed of 30 cm height was filled with potting mixture above the geotextile inter liner. Soil bed was prepared by mixing soil, coir pith compost (1.06 per cent N, 0.06 per cent P_2O_5 and 1.2 per cent K_2O) and enriched farm yard manure (1.5 per cent N, 0.72 per cent P_2O_5 and 0.31 per cent K_2O) in the ratio 2:1:1. Basal application of enriched farmyard manure, rock phosphate and potassium sulphate were given basally to each pots as per KAU (2017).

Two plants were selected randomly from each treatment and observations were made on growth and yield parameters. The yield parameters were recorded at the time of harvest in each treatment. The data were subjected to statistical analysis by applying the techniques of analysis of variance (Gomez and Gomez, 1984).

Growth attributes

The growth attributes *viz.*, plant height, primary branches and leaf area were significantly influenced by treatments during active vegetative and at harvest stage. The height of a plant, which indicates its ability to synthesise and store photosynthate, is one indicator of growth and production. Taller plants were observed with SA of vermiwash + FA of panchagavya at 3% (T_7) which was on par with T_3(Table 2). Higher plant height obtained by application of panchagavya may be related to the presence of bio enhancers and essential nutrients in it. The essential nutrients N, P, K and other micronutrients which were important for plant growth and development were plenty in panchagavya (Rakesh *et al*., 2017). Panda *et al.* (2020) found that the highest values of growth parameters *viz.* height, stem girth, number of leaves per plant were recorded in 3% panchagavya at 50 and 75 DAT, respectively. At 60 DAT, the data revealed that more branches were observed in soil application of vermiwash with foliar spray of vermiwash or pachagavya or MLE or soil application of cow's urine with foliar spray of vermiwash or pachagavya. At harvest, more number of branches were recorded in T_6 which was on par with T_7 and T_5. Higher number of branches might be due to better moisture holding capacity, supply of micronutrients and availability of major nutrients due to favourable soil conditions created by the organic sources of nutrients under wicking bed. Soil application of vermiwash along with FA of vermiwash or panchagavya showed significantly higher leaf area. This is certainly due to synergistic action of vermiwash and panchagavya. At later stages it was also comparable with foliar spray of vermiwash. Vijantie *et al*. (2021) proved that vermiwash was an effective fertilizer which contributed the growth of plants when sprayed directly as well as mixed with a definite ratio of vermicompost. The plant growth parameters and yield of the tomato plants improved when vermicompost and vermiwash were used as biofertilizers (Awadhpersad *et al*., 2021). From the experiment results, it may infer that growth of tomato was enhanced due to the organic foliar sprays along with surface application of organic liquid manures.

Yield attributes and yield

The analyzed data revealed that the yield attributes and the yield were significantly influenced by organic nutrition (Table 3).

Table 1: Physico-chemical properties of liquid organic manures.

Liquid organic manures	Colour	pH	EC (dSm^{-1})	OC (%)
Moringa leaf extract	Pale green	7.53	6.48	0.16
Cow's urine	Pale yellow	7.31	7.8	0.48
Vermiwash	Honey brown	7.2	9.65	0.23
Panchagavya	Light brown	5.83	10.20	0.86

The main yield attributing parameters in tomato in this experiment were flowers per cluster, fruits per truss and fruit weight. The difference in yield attributes might be due to differential translocation of photosynthates from vegetative to reproductive parts. The primary source of organic fertilizers is plant or animal matter, which has the ability to alter the properties of soil since it contains a lot of organic matter and both micro and macronutrients (Begum *et al*., 2023).

Soil application of cow's urine or vermiwash along with foliar spray of panchagavya 3 per cent and soil application of vermiwash along with foliar spray of vermiwash at 20, 40 and 60 DAT took lesser number of days to 50 per cent flowering. Parmar *et al.* (2020) also reported that high amount of proline amino acid present in milk, an important constitute of panchagavya caused earlier initiation of flowers. Soil application of vermiwash or cows urine with foliar application of panchagvya produced more flowers per cluster leading to higher yield. Foliar application of panchagavya at 3 per cent at 20, 40 and 60 DAT recorded more fruit weight leading to higher yield. From the results it is clearly indicated that foliar application had a definite role in increasing fruit weight leading to higher yield. The results of the experiment revealed that soil application of vermiwash or cows urine with foliar application of panchagavya at 3 per cent produced more yield than other treatments.

Soil application of cow's urine with foliar application of moringa leaf extract, vermiwash and panchagavya increased the yield of tomato by 19.5, 28.4 and 35.9 per cent, respectively over water spray, whereas soil application of vermiwash with the above liquid manures increased the yield of tomato by 10.9, 20.9 and 36.8 per cent, respectively. This clearly showed the effect of bio enhancers on increasing the productivity of tomato. Dewang and Devi (2022) observed that soil application of organic biostimulant (Fish Protein Hydrolyzate) increased the growth and yield of tomato.

The panchagavya preparation, which is rich in nutrients, auxins, gibberellins and microbial fauna, functions as a tonic to enrich the soil and encourage plant vigour and high-quality output (Kalia and Singh, 2023). This may be the reason for enhanced yield. The results clearly indicated that all foliar treatments with bio enhancers showed the superiority over water sprays.

Economics

The organic nutrition had a significant influence on economics of tomato cultivation in wicking bed system. All the treatments

Table 2: Effect of organic nutrition on growth attributes.

Treatments	Plant height (cm)		Number of branches		Leaf area (cm^2)	
	60 DAT	Final harvest	60 DAT	Final harvest	60 DAT	Final harvest
T_1: SA of cow's urine + FA of MLE at 4%	87.52	108.92	7.73	12.06	557.33	622.66
T_2: SA of cow's urine + FA of vermiwash at 3%	84.75	111.15	8.40	12.11	566.86	629.66
T_3: SA of cow's urine + FA of panchagavya at 3%	95.41	113.30	8.00	12.92	580.56	671.33
T_4: SA of cow's urine + FA of water spray	72.19	99.63	7.16	10.92	527.33	589.33
T_5: SA of vermiwash + FA of MLE at 4%	83.82	110.40	8.33	13.65	577.66	640.33
T_6: SA of vermiwash + FA of vermiwash at 3%	88.48	111.03	8.93	13.94	634.33	751.33
T_7: SA of vermiwash + FA of panchagavya at 3%	101.35	117.17	8.03	13.39	632.33	743.66
T_8: SA of vermiwash + FA of water spray	79.74	103.80	7.10	11.76	543.33	610.66
SEm (±)	2.53	1.56	0.27	0.27	13.37	7.35
CD at 5%	7.576	4.662	0.823	0.828	40.095	22.036

Table 3: Effect of organic nutrition on yield attributes and yield.

Treatments	Days to 50% flowering	Flowers per cluster	Fruits per truss	Fruit weight (g)	Yield per plant (g)
T_1: SA of cow's urine + FA of MLE at 4%	40.00	9.87	5.83	34.00	1072
T_2: SA of cow's urine + FA of vermiwash at 3%	38.66	10.27	6.00	33.67	1152
T_3: SA of cow's urine + FA of panchagavya at 3%	34.66	11.17	6.03	33.67	1219
T_4: SA of cow's urine + FA of water spray	42.00	8.33	5.77	29.67	897
T_5: SA of vermiwash + FA of MLE at 4%	38.66	9.33	5.77	35.00	1027
T_6: SA of vermiwash + FA of vermiwash at 3%	35.00	10.50	6.10	39.33	1120
T_7: SA of vermiwash + FA of panchagavya at 3%	33.00	11.27	6.50	38.33	1267
T_8: SA of vermiwash + FA of water spray	39.66	9.10	5.33	30.33	926
SEm (±)	0.85	0.24	0.17	1.04	38
CD at 5%	2.548	0.708	0.503	3.120	114.2

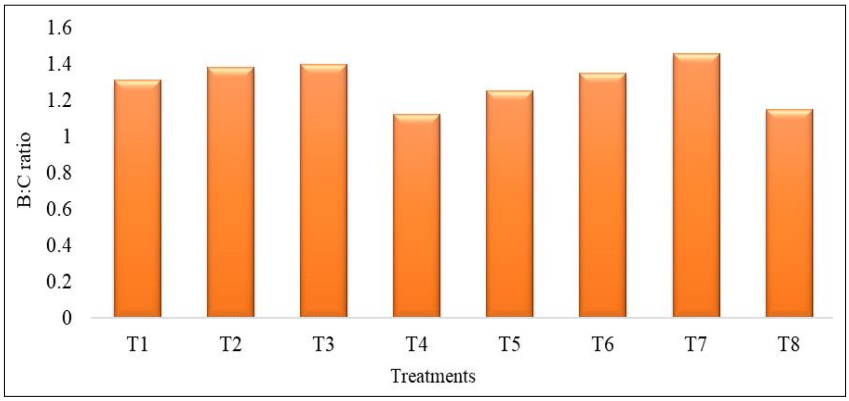

Fig 1: Effect of organic nutrition on B:C ratio.

recorded a BCR of greater than one indicating the profitability of the system. The treatment T_7 recorded higher BCR of 1.46 and a net returns of ` 23 per plant. This may due to the higher productivity recorded in this treatment. The BCR of various treatments are graphically represented in Fig 1.

CONCLUSION

Based on the above findings, it can be inferred that basal application of enriched farmyard manure supplemented with soil application of vermiwash or cow's urine at weekly intervals along with foliar application of panchagavya at 3% at 20, 40 and 60 DAT could be recommended for enhanced productivity and profitability of tomato under wicking bed system.

Conflict of interest

All authors declare that they have no conflicts of interest.

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