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# Assessment of different Organic sources on Turmeric (*Curcuma longa* L.) Varieties for Yield and Quality

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**ABSTRACT: A field trial was carried to find out the efficacy of organics on different varieties of turmeric on various morphological, yield attributes, yield and qualitative characters in turmeric during the years 2012-13 and 2013-14 at the Horticultural Research Station Bidhan Chandra Krishi Viswavidyalaya, Mondouri, West Bengal. Application of vermicompost resulted an appreciable increase in plant height, number of tillers per clump, number of leaves per plant and girth of the plant. Among the different doses and sources of organic manure, vermicompost @ 10t/ha exhibited highest plant height (148.40 cm), number of tillers per plant (2.52), number of leaves per plant (18.46), girth of plant (3.22 cm) and this was closely followed by the application of mustard cake @ 10t/ha. Most of the vegetative growth characters *viz*., girth of the plant and number of tillers per plant showed superiority with variety Suranjana when compared with the other two varieties (Rajendra Sonia and Megha Turmeric). However Megha Turmeric produced tallest turmeric plant. The yield comparision among the varieties showed almost similar with Suranjana (24.46 t/ha) and Rajendra Sonia (24.14 t/ha). Performance of Megha Turmeric with regard to yield was not appreciable. The pooled data of two years indicated that the variety Suranjana with application of vermicompost @ 10t/ha exhibited pronounced effect on number of primary finger (9.68), weight of clump (429.85 g) and highest rhizome yield per hectare (31.16 t/ha).The oleoresin and curcumin content increase progressively with increasing the dose of organic manure except with the variety Rajendra Sonia was found decreasing with increasing in the level of mustard cake. The interaction of Suranjana + vermicompost @ 10t/ha was superior for the highest oleoresin content (9.86%) while the curcumin content was found maximum with Rajendra Sonia + vermicompost @ 10t/ha (7.50%). The variety Suranjana treated with vermicompost @ 5t/ha indicated a total cost of cultivation of Rs. 155,446 with a net return of Rs. 380,954 and highest B:C ratio (2.45:1).**

**Keywords:** Turmeric, Variety, Vermicompost, yield, oleoresin and curcumin

## INTRODUCTION

*Curcuma longa* L. (Turmeric) is a perennial herbaceous crop that belongs to the family Zingiberaceae (Guerra *et al*., 2020). In Ayurveda turmeric is considered as 'Vighnaushadha' means the sacred medicine. The demand of turmeric increased all over the world as new ingredients of therapeutic and life saving properties were discovered. Turmeric is the major spice in which maximum number of products has been patented. Another factor that could influence the demand for turmeric is its increasing use as food colour, since synthetic colours are failing to disfavour in many countries (Anonymous, 1995). Turmeric (*Curcuma longa* L.) belongs to the family – Zingiberaceae. Nearly 40 species of the genus – '*Curcuma*' exist in India while *Curcuma longa* L. alone contribute commercial production to an extent of 96%. Turmeric (*Curcuma longa* L.) contains 5.8% moisture, 8.6% Protein, 8.9% Fat, 63% Carbohydrates, 6.9% Crude fibre, 6.8% Mineral matter, 175 IU/100 gm Vit. A, 49.8 mg/100g Vit. C. Turmeric contains a yellowish compound named curcumin. The curcuminoid is the active compound in turmeric rhizomes which has medicinal importance and has been used for curing hepatic disorders, skin diseases and blood purification (Kocaadam and Şanlier, 2017; Li *et al*., 2020; Marton *et al*., 2020). Turmeric used in herbal medicines but at this time, it is used at large scale for different purposes such as coloring agents for food, cosmetics, dyes, even in medicines due to its antioxidant properties (Anandaraj *et al*., 2014; Gopinath and Karthikeyan, 2018; Kotha and Luthria, 2019; Ahmed *et al*., 2020; Dua and Paul, 2020). Turmeric is cultivated most extensively in India, followed by Bangladesh, China, Thailand, Cambodia, Malaysia, Indonesia and Philippines. In India, Andhra Pradesh is the largest producer of turmeric followed by Tamil Nadu, Odisha, Karnataka, Kerala, West Bengal, Maharastra, Assam, Bihar and on limited scale in North East hill states. Organic farming assumes significant globally towards sustainable production and quality up gradation of turmeric (Sadanadan *et al*., 1998). The adverse effects of continuous use of high dose of chemical fertilizers on soil health and environment were realized; hence, the farmers are also showing considerable inclination towards traditional farming with least usage of fertilizers. Organic manures have positive influence on soil texture and structure, better water holding capacity and drainage which in turn help for better growth and development of rhizomatous crop like turmeric (Kale *et al*., 1991). One of the constraints in the popularization of turmeric production is low productivity, which can be attributed to poor nutrient management besides other factors. The crop is known to respond well to fertilizer application (Verma *et al*., 2019). Incorporation of manures in nutrient management of agricultural soils is an effort to reduce the environmental impacts of excessive use of synthetic fertilizers and improve nutrient availability under various agro-climatic conditions (Wu and Ma, 2015; Bai *et al*., 2016; Chadwick *et al*., 2020). Considering the economic importance of turmeric and environmental problems caused by application of chemicals, it is important to cultivate turmeric organically. Different organic manures

influence differently in terms of yield and quality of turmeric. Hence, it is necessary to know the best sources of organic manure which could help in increasing the yield and quality. Also the demand for organic products is increasing day by day, the consumers are preferring natural/ethnic foods, particularly organic foods across the world. Organically produced spices are in demand both in domestic and foreign markets. It is therefore, necessary to identify the best source of organic matter as nutrient along with improved varieties for profitable exploitation of the spices.

## MATERIALS AND METHOD

The research station is situated at 23.5$^{o}$ N latitude and 89$^{o}$ E longitude with an average altitude of 9.75 m above mean sea level. The soil of the experimental site is typical Gangetic Alluvial soil (Inceptisols) having sandy loam texture, well drained with medium fertility status. The experiment was laid out in a strip plot design with 8 treatments (mustard cake @5t/ha and 10 t/ha; cowdung manure @ 25t/ha and 50t/ha; farm yard manure @ 20t/ha and 40t/ha; vermicompost @ 5t/ha and 10t/ha) with 3 varieties (Suranjana, Rajendra Sonia and Megha Turmeric) and replicated twice. A plot size of 3 x 3 m was used with spacing of 25 x 30 cm. All necessary intercultural operations were done as needed by the experiment. The data collected from the field were subjected to statistical analysis of the Strip plot design by following procedure laid out by Gomez and Gomez, (1984). The significance different source of variation was tested by Fisher and Snedecor's 'F' test at probability level of 0.05 for appropriate degree of freedom. For determination of standard error of mean (S. Em.±) and the value of critical difference (C.D) between the treatment means as 5% level of significance, the statistical table formulated by Fisher and Yates (1979) was referred.

## RESULTS AND DISCUSSION

*A. Effect of organic sources*

The data presented in the table 1 revealed that treatment $VC_2$ (vermicompost @ 10t/ha) recorded maximum plant height of (148.40 cm), number of tillers per plant (2.52), number of leaves per plant (19.82), girth of the plant (3.22 cm). Number of tillers per plant were varied significantly with different organic sources. It is evident from table 1 that the maximum number of mother rhizome (1.97) was recorded with the treatment $MC_1$ (mustard cake @ 10t/ha), followed by 1.92 with $VC_2$ (vermicompost @ 10t/ha) and $CM_2$ (cowdung manure @ 50t/ha). Significant variation was recorded with regard to number of mother rhizome. Maximum number of primary finger per clump (8.84) was also recorded with the same treatment vermicompost @ 10t/ha, followed by the application of vermicompost @ 5t/ha (8.27) while the maximum number of secondary finger with recorded with farm yard manure @ 40t/ha (16.83) which was at par with 16.20 and 15.63 from the treatment $VC_2$ (vermicompost @ 10t/ha) and $FYM_1$ (farm yard manure @ 20t/ha) respectively. The perusal of data in table 2 revealed that weight of clump were also varied significantly with different treatments in both the years, as well as in pooled data. Maximum weight of clump 401.66 g was found from plant raised with vermicompost @ 10t/ha. The minimum weight of clump was recorded from the treatment cowdung manure @ 25 t/ha (361.92 g) as per pooled data. Like yield per plot the same pattern of influence of different treatments was noticed in respect of projected yield per hectare (Table 2). The highest yield was recorded with vermicompost @ 10t/ha (28.14 t/ha) followed by mustard cake @ 10t/ha (27.02 t/ha). The lowest yield was observed with the treatment farm yard manure @ 20 t/ha (18.54 t/ha).

Significant difference was observed with all the treatments. The treatment $VC_2$ (vermicompost @10 t/ha) recorded the maximum oleoresin content of 8.03% and curcumin content (5.75%) while the minimum oleoresin (6.06%) content and curcumin content (4.25%) was recorded with $CM_1$ (cowdung manure @ 25t/ha). All types of organic manure influenced positively. The plant grown with vermicompost at higher dose was the most prominent and had the maximum plant height (148.40 cm), number of tillers per plant (2.52), leaf number (19.19), girth of plant (3.22 cm) and leaf width (14.92 cm) of turmeric plant. This may be due to the increase in soil fertility in the amended soils which is evidenced by the higher available nitrogen, phosphorous and potassium in the soil. Vermicompost increases the growth rate because of better water and mineral uptake such as; nitrogen and phosphorus, which lead to the biological yield improvement (Atiyeh *et al*., 2002; Arancon *et al*., 2004). The present investigation indicated increased plant height with application of vermicompost, the results of which is similar to the findings of Mohammad *et al*., (2012). They also obtained most significant plant height (50.1 cm) in anise by applying 10 tonnes vermicompost per hectare. Role of organic manures in maintaining soil health and their influence on growth and development of crop has been well documented by many workers (Sultan, 1995; Singh *et al.*, 1997). Besides influencing the physico chemical properties of soil, vermicompost is also known to contain growth promoting substances which enhance microbial activity and prevent nitrogen loss by leaching (Sultan, 1995; Shinde *et al*., 1992). Compared to the availability of nutrients from most of the bulky organic manures, the release of nutrients from the added vermicompost is more and could be the reason for higher plant height and other growth benefits.

*B. Effect of varieties*

As evident from the table 1 that among the three varieties i.e Suranjana ($V_1$), Rajendra Sonia ($V_2$) and Megha Turmeric ($V_3$), the plant height was found to be maximum with $V_3$ (157.19 cm), while the minimum was obtained with variety $V_1$ (133.05 cm). Significant variation was observed with different varieties in terms of plant height. The number of tillers per plant also differed with different varieties. The maximum number of tillers was recorded from the variety Rajendra Sonia (2.28) which was at par with Suranjana (2.27) while the minimum number of tillers was recorded with Megha Turmeric (1.74). Perusal of data clearly indicates the significant variation in number of leaves per plant with different varieties. The variety $V_1$ (Suranjana) was found superior for the production of highest number of leaves 17.48 while the lowest number of leaves 14.70 was recorded from variety $V_3$ (Megha Turmeric). It is also revealed from the data in table (1) that girth of the plant (3.21cm), number of mother rhizome (2.02), number of primary fingers (8.06) was recorded maximum with the variety Suranjana while the minimum was recorded with Rajendra Sonia. Perusal of data clearly indicates the maximum weight of clump with the variety Rajendra Sonia (407.31 g), which was at par with Suranjana (406.39 g). The data in Table 2, revealed the maximum yield per hectare with the variety Suranjana (24.46 t/ha) as compared to the lowest with Megha Turmeric (20.59 t/ha). Significant variation was observed among different varieties with regard to oleoresin content. Among the three varieties the maximum oleoresin (7.72%) content was recorded with $V_1$ (Suranjana) while the minimum of 6.17 % was recorded from $V_3$ (Megha Turmeric). The different varieties showed significant influence on curcumin content of turmeric. The highest curcumin content was recorded from the variety Rajendra Sonia (6.20%) followed by Suranjana (5.39%) and Megha Turmeric (3.07%).

*C. Effect of organic sources x varieties*

It is revealed from the pooled data (Table 1) that the maximum plant height (163.76 cm) was recorded with $V_3VC_2$ (Megha Turmeric + vermicompost @ 10t/ha). The interaction between the variety and the treatment have influenced significantly with regard to plant height. It is also indicated that different combination of varieties and treatments have significant influence on number of tillers per plant. The maximum number of tillers per plant (3.17), number of leaves (20.97). Significant variation was observed with regard to number of leaves per plant. It is evident from the data in Table 1, that the maximum girth of the plant was recorded with Suranjana applied with farm yard manure @ 40t/ha (3.69cm) which was at par with Rajendra Sonia with application of vermicompost @ 10t/ha (3.61cm). It is observed from table 1 that maximum number of mother rhizome (2.46), number of primary fingers (9.68) was recorded from Suranjana with application of vermicompost @ 10t/ha. However the highest number of secondary rhizome (18.23) was noticed from $V_3FYM_2$ (Megha Turmeric + farm yard manure @ 40t/ha). The interaction between varieties and treatment also have significant influence with respect to number of mother rhizome.

**Table 1: Effect of organic sources, varieties and their interaction on plant height and number of tillers, number of leaves per plant, girth of the plant, number of mother rhizome per clump, number of primary finger and number of secondary finger.**

| | Plant height (cm) | Number of tillers per plant | Number of leaves per plant | Girth of the plant (cm) | Number of mother rhizome per clump | Number of primary finger | Number of secondary finger |
|---|---|---|---|---|---|---|---|
| $MC_1$ | 134.56 | 2.07 | 15.50 | 2.79 | 1.65 | 7.35 | 14.74 |
| $MC_2$ | 144.32 | 2.36 | 17.83 | 3.07 | 1.97 | 7.97 | 15.16 |
| $CM_1$ | 132.23 | 1.63 | 14.04 | 2.75 | 1.81 | 6.81 | 14.29 |
| $CM_2$ | 137.44 | 1.92 | 15.36 | 2.92 | 1.92 | 7.79 | 15.63 |
| $FYM_1$ | 134.17 | 1.87 | 14.58 | 2.99 | 1.72 | 6.92 | 15.01 |
| $FYM_2$ | 143.90 | 2.11 | 14.97 | 3.08 | 1.91 | 7.78 | 16.83 |
| $VC_1$ | 140.68 | 2.28 | 16.44 | 3.01 | 1.65 | 8.27 | 15.37 |
| $VC_2$ | 148.40 | 2.52 | 19.19 | 3.22 | 1.92 | 8.84 | 16.20 |
| **SEm ±** | **0.5612** | **0.0236** | **0.6085** | **0.0499** | **0.010** | **0.1838** | **0.4472** |
| **CD(0.05)** | **1.7021** | **0.0716** | **1.8456** | **0.1513** | **0.031** | **0.5575** | **1.3566** |
| $V_1$ | 133.05 | 2.28 | 17.48 | 3.21 | 2.02 | 8.06 | 15.45 |
| $V_2$ | 128.15 | 2.27 | 15.78 | 2.86 | 1.87 | 7.63 | 14.98 |
| $V_3$ | 157.19 | 1.74 | 14.70 | 2.87 | 1.56 | 7.45 | 15.78 |
| **SEm ±** | **0.372** | **0.0176** | **0.2509** | **0.0296** | **0.01** | **0.0974** | **0.2619** |
| **CD(0.05)** | **1.0690** | **0.0506** | **0.7267** | **0.0851** | **0.022** | **0.2799** | **N.S** |
| $V_1MC_1$ | 126.24 | 1.88 | 16.70 | 2.76 | 1.97 | 7.25 | 14.25 |
| $V_2MC_1$ | 123.47 | 2.70 | 15.92 | 2.85 | 1.80 | 8.25 | 15.65 |
| $V_3MC_1$ | 153.97 | 1.62 | 13.89 | 2.77 | 1.18 | 6.55 | 14.32 |
| $V_1MC_2$ | 138.78 | 2.17 | 19.66 | 3.30 | 2.23 | 7.67 | 14.67 |
| $V_2MC_2$ | 136.60 | 2.83 | 18.67 | 2.79 | 2.35 | 8.80 | 16.00 |
| $V_3MC_2$ | 157.59 | 2.10 | 15.16 | 3.14 | 1.33 | 7.43 | 14.82 |
| $V_1CM_1$ | 125.54 | 1.77 | 14.96 | 2.93 | 2.09 | 6.72 | 14.55 |
| $V_2CM_1$ | 115.52 | 1.75 | 13.33 | 2.59 | 1.70 | 6.83 | 12.84 |
| $V_3CM_1$ | 155.62 | 1.38 | 13.83 | 2.75 | 1.65 | 6.89 | 15.50 |
| $V_1CM_2$ | 131.73 | 2.29 | 15.42 | 3.22 | 2.45 | 8.75 | 16.48 |
| $V_2CM_2$ | 120.14 | 1.95 | 15.91 | 2.75 | 1.63 | 7.25 | 13.33 |
| $V_3CM_2$ | 160.46 | 1.53 | 14.75 | 2.78 | 1.69 | 7.37 | 17.08 |
| $V_1FYM_1$ | 120.78 | 2.03 | 16.25 | 3.69 | 1.50 | 6.85 | 15.77 |
| $V_2FYM_1$ | 131.51 | 1.95 | 13.41 | 2.44 | 1.79 | 6.62 | 15.07 |
| $V_3FYM_1$ | 150.23 | 1.65 | 14.08 | 2.83 | 1.87 | 7.28 | 14.20 |
| $V_1FYM_2$ | 142.14 | 2.28 | 17.25 | 3.24 | 1.70 | 8.55 | 15.52 |
| $V_2FYM_2$ | 132.40 | 2.15 | 13.50 | 2.78 | 2.05 | 7.38 | 16.75 |
| $V_3FYM_2$ | 157.16 | 1.92 | 14.17 | 3.22 | 1.98 | 7.41 | 18.23 |
| $V_1VC_1$ | 136.95 | 2.70 | 18.66 | 3.13 | 2.17 | 9.02 | 16.06 |
| $V_2VC_1$ | 126.34 | 2.37 | 15.83 | 3.09 | 1.67 | 7.78 | 14.85 |
| $V_3VC_1$ | 158.76 | 1.77 | 14.83 | 2.81 | 1.10 | 8.03 | 15.22 |
| $V_1VC_2$ | 142.26 | 3.17 | 20.97 | 3.40 | 2.05 | 9.68 | 16.34 |
| $V_2VC_2$ | 139.20 | 2.43 | 19.68 | 3.61 | 1.98 | 8.17 | 15.37 |
| $V_3VC_2$ | 163.76 | 1.95 | 16.91 | 2.66 | 1.72 | 8.67 | 16.90 |
| **SEm ±** | **1.0522** | **0.0497** | **0.7095** | **0.0837** | **0.022** | **0.2756** | **0.7406** |
| **C.D.(P=0.05)** | **3.0236** | **0.1428** | **2.0554** | **0.2405** | **0.062** | **NS** | **N.S** |

$V_1$= Suranjana; $V_2$= Rajendra Sonia; $V_3$= Megha Turmeric; $MC_1$= Mustard cake- 5t/ha; $MC_2$= Mustard cake- 10t/ha; $CM_1$= Cowdung manure- 25t/ha; $CM_2$= Cowdung manure- 50t/ha; $FYM_1$= Farm yard manure- 20t/ha; $FYM_2$= Farm yard manure- 40t/ha; $VC_1$= Vermicompost- 5t/ha and $VC_2$= Vermicompost- 10t/ha

The data in Table 2, revealed the marked variation among the different interactions. The maximum weight of clump (429.85 g) was recorded from $V_1VC_2$ (Suranjana + vermicompost @ 10t/ha), which was at par (422.59 g) with $V_2MC_2$ (Rajendra Sonia + mustard cake @ 10t/ha). The variety Suranjana when applied with vermicompost @ 10t/ha was found superior for production of maximum rhizome yield per hectare of 31.16 t/ha followed by Rajendra Sonia + vermicompost @ 10t/ha (29.38 t/ha). The lowest yield per hectare was noticed from Megha Turmeric with application of cowdung manure @ 25t/ha (17.33 t/ha). Among the different organic manures and their combinations with turmeric varieties, vermicompost was found to be the most effective

organic sources followed by mustard cake. Accordingly the higher dose of vermicompost application (10 t/ha) was considered the best treatment with a fresh rhizome yield. A yield of 31.16 t/ha was however obtained from the interaction between Suranjana and vermicompost @ 10t/ha ($V_1VC_2$). This treatment was also exhibited superiority for the weight of mother rhizome number of primary fingers, weight of clump, yield per hectare. The higher and easily available nutrient content in vermicompost and their better uptake by the plants might be the reason for the highest rhizome yield and yield attributes in this treatment. The reports of Nagavallemma *et al*., (2004) that vermicompost contains a higher percentage of nutrients necessary for plant growth in readily available forms. Atiyeh *et al*., (2000) and Zaller (2007) indicated that vermicompost is potential for improving plant growth and dry matter yield when added to the soil corroborates the findings of the present investigation. It may be mention that Vadiraj *et al*., (1998) observed significant positive influence of turmeric yield with application of vermicompost @ 10 t/ha. Mohammad *et al*., (2012) also obtained the highest yields by applying 10 t/ha vermicompost (9797.2 kg/ha) in anise. Applications of vermicompost singly or in combination with either other organic fertilizers or chemical fertilizers have been proved effective to enhance growth and yield of various plants like Tomato (Lazcano *et al*., 2009), Garlic (Suthar 2009) Kalmegh (Vijaya *et al.,* 2008), and Potato (Alam *et al*., 2007). Dhama, (2003) reported that the variation in yield response of turmeric to organic manuring depends on decomposition of organic residues, C: N ratio, nutrient release pattern, climate and soil characteristics.

**Table 2: Effect of organic sources, varieties and their interaction on weight of clump, projected yield/ha, oleoresin and curcumin content.**

| Treatment | Weight of clump (g) | Projected yield t/ha | Oleoresin (%) | Curcumin (%) |
|---|---|---|---|---|
| $MC_1$ | 381.84 | 24.97 | 6.90 | 4.79 |
| $MC_2$ | 396.21 | 26.76 | 7.32 | 4.89 |
| $CM_1$ | 361.92 | 19.56 | 6.06 | 4.25 |
| $CM_2$ | 370.65 | 20.42 | 6.85 | 4.66 |
| $FYM_1$ | 364.25 | 18.54 | 6.27 | 4.60 |
| $FYM_2$ | 377.16 | 20.87 | 6.82 | 4.90 |
| $VC_1$ | 391.57 | 25.25 | 7.64 | 5.26 |
| $VC_2$ | 401.66 | 28.14 | 8.03 | 5.75 |
| **SEm ±** | **1.4638** | **0.2449** | **0.1123** | **0.0821** |
| **CD(0.05)** | **4.4401** | **0.7429** | **0.3407** | **0.2489** |
| $V_1$ | 406.39 | 24.46 | 7.72 | 5.39 |
| $V_2$ | 407.31 | 24.14 | 7.07 | 6.20 |
| $V_3$ | 328.27 | 20.59 | 6.17 | 3.07 |
| **SEm ±** | **0.9059** | **0.1879** | **0.0943** | **0.1264** |
| **CD(0.05)** | **2.6242** | **0.5443** | **0.2733** | **0.3662** |
| $V_1MC_1$ | 405.70 | 25.66 | 7.31 | 5.33 |
| $V_2MC_1$ | 413.03 | 26.58 | 7.18 | 6.26 |
| $V_3MC_1$ | 326.80 | 22.66 | 6.21 | 2.77 |
| $V_1MC_2$ | 411.71 | 26.76 | 7.78 | 5.52 |
| $V_2MC_2$ | 422.59 | 28.56 | 7.76 | 5.68 |
| $V_3MC_2$ | 354.32 | 24.98 | 6.43 | 3.46 |
| $V_1CM_1$ | 395.88 | 21.87 | 6.34 | 4.46 |
| $V_2CM_1$ | 387.88 | 19.48 | 6.22 | 5.83 |
| $V_3CM_1$ | 301.98 | 17.33 | 5.63 | 2.46 |
| $V_1CM_2$ | 402.16 | 22.67 | 7.11 | 5.69 |
| $V_2CM_2$ | 396.05 | 20.76 | 7.36 | 5.77 |
| $V_3CM_2$ | 313.75 | 17.84 | 6.09 | 2.53 |
| $V_1FYM_1$ | 388.73 | 18.85 | 6.55 | 5.18 |
| $V_2FYM_1$ | 397.30 | 19.29 | 6.38 | 5.88 |
| $V_3FYM_1$ | 306.71 | 17.48 | 5.89 | 2.74 |
| $V_1FYM_2$ | 397.05 | 21.91 | 7.80 | 5.35 |
| $V_2FYM_2$ | 406.39 | 22.92 | 6.64 | 6.00 |
| $V_3FYM_2$ | 328.03 | 17.79 | 6.01 | 3.35 |
| $V_1VC_1$ | 420.04 | 26.82 | 9.04 | 5.49 |
| $V_2$ $VC_1$ | 416.86 | 26.12 | 7.39 | 6.68 |
| $V_3VC_1$ | 337.80 | 22.81 | 6.48 | 3.61 |
| $V_1VC_2$ | 429.85 | 31.16 | 9.86 | 6.08 |
| $V_2VC_2$ | 418.37 | 29.38 | 7.64 | 7.50 |
| $V_3VC_2$ | 356.77 | 23.87 | 6.59 | 3.66 |
| **SEm ±** | **2.5622** | **0.5314** | **0.2668** | **0.3575** |
| **C.D.(P=0.05)** | **7.4225** | **1.5395** | **0.7730** | **N.S** |

$V_1$= Suranjana; $V_2$= Rajendra Sonia; $V_3$= Megha Turmeric; $MC_1$= Mustard cake- 5t/ha; $MC_2$= Mustard cake- 10t/ha; $CM_1$= Cowdung manure- 25t/ha; $CM_2$= Cowdung manure- 50t/ha; $FYM_1$= Farm yard manure- 20t/ha; $FYM_2$= Farm yard manure- 40t/ha; $VC_1$= Vermicompost- 5t/ha and $VC_2$= Vermicompost- 10t/ha

The combination of $V_1VC_2$ (Suranjana + vermicompost @ 10t/ha) recorded maximum oleoresin content of 9.86% followed by $V_1VC_1$ (Suranjana + vermicompost @ 5t/ha) which recorded 9.04%. The minimum oleoresin content of 5.63% was recorded from $V_3CM_1$ (Megha Turmeric + cowdung manure @ 25t/ha). The interaction of $V_2VC_2$ (Rajendra Sonia+ vermicompost @ 10t/ha) recorded the maximum curcumin content (7.50%) followed by 6.68% with $V_2VC_1$ (Rajendra Sonia + vermicompost @ 5t/ha). The lowest (2.46%) curcumin content was recorded from $V_3CM_1$ (Megha Turmeric + cowdung manure @ 25t/ha).

Curcumin content of rhizomes also significantly increased by vermicompost application. With regard to curcumin recovery percentage on turmeric, among the treatments, vermicompost @ 10t/ha gave highest (5.75%) followed by $VC_1$ (5.26%) and

$FYM_2$ (4.90%) (vermicompost @ 5 t/ ha and farm yard manure @ 40t/ha). Sadanandan *et al*., (2002) also reported that application of organic manure and biofertilizer increased the curcumin content. Vermicompost and mustard cake treatment had significantly higher amount of oleoresin than other organic manure. Curcumin content was not statistically significant among the interaction of varieties and treatments. The highest content (7.50%) was recorded in with Rajendra Sonia with application of vermicompost @ 10t/ha. The next best combination with respect to curcumin content was Rajendra Sonia with application of vermicompost @ 5t/ha (6.68%), followed by Rajendra Sonia with application of mustard cake @ 5t/ha (6.26%). Vermicompost in addition to supplying the essential plant nutrients, might have also stimulated all the enzymes, hormones and growth regulators necessary for the synthesis of curcumin. Kumar *et al*., (1992) also reported that increased application of organic manures would result in increased curcumin content of turmeric.

**Table 3: Effect of organic sources x varieties on turmeric (*Curcuma longa* L.) on yield and economics of cultivation in the new alluvial zone of West Bengal.**

| Treatments | Projected yield (t/ha) | Total cost of cultivation | Gross return (Rs./ha) | Net return (Rs./ha) | Benefit cost ratio |
|---|---|---|---|---|---|
| $V_1MC_1$ | 25.66 | 175446 | 513200 | 337754 | 1.93 |
| $V_2MC_1$ | 26.58 | 175446 | 531600 | 356154 | 2.03 |
| $V_3MC_1$ | 22.66 | 175446 | 453200 | 277754 | 1.58 |
| $V_1MC_2$ | 26.76 | 250446 | 535200 | 284754 | 1.14 |
| $V_2MC_2$ | 28.56 | 250446 | 571200 | 320754 | 1.28 |
| $V_3MC_2$ | 24.98 | 250446 | 499600 | 249154 | 1.00 |
| $V_1CM_1$ | 21.87 | 130446 | 437400 | 306954 | 2.35 |
| $V_2CM_1$ | 19.48 | 130446 | 389600 | 259154 | 1.99 |
| $V_3CM_1$ | 17.33 | 130446 | 346600 | 216154 | 1.66 |
| $V_1CM_2$ | 22.67 | 160446 | 453400 | 292954 | 1.83 |
| $V_2CM_2$ | 20.76 | 160446 | 415200 | 254754 | 1.59 |
| $V_3CM_2$ | 17.84 | 160446 | 356800 | 196354 | 1.22 |
| $V_1FYM_1$ | 18.85 | 130446 | 377000 | 246554 | 1.89 |
| $V_2FYM_1$ | 19.29 | 130446 | 385800 | 255354 | 1.96 |
| $V_3FYM_1$ | 17.48 | 130446 | 349600 | 219154 | 1.68 |
| $V_1FYM_2$ | 21.91 | 160446 | 438200 | 277754 | 1.73 |
| $V_2FYM_2$ | 22.92 | 160446 | 458400 | 297954 | 1.86 |
| $V_3FYM_2$ | 17.79 | 160446 | 355800 | 195354 | 1.22 |
| $V_1VC_1$ | 26.82 | 155446 | 536400 | 380954 | 2.45 |
| $V_2$ $VC_1$ | 26.12 | 155446 | 522400 | 366954 | 2.36 |
| $V_3VC_1$ | 22.81 | 155446 | 456200 | 300754 | 1.93 |
| $V_1VC_2$ | 31.16 | 210446 | 623200 | 412754 | 1.96 |
| $V_2VC_2$ | 29.38 | 210446 | 587600 | 377154 | 1.79 |
| $V_3VC_2$ | 23.87 | 210446 | 477400 | 266954 | 1.27 |

$V_1$= Suranjana; $V_2$= Rajendra Sonia; $V_3$= Megha Turmeric; $MC_1$= Mustard cake- 5t/ha; $MC_2$= Mustard cake- 10t/ha; $CM_1$= Cowdung manure- 25t/ha; $CM_2$= Cowdung manure- 50t/ha; $FYM_1$= Farm yard manure- 20t/ha; $FYM_2$= Farm yard manure- 40t/ha; $VC_1$= Vermicompost- 5t/ha and $VC_2$= Vermicompost- 10t/ha

## CONCLUSION

The present study concluded that application of vermicompost @10 t/ha proved beneficial with respect to vegetative growth characters, yield and quality (oleoresin and curcumin). Economic analysis indicated that the best treatment in terms of Benefit : cost ratio was observed in $V_1VC_1$: Suranjana + vermicompost @ 5t/ha. A total cost of cultivation of Rs. 1,55,446 with a net return of Rs. 3,80,954 and highest B:C ratio (2.45:1) was received with this treatment. Thus, this combination may be encouraged for future organic cultivation of turmeric.

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