Annals of Plant and Soil Research 24(2):294-299 (2022)
https://doi.org/10.47815/apsr.2022.10164

Effect of sugarcane pressmud with inorganic fertilizers on growth and yield of turmeric (*Curcuma longa* L.)

S.K. BAIRAGI

Department of Horticulture, Amar Singh PG College, Lakhaoti - 203407, Bulandshahr, Uttar Pradesh

Received: January, 2022; Revised accepted: March, 2022

ABSTRACT

A field experiment was conducted at Amar Singh PG College, Lakhaoti, Bulandshahr (Uttar Pradesh) during 2018-19and 2019-20, to assess the efficacy of sugarcane pressmud on growth, yield and economics of turmeric (Curcuma longa L.). Six different levels of pressmud were evaluated in randomized block design with three replications. The results indicated that turmeric responded significantly to the application of pressmud over control. Application of 20 t pressmud ha^{-1} along with RDF resulted in the highest plant height (97.4 cm), maximum leaf length (49.4 cm) and leaf breadth (12.9 cm). The highest number of rhizomes per plant (21.5), maximum fresh rhizome weight per plant (310.3 g) and fresh rhizome yield (34.5 t ha^{-1}) were produced with the application of RDF + 20 t pressmud ha^{-1}.The yield increment with RDF + 20 t pressmud ha^{-1} was 22.7%, over the control (RDF only).The growth, yield attributes and yield of turmeric rhizomes tended to decrease with higher levels of pressmud beyond 20 t pressmud ha^{-1}. The control treatment performed the poorest as against different levels of pressmud application, recording the lowest values for all these characters.Economic assessment of different treatments revealed that the maximum net return (Rs. 4,78,757 ha^{-1}) with the highest B:C ratio (2.95) was obtained with the application of RDF + 20 t pressmud ha^{-1} as compared to control with a net return of Rs. 3,54,677 ha^{-1} and B:C ratio of 2.51.

Keywords: Pressmud, growth, yield, economics, turmeric

INTRODUCTION

Turmeric (*Curcuma longa* L.) is an important commercial spice crop grown in India. The tuberous rhizomes of turmeric have long been used as a condiment, natural dye, cosmetic and as an Ayurvedic medicine in India. Due to its wide utilization in Ayurvedic medicines; and in drugs and cosmetic industry worldwide, turmeric is considered as an important commercial crop, having tremendous export potential (Uma Devi, 2008). India is the largest producer, (producing about 80% of the world's total production), consumer (consuming about 80% of its total production) as well as supplier (supplying approximately 94% of the world's demand) of turmeric (Chamroy *et al.*, 2015). Despite being the world leader in production, the productivity of turmeric in India is the lowest in the world, owing to very low organic matter content of most Indian soils. The need of the hour is to improve soil health by supplementing the much needed organic matter. Organic matter not only increases the yield but also improves the physical, chemical and biological property of the soil,thereby increasing its overall fertility, and thus, crop productivity. The organic sources help to maintain nutrient equilibrium in the soil whereas, the inorganic fertilizers readily furnish nutrients which would enhance the initial growth in the crop and finally results in better growth, development and yield (Anuradha *et al.*, 2018). Turmeric being a long duration (8-9 months) and shallow rooted crop, its nutritional demand is quite high (Reshma and Vishwanath, 2020). Since, most soils in India are low in organic matter content, turmeric responds well to the application of organic matter. Experimentalevidences are available on the beneficialeffects of organic matter either alone or in combinationwith inorganic fertilizers on growth, productivity andquality of turmeric (Lohar and Hase, 2021; Kadam and Kamble 2020). Since, the traditional sources of organic matter are in short supply, alternateand readily available means of organic matter has to be explored. One such source of organic matter, available readily in abundance, could be sugarcane pressmud.Sugarcane pressmud is a solid, dark coloured waste by-product of sugar mills,

Corresponding author: e-mail: drskbairagi@gmail.com

produced after filtration of sugarcane juice.It is rich in organic carbon, NPK and othermicronutrients. On an average 100g pressmud contains around 50% organic carbon, 3.3% humic acid, 3.6% fulvic acid, 1.5-2.5% N, 2.0-3.0% P, 1.0-2.0% K, 0.3-0.5% S, 10.0-11.0% Ca, 0.5-1.0% Mg, 128 ppm Cu, 6300 ppm Fe, 308 ppm Mn and 883 ppm Zn(Kumar *et al.*, 2017). Keeping in view the short supply of traditional sources of organic matter *viz*., FYM, crop residues *etc*., and availability of pressmud as an excellent source of organic matter and other micronutrients, an experiment was devised to assess the efficacy of pressmud on growth and yield attributing characters in turmeric.

MATERIALS AND METHODS

The experiment was conducted at the Horticultural Research Farm of Amar Singh PG College, Lakhaoti, Bulandshahr, Uttar Pradesh, during 2018-19 and 2019-20. The experimental field is located at $28^0$31'36"N longitude and $77^0$58'29"E latitude; and at an average altitude of about 200 m above the mean seal level. The soil of the experimental field was deep, sandy loam in texture and slightly saline with a pH of 7.8. The soil had 4.1 g organic carbon, 175 kg ha^{-1} available N, 14.0 kg ha^{-1} available P and 155 kg ha^{-1} available K. The experiment was comprised of six treatments *viz*., T_1: RDF, 120:80:80 kg NPK ha^{-1}; T_2: RDF + 10 t pressmud ha^{-1}; T_3: RDF + 15 t pressmud ha^{-1}; T_4: RDF + 20 t pressmud ha^{-1}; T_5: RDF + 25 t pressmud ha^{-1}; and T_6: RDF + 30 t pressmud ha^{-1}.The pressmud was sourced from the effluent treatment plant of Anamika Sugar Mills Pvt Ltd, Agauta, Bulandshahr. The pressmud was composted at the experimental farm for a period of about six months.The experiment was laid out in randomized block design with three replications. The crop was planted in the second week of June during both the years; and harvested at full maturity. Ridges were prepared 45 cm apart, and the seed rhizomes (var. 'Rajendra Sonia') were planted on the ridges 20 cm apart, thus maintaining a planting distance of 45x20 cm. The entire dose of phosphorus and about one-third of the nitrogen was given in the form of diammonium phosphate, as basal dose to all the plots, at the time of field preparation. Rest of the nitrogen (in the form of urea) and the entire potassium (in the form of muriate of potash) were applied in two split doses of equal quantities. Half the quantity of nitrogen and potassium was applied at 45 days after planting (DAP) and the rest half at 90 DAP, as furrow placement, followed by earthing-up. The requisite quantity of pressmud was given to respective plots as per treatments, along with diammonium phosphate, at the time of field preparation. The field was kept free from weeds throughout the crop duration. Recommended package of practiceswere followed to raise the crop. The data were collected on growth parameters (at 150 DAP, when the plant had developed full canopy), like-plant height, number of tillers per plant, number of leaves per plant, leaf length, leaf breadth; and yield parameters (at harvesting time) like number of rhizomes per plant, fresh rhizome weight per plant and yield. The pooled data were subjected to analysis of variance and critical difference at 5% level of probability for significance of treatments for comparing the means by the method as advocated by Panse and Sukhatme (1985). The economics of turmeric production was calculated depending on the prevailing input cost and market price.

RESULTS AND DISCUSSION

Vegetative characters:

A perusal of the data (Table 1) indicated that all the vegetative characters of turmeric responded significantly to the application of pressmud over RDF alone. Among the different levels of pressmud application, the maximum plant height of 97.4 cm was recorded with RDF + 20 tpressmud ha^{-1}closely followed by RDF + 25 t pressmud ha^{-1}(94.4 cm). Both these treatments proved significantly superior over the control, which recorded the lowest plant height of 81.4 cm. The highest number of tillers per plant (2.93) andnumber of leaves per plant (22.9) were recorded with RDF + 25 t pressmud ha^{-1}. The least number of tillers per plant (2.62) and number of leaves per plant (19.7) were notedin control. The variation among the treatments for these two characters were non-significant, indicating thatvarying levels of pressmud did

not have much effect on these two vegetative parameters. A similar effect of organic matter on the number of leaves in turmeric was reported by Kumar *et al.* (2016). Applicationof RDF + 20 t pressmud ha^{-1}produced significantly longer (49.4 cm) and broader (12.9 cm) leaves in turmeric than the control (38.4 and 10.2 cm, respectively).The increased plant height and luxuriant foliage growth may be attributed to the appreciable amount of micronutrients in readily available form with pressmud. The high organic matter content of pressmud improves thesoil conditions for theuptake of nutrients by the increased quantity of plant roots (Kumar *et al.*, 2016). The higher uptake of nutrients from the soil could have resulted in the production of taller plants with more photosynthetic area in the form of longer and broader leaves.Similar results have also been reported by Lohar and Hase (2021); Kadam and Kamble (2020); Kumar *et al.*, (2016); Chamroy *et al.*, (2015) in turmeric.

Table 1: Effect of pressmud on vegetative characters of turmeric (average of two years)

Treatments	Plant height (cm)	Number of tillers per plant	Number of leaves per plant	Leaf length (cm)	Leaf breadth (cm)
T_1	81.4	2.62	19.7	38.4	10.2
T_2	84.6	2.73	20.6	41.7	11.1
T_3	89.2	2.81	20.9	45.8	11.7
T_4	97.4	2.93	21.9	49.4	12.9
T_5	94.4	2.9	22.9	46.6	12.0
T_6	88.5	2.68	20.1	43.4	11.1
SEm±	1.51	0.10	0.28	0.43	0.17
CD (P=0.05)	9.86	ns	ns	5.96	1.42

Yield attributing characters:

The data (Table 2) revealed the beneficial effect of sugarcane pressmud in improving the yield attributing characters of turmeric significantly over control. Among the different treatments applied, RDF + 20 t pressmud ha^{-1} came out to be the best treatment in improving all the yield attributing characters. An application of 20 t pressmud ha^{-1} along with RDF resulted in the highest number of rhizomes per plant (21.5) followed by RDF + 25 t pressmud ha^{-1} (19.0), while the least number of rhizomes per plant (15.4) was counted in control. With regard to fresh rhizome weight per plant also, RDF + 20 t pressmud ha^{-1} recorded the highest weight (310.3 g) followed by RDF + 15 t pressmud ha^{-1} (295.4 g), while thelowest fresh rhizome weight per plant (252.9 g) was obtained with control. The number of rhizomes per plant and fresh rhizome weight per plant by RDF + 20 t pressmud ha^{-1} cumulatively produced the highest fresh rhizomes yield (34.47 t ha^{-1}) than other levels of pressmud. The second highest rhizome yield was obtained with RDF + 15 t pressmud ha^{-1} (32.81 t ha^{-1}), while the lowest yield (28.09 t ha^{-1}) was produced by the control. The present findings are in agreement with the observations of Kadam and Kamble (2020); Chamroy*et al.*, (2015); Kamal and Yousuf (2012); Balakrishnamurthy (2007) in turmeric.The addition of pressmud improves the soil texture; and makes the soil loose and friable, a condition favourable for the development of underground storage organs such as rhizomes. The manifold improvement of soil properties may have resulted in increasing the availability of both macro and micro nutrients in readily available form. A better soil micro-environment and increased availability of the complete set of nutrients may have resulted in the increase in photosynthetic area in the form of longer and broader leaves. An increase in the amount of photosynthates, and its preferential influxto the sink, and a loose and friable soil, propitious for the bulking of rhizomes, may havebeen responsible for the production of more number of bolder rhizomes per plant, and thus more yield in turmeric.

Fig. 1: Effect of pressmud on yield of turmeric

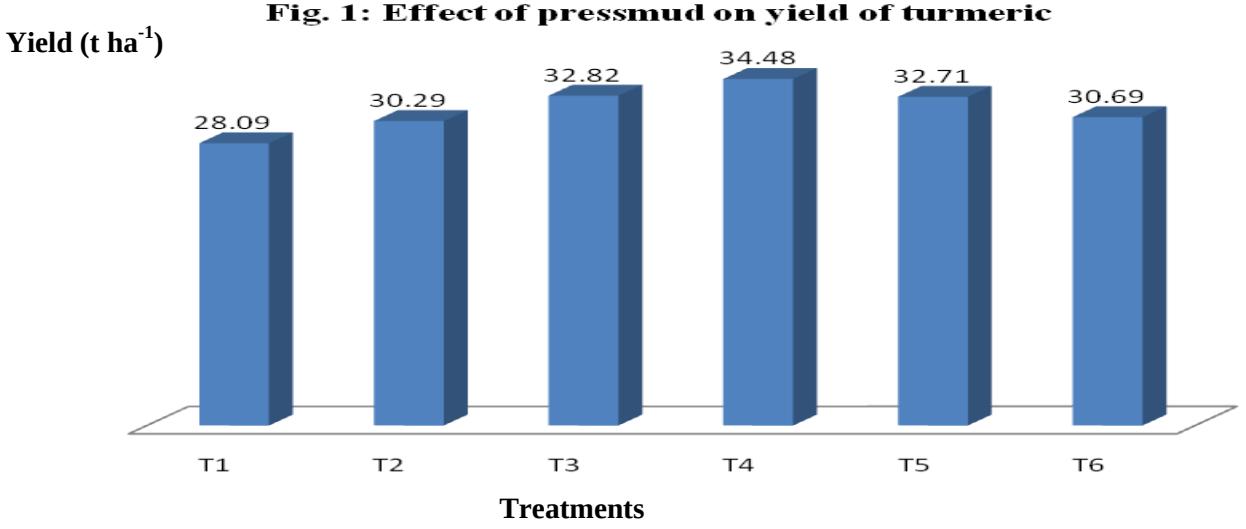

Table 2: Effect of pressmud on yield attributing characters and yield of turmeric (average of two years)

Treatments	Number of rhizomes per plant	Fresh rhizome weight per plant (g)	Yield (t ha^{-1})
T_1 (RDF only)	15.4	252.9	28.09
T_2: RDF + 10 t pressmud ha^{-1}	17.4	272.6	30.28
T_3: RDF + 15 t pressmud ha^{-1}	18.8	295.4	32.81
T_4: RDF + 20 t pressmud ha^{-1}	21.5	310.3	34.47
T_5: RDF + 25 t pressmud ha^{-1}	19.0	294.4	32.71
T_6: RDF + 30 t pressmud ha^{-1}	17.9	276.2	30.69
SEm±	0.18	3.33	0.49
CD (P=0.05)	2.86	23.62	3.32

Another important observation in the present experiment worth discussion was the decreasing trend of vegetative growth of turmeric plants with higher levels of sugarcane pressmud application after a certain limit. It might be due to the existenceof additional contents of heavy metals in sugarcane pressmud. This may have interfered with the cation exchange capacity of the soil, reducing the overall uptake of necessary nutrients from the soil colloid. Reduced uptake of essential nutrients may have resulted in lesser vegetative growth.A reduced photosynthetic area would lead to less amount of photosynthate to be accumulated in the storage organs, and thus lower yields.Kumar and Chopra (2016) also reported similar results.

Table 3: Economics of turmeric production with different levels of pressmud application

Treatments	Cost of cultivation (Rs. ha^{-1})	Gross Income (Rs. ha^{-1})	Net Income (Rs. ha^{-1})	Benefit : Cost Ratio
T_1 (RDF only)	235213	589890	354677	2.51
T_2: RDF + 10 t pressmud ha^{-1}	240163	636090	395927	2.65
T_3: RDF + 15 t pressmud ha^{-1}	242638	689220	446582	2.84
T_4: RDF + 20 t pressmud ha^{-1}	245113	724080	478967	2.95
T_5: RDF + 25 t pressmud ha^{-1}	247588	686910	439322	2.77
T_6: RDF + 30 t pressmud ha^{-1}	250063	644490	394427	2.58

Economics:

The economic analysis for the effect of different levels of pressmud application on turmeric has been presented in Table 3 and Fig. 2. It is evident from data that application of pressmud along with RDF increased the profitability of turmeric cultivation. The figures

on expenditure-income showed that RDF + 20 t pressmud ha^{-1}gave the highest monitory return of Rs. 4,78,757 ha^{-1} with the highest benefit : cost ratio (2.95), followed by RDF + 15 t pressmud ha^{-1}with a net profit of Rs. 4,46,552 ha^{-1} and 2.84 B:C ratio. The higher profitability of turmeric with RDF + 20 t pressmud ha^{-1} may be attributed to higher yields. The lowest net profit (Rs. 3,54,677 ha^{-1}) with the least B:C ratio (2.51) was obtained with control. Kadte*et al.*, (2018) and Roy and Hore (2011) also reported turmeric cultivation to be highly remunerative with the use of organic sources of nutrients.

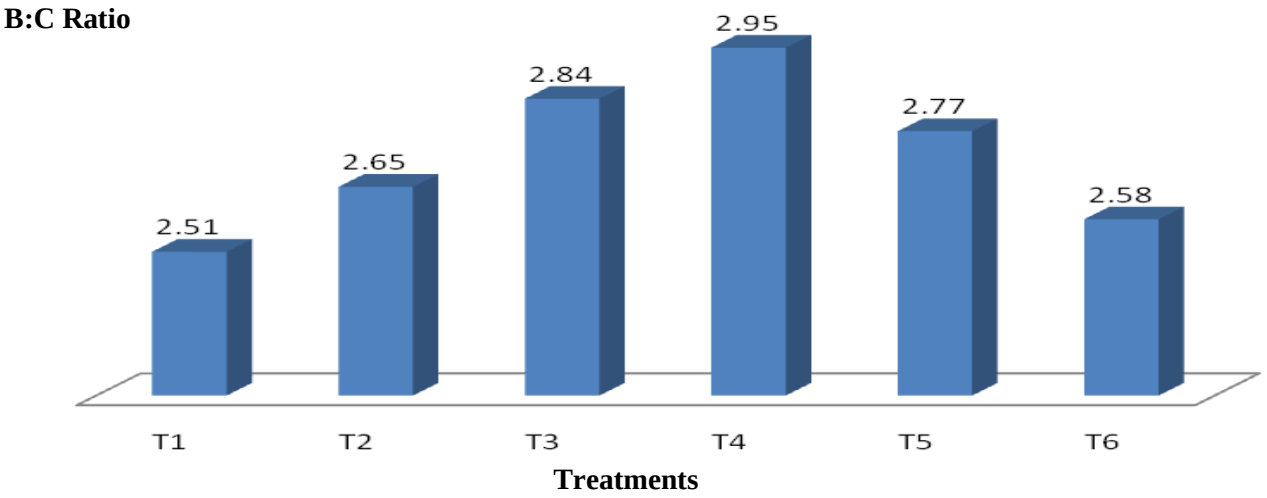

Fig. 2: Economics of turmeric production with different levels of pressmud

It is evident from the present study that sugarcane pressmud had exerted significant effect on the growth and yield attributes of turmeric. Applicationof 20 tpressmud ha^{-1},along with RDF was found to be very effective and economically remunerative for getting substantially higher yield in turmeric in plains of Uttar Pradesh. Therefore, application of pressmud may be recommended for sustainable production of turmeric in the region.

REFERENCES

Anuradha, U.B., Patil, S.S., Kurubar, A.R., Ramesh, G. and Hiregoudar, S. (2018) Effect of integrated nutrient management on growth and yield of turmeric (*Curcuma longa* L.) cv. Salem. *International Journal of Current Microbiology and Applied Sciences* **7**(1): 3196-3203

Balakrishnamurthy, G., Kamalkumar, R. and Prabu, T. (2007) Standardization of organic manures and bioregulators for organic production of turmeric (*Curcuma longa* L.) Tamil Selvan, M., Cheriyan, H., Sadanandan, A. K. and Khan, H. (eds.) *Souvenir of National Seminar on Organic Spices and Aromatic Crops*, 1-2 February 2007, Calicut, Kerala. pp 123-130.

Chamroy, T., Rajwade1, V. B. and Bajad, V. V. (2015) Effect of organic and inorganic manurial combinations on turmeric (*Curcuma longa* L.).*Plant Archives* **15**(1): 67-69.

Kadam, J.H. and Kamble, B.M. (2020).Effect of organic manures on growth, yield and quality of turmeric (*Curcuma longa* L).*Journal of Applied and Natural Science***12**(2): 91-97.

Kadte, A.J., Perke, D.S. and Kale, P.S. (2018) Economics of Turmeric Production in Sangli District of Maharashtra, India. *International Journal of Current*

*Microbiology and Applied Sciences***6**: 2279-2284

Kamal, M.Z.U. and Yousuf, M. N. (2012) Effect of organic manures on growth, rhizome yield and quality attributes of turmeric. *The Agriculturists***10**(1): 16-22.

Kumar, K.R., Rao, S.N. and Kumar, N.R. (2016) Effect of organic and inorganic nutrient sources on growth, quality and yield of turmeric (*Curcuma longa* L.). *Green Farming***7**(4): 889-892.

Kumar, S., Meena, R.S., Jinger, D., Jatav, H. S. and Banjara, T. (2017) Use of pressmud compost for improving crop productivity and soil health.*International Journal of Chemical Studies***5**(2): 384-389

Kumar, V. and Chopra, A.K. (2016) Effects of sugarcane pressmud on agronomical characteristics of hybrid cultivar of eggplant (*Solanummelongena* L.) under field conditions.*International Journal of Recycling of Organic Waste in Agriculture***5**: 149–162.

Lohar, R.R. and Hase, C.P. (2021) Effect of chemical fertilizers and organic sources on growth, yield and quality of turmeric (*Curcuma longa* L.) and soil fertility.*Agricultural Research Journal***58**(4): 624-631.

Panse, V.G. and Sukhatme, P.V. (1985) Statistical Methods for Agriculture Workers. Indian Council of Agricultural Research (ICAR), New Delhi, pp 143-149.

Reshma, H. M. and Vishwanath, Y.C. (2020) Advances in production technology of turmeric.*Journal of Pharmacognosy and Phytochemistry* 9(4): 1198-1203.

Roy, S.S. and Hore, J.K. (2011) Effect of different bio-organic inputs on growth, yield and economics of turmeric grown as intercrop in arecanut plantation *Indian Journal of Horticulture* **68**(3): 375-378

Uma Devi, G. (2008) Deployment of organic and inorganic amendments to manage rhizome rot of turmeric. *Journal of Mycology and Plant Pathology***3**(2): 307-310.