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Yield Response of Turmeric (*Curcuma longa* L.) under Drip Fertigation and Plastic Mulch Conditions

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ABSTRACT

Field experiments were conducted on the lateritic sandy loam soils of Kharagpur, West Bengal, India during 2015-2017 to determine the fertilizer requirement of Turmeric as an intercrop of Sapota and to evaluate the economic feasibility of drip fertigation with and without plastic mulch. The research trials for the consecutive two years showed that 80% of fertigation met with drip and plastic mulch (T_4) resulted maximum plant height, stem girth, functional leaves, corm weight, corm length and yield. The highest yield was observed under the treatment 0.8 VDM (16.64 t ha^{-1}) with 85% increase in yield as compared to furrow fertigation (8.99 t ha^{-1}).

Key words: *Turmeric; Drip irrigation; Mulching; Water requirement, Yield.*

INTRODUCTION

Turmeric, Curcuma longa L., which is a member in Zingiberaceae, was originated from South-east Asia. Turmeric is known as the "golden spice" as well as the "spice of life". Turmeric was consumed in multidisciplinary, such as food, spice, cosmetic and medicine. It has been used in India as a medicinal plant, and held sacred from time immemorial. It is a dye, with varied usages in drug and cosmetic industries. It is used as medicinal for external application and taken internally as a stimulant. 'Kum-kum', is also a bi-product of turmeric. Turmeric is cultivated most extensively in India, followed by Bangladesh, China, Thailand, Cambodia, Malaysia, Indonesia, and Philippines. India is one of the leading grower of turmeric, covering an area of about 1,80,960 ha with production of about 7,92,980 tonnes per annum. Andhra Pradesh, Karnataka, Kerala, Tamilnadu, Maharashtra, Orissa and West Bengal are potential states for turmeric production. It can be grown under shaded conditions and as an intercrop to the wide spacing fruit crops such as Mango, Guava, Citrus, and Litchi etc.

Owing to its long duration and high productivity, turmeric requires heavy input of fertilizers[9]. In Tamil Nadu, a nutrient dosage of 150: 60: 108 kg NPK ha-1has been generally recommended[1]. In almost all the turmeric growing regions, the nutritional requirements are met through application of fertilizers in the soil. Split application of nutrients, especially nitrogen and potassium, has been recommended to improve the yield and quality[4].

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Turmeric being a crop with high water requirement, assured water supply throughout its growth period of 9 to 10 months is essential. Normally turmeric crop is irrigated at an interval of 5-7 days depending on soil and weather factors. Increasing scarcity of water often encountered in many parts of turmeric growing regions necessitates alternative means to provide adequate water to the crop without wastage. Of late, fertigation i.e. application of fertilizer through drip irrigation has been found to dramatically improve the quality of many horticultural crops[2]. While fertigation can be practiced using conventional fertilizers such as urea and potash with reduced costs, use of water soluble fertilizers may be effectively employed to improve the quality. Hence, the present study was taken up in turmeric cv. Suguna with the objective of studying the impact of fertigation in the fertilizer use efficiency, quality and yield of turmeric cv. Suguna.

MATERIAL AND METHODS

The field experiment was conducted during the months of July to December in 2 years (2015-2017) at the experimental farm of Precision Farming Development Center, Agricultural and Food Engineering Department, Indian Institute of Technology, Kharagpur, West Bengal, India, located at $22^{o}19'$ N latitude and $87^{o}19'$ E longitude at an altitude of 48 m above mean sea level. The soil at the experimental field is a lateritic sandy loam (18.4% clay, 22.6% silt and 59.0% sand) having a maximum soil water holding capacity of 14.9%, bulk density of 1.44 g cm^{-3} with a final steady state infiltration rate of 10 mm h^{-1}. A field plot of size 1000 m^2 as inter space to Sapota crop is selected for experimental studies. The field plot is divided in beds of equal size of 1m x 6m and each bed represented a single treatment. Turmeric (Var. PCT-13(Suguna)) was being planted in two rows on each bed with spacing of 0.3 m between plant to plant and 0.5 m between two rows. In between two treatments (i.e. two beds) 1.0 m wide strips were left to minimize the chances of moisture movement from one treatment to another treatment. The experiments were laid out following the Randomized Block Design (RBD) with 8 treatments and 3 replications. The treatments were randomly applied to each block.

The various treatments were as follows:

T1 (VD)	:100% Fertigation met with drip irrigation without mulch
T2 (VDM)	:100% Fertigation met with drip irrigation with 50µ black plastic mulch
T3 (0.8VD)	:80% Fertigation met with drip irrigation without mulch
T4 (0.8VDM)	:80% Fertigation met with drip irrigation with 50 µ black plastic mulch
T5 (0.6VD)	:60% Fertigation met with drip irrigation without mulch
T6 (0.6VDM)	:60% Fertigation met with drip irrigation with 50 µ black plastic mulch
T7 (FM)	:100% Fertigation under furrow irrigation method with 50 µ black plastic mulch
T8 (F)	:100% Fertigation under furrow irrigation method without mulch

The drip irrigation system was installed and operated daily to provide the sufficient moisture to the plants. The lateral lines were laid parallel to the crop rows and each lateral served two rows of crop. The laterals were provided with on line emitters of 4 lph discharge capacity. Emitters were fixed 0.3m apart to serve the irrigation water requirement of four plants.

The black plastic film of 50µ thickness (200 gauge) were used as mulch materials to cover 100% of area under each treatment. The mulch was provided in between two rows of the crop. In case of furrow, 20 cm wide strip on both sides of furrow was covered with mulch material. Standard agronomic practices such as fertilization and plant protection measures were applied during the entire crop period. For furrow irrigated plots 10 t/ha FYM and 500 kg Neem Cake was applied as basal dose and 150: 60: 108 kg NPK/ha was applied in three split doses viz. 40, 80, and 120 days after planting in drip irrigated plots water soluble fertilizers were applied at 7 days

interval to meet the nutritional requirement of crop.

Biometric observations on plant height (cm), stem girth (cm), functional leaves (nos.), corm weight (g), corm length (cm) and yield (t ha^{-1}) were measured at 15 days interval in order to monitor the influence of irrigation treatments and plastic mulch on crop growth.

RESULTS AND DISCUSSION

Soil Temperature

The measurement of soil temperature was done at 15, 30 and 90 cm of soil depth both for the control (without mulch) and black plastic mulch (100µ). It can be seen from the observations presented in Table-1 that average temperature at 15 cm soil depth during winter season varied between 13.5oC to 27.5oC under control plot where as temperature varied between 15 to 31.5oC under black plastic mulch condition. During summer months (March to May) temperature at different depth ranged from 14.5 to 32.5oC in control plot and 15 to 35oC under black plastic mulch. In general rise in the soil temperature was observed under plastic mulch condition. Increase in soil temperature has been reported under plastic mulch condition. They also reported faster growth of rice. Rise in the soil temperature during winter season under plastic mulch might have influenced for increase in the yield of Turmeric crop due to increased activity of micro organisms which transforms nutrients. Soil treated with plastic mulch caused accumulation of more organic matter and humic acid which is the store house of plant nutrients that supplies nutrient to plant.

Biometric response of Turmeric crop with drip fertigation and plastic mulch

Treatment-wise biometric observations of the crop were recorded from July 2015 to December 2017. Table 2 shows the pooled values of biometric attributes (plant height (cm), stem girth (cm), functional leaves (nos.), corm weight (g), corm length (cm) and yield (t ha^{-1}) under different treatments.

From the Table 2, it is revealed that the drip fertigation with plastic mulch has the significant influence on plant growth and yield in comparison to furrow fertigation with and without mulch (T_7 & T_8). Some of the vegetative attributes (functional leaves and corm weight) at 80% and 100% fertigation requirement met with drip fertigation along with plastic mulch (T^4 & T^2) were statistically at par. Results showed highest value of plant height (139.4 cm), stem girth (10.81 cm), functional leaves (11.41 nos.), corm weight (863.5 g), corm length (11.72 cm) and yield (16.64 t ha^{-1}) under the treatment T_4 and lowest under the treatment T_8^6.

The yield data presented in Table 2 shows that the yield of Turmeric crop was also statistically significant under different treatment combinations. The Turmeric yield was found to decrease as the amount of fertigation dose was reduced from 100 % to 60 % of fertigation requirement. Maximum yield of 16.64 t ha^{-1} was found in treatment T_4. With the same level of fertigation application between two treatments, the yield was always greater in case of plastic mulch treated plants. This could be due to greater nutrients and water availability to plants as compared to non mulched condition[3,5]. With 80 % fertigation supply through drip system the yield of Turmeric was estimated to be 85.1 % more than the conventional furrow irrigation. It is observed that with the increased fertilizer supply from 60 to 80 % there was corresponding increase (29.6 %) in yield however, there is a decrement in yield (5.05 %) was found with the increased water supply from 80 to 100 %. This may be due to better soil water environment in root zone because of reduction in bulk density and greater porosity with less water application due to drip irrigation and hence in case of water scarcity the drip irrigation is a viable option to adopt.

Yield was always greater than that of the conventional furrow irrigation treatment (T_8) for all fertigation treatments i.e. T_1, T_3, & T_5. There was significant increase in yield under drip in combination with plastic mulch as compared to that of drip alone and furrow irrigation method. The percentage increase in yield for different levels of fertigation under drip with plastic mulch was found to be 12.3

% (T_2), 5.7 % (T_4) and 21.6 % (T_6) as compared to that of drip alone (T_1, T_3 and T_5) respectively. The furrow fertigation method with plastic mulch (T_7) resulted 14.7 % increase in yield as compared to furrow fertigation alone (T_8)[7,8].

Table 1: Temperature variation in control and plastic mulched plots at different soil depth

Season	Soil temperature in Control (°C)			Soil temperature in plastic mulch (°C)		
	15 cm	30 cm	90 cm	15 cm	30 cm	90 cm
Winter (Dec-Feb)	13.5-27.5	14.5-29.0	16.5-26.0	15.0-31.5	17.5-30.5	17.0-28.0
Summer (March-May)	17.0-30.5	14.5-30.5	17.5-32.5	16.5-35.0	15.0-32.0	17.5-33.5

Table 2: Biometric observation and Yield (t ha^{-1}) of turmeric: (Two years pooled data)

Treatment	Plant Height (cm)	Stem Girth (cm)	Functional Leaves (nos.)	Corm Weight (g)	Corm Length (cm)	Yield (t ha^{-1})
T_1 (VD)	106.1	8.73	9.89	428.3	8.35	14.10
T_2 (VDM)	126.5	9.92	10.91	806.8	9.72	15.84
T_3 (0.8 VD)	107.4	9.63	9.28	358.3	8.65	15.75
T_4 (0.8 VDM)	139.4	10.81	11.41	863.5	11.72	16.64
T_5 (0.6 VD)	103.1	8.25	9.41	354.7	6.64	10.56
T_6 (0.6 VDM)	113.6	9.62	10.24	600.2	8.86	12.84
T_7 (FM)	96.0	8.32	9.08	287.3	5.91	10.31
T_8 (F)	91.5	7.29	8.74	252.7	5.69	8.99
C.D. (P=0.05)	**10.6**	**0.87**	**0.73**	**66.8**	**0.55**	**0.66**

CONCLUSION

Treatments 80% fertigation requirement met with drip fertigation along with plastic mulch showed highest value of plant height, stem girth, functional leaves, corm weight, corm length and yield under the treatment T_4 and lowest under the treatment T_8.

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