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Crop Weather Relationship of Turmeric Under Different Mulching Practices

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ABSTRACT

Turmeric (*Curcuma longa* L.) is also known as "golden spice" or "Indian saffron," is an important spice crop that originated and is cultivated in India. It is an annual herbaceous crop and belongs to the family Zingiberaceae. Weather is one of the most important independent variables in turmeric production. A field experiment was carried out at the College of Agriculture, KAU, Vellanikkara, under the department of Agricultural Meteorology from 2020 to 2021. The experiment was laid out in a split plot design with four different dates of planting (D1-1st May, D2-15th May, D3-1st June and D4-15th June) as the main plot treatments and four different mulches (M1-white polythene mulch, M2-black polythene mulch, M3-paddy straw mulch and M4-green leaf mulch) as subplot treatments. The whole crop period was divided into four phenophases *viz*. planting to 100% germination, 100% germination to initiation of active tillering, active tillering to bulking and bulking to physiological maturity. The effect of planting dates and mulches on yield was found to be significant. May 1st and May 15th dates of planting had produced more yield and they were on par. Paddy straw mulch produced a superior yield among mulching treatments. The decrease in maximum temperature, bright sunshine hours and evaporation, as well as the increase in minimum temperature, forenoon relative humidity and rainfall during the bulking stage enhanced the yield of the turmeric crop.

Keywords: Micrometeorological modification, Mulches, Phenophases, Planting date, Yield

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INTRODUCTION

Turmeric (*Curcuma longa* L.) is also known as "golden spice" or "Indian saffron," is an important spice crop that originated and is cultivated in India. It is an annual herbaceous crop and belongs to the family *Zingiberaceae*. The yellow color of turmeric is due to a mixture of curcuminoides and curcumin (Maheswari *et al.*, 2006). India is the largest producer of turmeric in the world, and Indian turmeric is considered to be the best, because it has the highest curcumin content. India contributes 80% of the world's production. The most important states for turmeric cultivation are Andhra Pradesh, Tamil Nadu, Odisha, Kerala, Maharashtra, West Bengal, and the north-eastern states (Kour and Brar, 2016). Turmeric is mainly planted in the hot summer months and grown as a rainfed crop. Changes in climate have enormous influence on crop growth and development, resulting in large year-to-year and location-to-location variations in the crop yield. The aim of crop weather relationship studies is to understand the crop response to climate. Mulching is an important cultural practice in turmeric, which helps to maintain an optimum microclimatic condition that reduces weed growth, adds organic matter, and conserves moisture. The aim of this study is to understand the influence of different weather parameters on the growth and yield of turmeric crop under different planting dates and micrometeorological modifications with mulches.

MATERIALS AND METHODS

A field experiment was conducted from May 2020 to February 2021 at the College of Agriculture, KAU, Vellanikkara with the turmeric variety, *Kanthi*. The experiment was laid out in a split plot design with four dates of planting, viz., D1 - 1st May, D2-15th May, D3- 1st June, and D4 - 15th June as the main plot treatment. The four different mulch treatments M1:-white polythene mulch, M2-black polythene mulch, M3-paddy straw mulch, and M4-green leaf mulch were taken as sub-plot treatments. The whole crop period was divided into four phenophases, *viz.*, P1-planting to 100% germination; P2-100% germination to the initiation of active tillering, P3-active tillering to bulking and P4- bulking to physiological maturity. The treatments were replicated four times with a bed size of 3.6 m^2 and a spacing of 25cm x 25cm.Weather data were collected from the principal agrometeorological observatory, Vellanikkara and micrometeorological observations were recorded from the experimental field laid out in College of Agriculture, KAU, Vellanikkara. Biometric parameters, yield and yield attributes were recorded. The maturity stage of

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Turmeric crop varied for different treatments. The crop took around 8 months for harvesting. The influence of dates of planting and mulching and their interaction on yield were understood by carrying out an analysis of variance using R-statistical software (RStudio Team 2020). The influence of weather parameters on yield was found by doing correlation analysis between yield and weather parameters in each phenophase using SPSS software.

RESULTS AND DISCUSSION

Influence of dates of planting on Biometric observations

The biometric parameters like plant height, number of leaves, leaf area, number of tillers and dry matter accumulation were significantly higher on the earlier date of plantings. The May 1st planting recorded highest number of leaves and leaf area. May 15th planting showed maximum height. Earlier planted crops experienced better weather conditions due to more growing time, less weed competition, good aeration, light interception and the absorption of more nutrients and minerals. This might be the reason for the increased growth and production of earlier crops. This result was supported by the studies of Kumar *et al.* (2008), Kandiannan and Chandragiri (2006) and Ishimine *et al.* (2004). All these biometric parameters were showing a decreasing trend in June 15th planting.

Influence of dates of planting on yield and yield attributes

The effect of date of planting on yield and yield attributes showed that it was significant in cases of fresh and dry yield, width and weight of primary rhizome, number and weight of secondary rhizomes, weight of mother rhizomes. The fresh yield of the crop was recorded to be higher and on par in earlier plantings on May 1st (24388.09 kg ha^{-1}) and May 15th (24891.41 kg ha^{-1}), followed by the third date of planting, June 1st (19447.07 kg ha^{-1}). The least yield was recorded on the last date of planting, June 15th (12117.38 kg ha^{-1}) (Fig 1.). Similar findings were suggested by Kumar *et al.* (2018). The first and second dates of planting, May 1st and May 15th have recorded maximum dry yields of 4645.78 kg ha^{-1} and 4697.68 kg ha^{-1}, respectively and were on par with each other. The width of the primary rhizome of turmeric recorded on May 1st, May 15th and June 1st dates of planting were more and on par with each other (1.96cm, 1.93cm, and 1.88cm). The number of secondary rhizomes of turmeric recorded was 30.16, 33.07, and 31.68 on May 1st, May 15th and June 1st dates of planting respectively and were on par. The weight of the mother rhizome of turmeric showed that the May 1st, May 15th and June 1st dates of planting were on par and recorded 74.97g, 66.73g and 69.60g, respectively. The weight of the primary rhizome of turmeric showed maximum weights of 130.87g, 134.75g, and 122.40g recorded on the 1st, 2nd and 3rd dates of planting and they were on par. The secondary rhizome of turmeric showed that the maximum weights of 88.65g, 91.03g, and 99.25g were shown on the 1st, 2nd, and 3rd dates of planting and they were on par to each other. (Table 1).

Table 1: Effect of dates of planting on yield and yield attributes

Date of planting	Fresh Yield (kg ha^{-1})	Primary rhizome				Secondary rhizome		Mother rhizome		Dry yield (kg ha^{-1})
		Length (cm)	Width (cm)	Number	Weight (g)	Number	Weight (g)	Number	Weight (g)	
D1-1st May	24388.09^{a}	14.75	1.96^{a}	10.21	130.87^{a}	30.16^{a}	88.65^{a}	1.87	74.97^{a}	4645.78^{a}
D2- 15th May	24891.41^{a}	11.17	1.93^{a}	11.86	134.75^{a}	33.07^{a}	91.03^{a}	2.05	66.73^{a}	4697.68^{a}
D3- 1st June	19447.07^{b}	12.07	1.88^{a}	12.36	122.40^{a}	31.68^{a}	99.25^{a}	2.42	69.60^{a}	3547.44^{b}
D4- 15th June	12117.38^{c}	11.30	1.61^{b}	12.78	76.22^{b}	23.51^{b}	41.95^{b}	2.56	39.75^{b}	2173.89^{c}
CD	3836.19	NS	0.10	NS	33.66	6.53	30.38	NS	11.86	731.21

Influence of mulches on biometric observations

Biometric observations showed that plant height, number of leaves, leaf area, number of tillers, and dry matter accumulation were significantly higher in treatment with paddy straw mulch followed by the green leaf mulch. Similar findings have been reported by Thankamani *et al.* (2016), Rair *et al.* (2011) and Kumar *et al.* (2008).

Influence of mulches on yield and yield attributes

The fresh yield of turmeric showed a significant difference between different mulches. The maximum fresh yield of 23952.73 kg ha^{-1} was recorded by paddy straw (M3) mulch and minimum fresh yield of 16278.71 kg ha^{-1} was recorded by black polythene mulch (M2). The white polythene mulch (M1) produced 19040.82 kg ha^{-1} and the green leaves mulch (M4) produced 21571.68 kg ha^{-1}. All four mulches showed significant differences in yields, similar findings were suggested by Thankamani*et al.* (2016). All four mulches showed significant differences between dry yields (Table 2). The maximum dry yield of 4543.68 kg ha^{-1} and minimum dry yield of 2973.27 kg ha^{-1} were recorded by paddy straw (M3) and black polythene mulch (M2) respectively. The white polythene mulch (M1) produced 3515.27 kg ha^{-1} and the green leaves (M4) produced 4032.56 kg ha^{-1}.

Crop weather relation

Biometric observations

More vegetative growth was observed in the turmeric crop during second phenophase i.e. from germination to the initiation of active tillering. Crop height showed a positive correlation with the maximum temperature during this phase. This was in accordance with the results of Ishimine *et al.*(2004). Ishimine and his co-workers reported that shoot length and number increased significantly due to the rising temperature

Table 2: Effect of mulches on yield and yield attributes

Date of planting	Fresh Yield (kg ha^{-1})	Primary rhizome				Secondary rhizome		Mother rhizome		Dry yield (kg ha^{-1})
		Length (cm)	Width (cm)	Number	Weight (g)	Number	Weight (g)	Number	Weight (g)	
M1-white polythene	19040.82^{c}	10.86	1.85	12.43	118.40	1.85	76.57	2.32	63.21	3515.27^{c}
M2- black polythene	16278.71^{d}	12.43	1.87	11.10	118.93	1.87	69.47	2.28	59.70	2973.27^{d}
M3- paddy straw	23952.73^{a}	13.12	1.84	12.32	119.22	1.84	92.20	2.18	69.32	4543.68^{a}
M4- green leaf	21571.68^{b}	12.89	1.83	11.36	107.68	1.83	82.63	2.11	58.82	4032.56^{b}
CD	2280.661	NS	NS	NS	NS	NS	NS	NS	NS	427.77

Yield and yield attributes

An increase in maximum temperature was found to be decreasing the yield of turmeric in all mulches. It was found that the average maximum temperature was lower on the first and second dates of planting compared to the third and fourth dates of planting, The yield was in accordance with the temperature; it was observed to be higher on the first and second dates of planting and lower on the third and fourth dates of planting(Fig. 1). This was similar to the result of Kandiannanet al. (2015). An increase in the minimum temperature contributed to an increase in the yield of turmeric. The average yield and minimum temperature were higher on early planting dates and lower on late planting dates (Fig.2.)

This result was in accordance with Kandiannan*et al.* (2015). The experimental results showed that rainfall had a positive correlation with yield. The increased cumulative rainfall

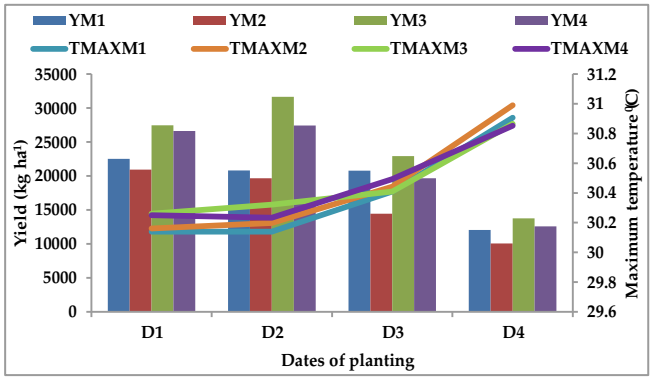

Fig. 1: Influence of maximum temperature on yield of turmeric during P3 stage

YM1- yield in white polythene mulch, YM2- yield in black polythene mulch,
YM3- yield in paddy straw mulch, YM4- yield in green leaf mulch,
TMAXM1- maximum temperature in white polythene mulch,
TMAXM2- maximum temperature in black polythene mulch,
TMAXM3- maximum temperature in paddy straw mulch,
TMAXM4- maximum temperature in green leaf mulch
D1- 1st May, D2- 15th May, D3- 1st June, D4- 15th JuneFig. 1: Influence of maximum temperature on yield of turmeric during P3 stage

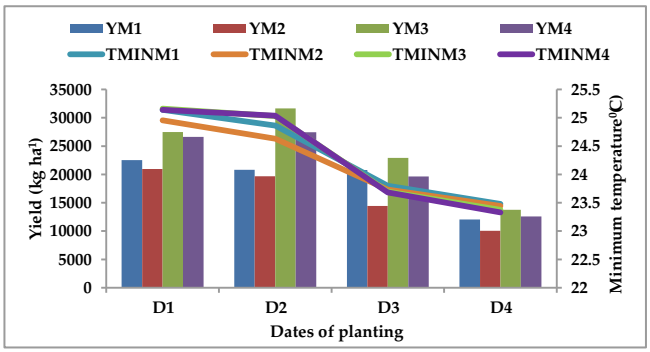

Fig. 2: Influence of minimum temperature on yield of turmeric during P3 stage

YM1- yield in white polythene mulch, YM2- yield in black polythene mulch,
YM3- yield in paddy straw mulch, YM4- yield in green leaf mulch,
TMINM1- minimum temperature in white polythene mulch,
TMINM2- minimum temperature in black polythene mulch,
TMINM3- minimum temperature in paddy straw mulch,
TMINM4- minimum temperature in green leaf mulch
D1- 1st May, D2- 15th May, D3- 1st June, D4- 15th June

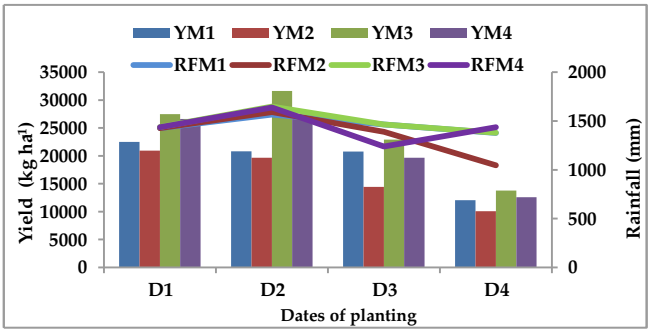

Fig. 3: Influence of rainfall during 3rdphenophase on yield

YM1- yield in white polythene mulch, YM2- yield in black polythene mulch,
YM3- yield in paddy straw mulch, YM4- yield in green leaf mulch
RFM1- rainfall recorded in white polythene mulch,
RFM2- rainfall recorded in black polythene mulch,
RFM3- rainfall recorded in paddy straw mulch,
RFM4- rainfall recorded in green leaf mulch
D1- 1st May, D2- 15th May, D3- 1st June, D4- 15th June

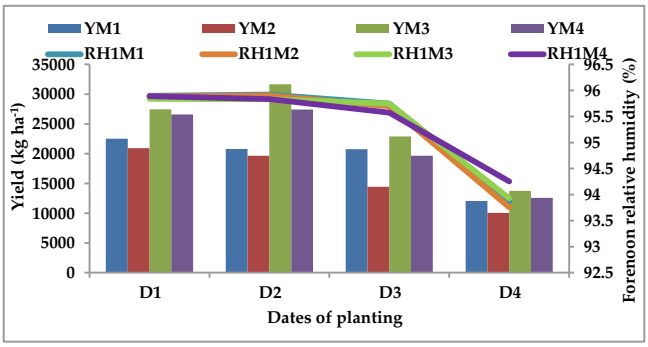

Fig. 4: Influence of forenoon relative humidity on yield of turmeric during P3 stage

YM1- yield in white polythene mulch, YM2- yield in black polythene mulch,
YM3- yield in paddy straw mulch, YM4- yield in green leaf mulch
RH1M1- forenoon relative humidity in white polythene mulch,
RH1M2- forenoon relative humidity in black polythene mulch,
RH1M3- forenoon relative humidity in paddy straw mulch,
RH1M4- forenoon relative humidity in green leaf mulch
D1- 1st May, D2- 15th May, D3- 1st June, D4- 15th June

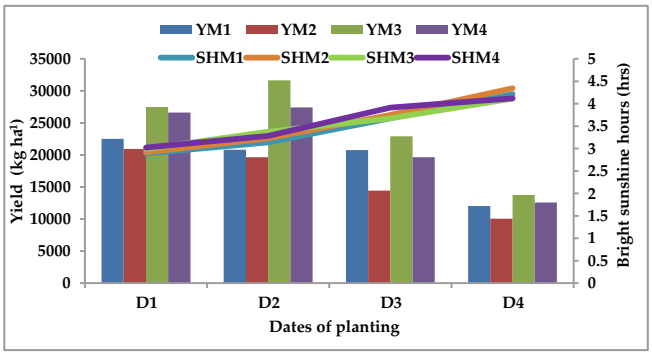

Fig. 5: Influence of bright sunshine hours on yield of turmeric during P3 stage

YM1- yield in white polythene mulch, YM2- yield in black polythene mulch,
YM3- yield in paddy straw mulch, YM4- yield in green leaf mulch
SHM1- sunshine hours in white polythene mulch,
SHM2- sunshine hours in black polythene mulch,
SHM3- sunshine hours in paddy straw mulch,
SHM4- sunshine hours in green leaf mulch
D1- 1st May, D2- 15th May, D3- 1st June, D4- 15th June

during the reproductive and maturity phases resulted in an increased yield for the crop. Due to the longer growing period in the earlier planting dates, the cumulative rain fall was high (Fig.3). This resulted in more yield than later-planted crops in all mulching treatments. (Kandiannanet al., 2015). It was observed that an increase in relative humidity resulted in an increase of yield during reproductive growth stages (Fig. 4) This is in accordance with the results of Kandiannan*et al.* (2015) Bright sunshine hours showed a negative correlation with yield (Fig.5). Kandiannan*et al.* (2015) reported that an increase in sunshine hours resulted in a decline in yield.

CONCLUSION

Earlier plantings, especially on May 1st and May 15th had positive significant influence on biometric and yield parameters. The paddy straw and green leaf mulches had positive significant influence on both biometric and yield parameters, highlighting their role in enhancing turmeric growth and yield. Increased maximum temperatures during the reproductive stage led to reduce the yield, emphasizing the importance of temperature management. Rainfall had positive influence on yield, favoring earlier planting dates with an extended growing period and higher cumulative rainfall. Relativehumidity positively influencined the yield during reproductive stages. Optimization of planting dates and selection of appropriate mulching practices are pivotal for maximizing turmeric yield. Crop weather relationship studies contribute to the existing knowledge and provide practical recommendations for turmeric farmers aiming to enhance production in diverse environmental conditions.

CONFLICT OF INTEREST

All the author both individually and collectively, affirms that they do not possess any conflicts of interest either directly or indirectly related to the research being reported in the publication.

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