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Tomato growth influenced by mulching materials and biostimulants

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Abstract
A field test was carried out at the Centre for Climate Resilient Agriculture, Shivamogga during the 2020 *kharif* growing season on red sandy loam soil to know tomato growth influenced by mulching materials and biostimulants. The experiment was laid out in factorial randomized complete block design consisting of four mulching materials (M_1: Pongamia leaves @ 4 t ha^{-1}, M_2: Polyethene mulch, M_3: Paddy straw @ 10 t ha^{-1} and M_4: No mulch) and three biostimulants (N: Nano nitrogen @ 4 ml lit^{-1}, B: Brassinolide @ 5 ml lit^{-1} and C: Control) with three replications in open field conditions. The experimental results reveal that among the mulching materials paddy straw at 10 t ha^{-1} was found to be significantly superior to other mulching materials in terms of plant height (157.98 cm), number of leaves (87.10), stem diameter (2.07 cm), number of flower clusters (33.89) and total number of flowers (230.89) compared to control. Among biostimulants, brassinolide at 5 ml lit^{-1} foliar spray produced noticeable differences in higher plant height (157.04 cm), number of leaves (80.23), stem diameter (2.03 cm), number of flower clusters (32.43) and total number of flowers (224.42) compared to control was observed. Paddy straw is used as mulching materials at 10 t ha^{-1} with brassinolide biostimulant at 5 ml lit^{-1} combination was found to be the best treatment compared to all other treatments.

Keywords: Pongamia, paddy straw, polythene sheet, nano nitrogen and brassinolide

Introduction
Tomato is a poor man's apple since it is the largest vegetable crop in the world and a popular protective food due to its distinctive nutrient content and general ease of production. Tomato are indeed a short-lived crop that requires both warm and temperate conditions. India overtook China as the second-largest producer of fruits and vegetables. 7.94 lakhs ha in India are under cultivation, producing 191.70 tonnes and yielding 158 q ha^{-1}. 46.16 million ha are cultivated worldwide, producing 1279.7 million tonnes at a rate of 458 q ha^{-1}. Karnataka, with a production of 2,077 tonnes and productivity of 31 MT per hectare over a 67,000 hectare area, comes in third with a 10.23 % share. Tomato production was 21.18 million tonnes in 2021–2022; nevertheless, when compared to the previous two years, production remained constant, while productivity fell from 26.1 to 24.3 tonnes in 2022. (Anon, 2022) [2]. The final yield of any crop is significantly influenced by the microclimate. The diverse ways in which global warming influences our agriculture production result in low crop output and productivity, which must be addressed to achieve sustainable production with suitable techniques that ensure surplus food security even in unfavourable climatic conditions. After crop harvest, handling crop residues is a massive task in agricultural production. Statistics from the Ministry of New and Renewable Energy indicate that India produces 500 Mt of crop residues per year [10]. Abiotic stress should be monitored to boost agricultural production by using fewer resources, improve soil fertility by adding nutrients to the soil in the form of organic carbon or humus and maintain a favourable microclimate during the crop growth period. Improper management also contributes to climate change for illustration burning residues provokes global warming and foul smell generates environmental pollution. Using crop residues as mulching materials is an insulator on the soil surface, nutrient recycling, weed control, soil moisture, soil temperature and erosion control. Under adverse environmental conditions it stimulates crop growth and ultimately lowers losses. It encourages proper crop growth and yields under adverse environmental conditions and as a result, reduces cultivation costs while increasing productivity. Similarly, abiotic stress such as drought, high soil salinity, heat and cold are common adverse environmental conditions that limit crop productivity. Plant biostimulants include various substances and microorganisms that enhance plant growth and

resistance to biotic and abiotic stress and increase yield and quality. Biostimulant treatments in crops can improve plant resilience to environmental perturbations and sustainability. It is also noted that a small concentration reduces the need for fertilizers and increases plant growth, water resistance and abiotic stresses is efficient, favoring the excellent performance of plant's vital processes and allowing high yield with good quality produce. The objective is to find out whether tomato growth is influenced by mulching materials and biostimulants.

Materials and Methods

A field experiment was conducted at the Centre for Climate Resilient Agriculture (CCRA), College of Agriculture, Shivamogga during *Kharif* 2020. The research area is located in Karnataka's Southern Transition Zone (Zone VII), 650 meters above mean sea level, between latitudes 130 58' N and 75 0 42' E. The experiment comprised twelve treatment combinations *i.e.*, four mulching materials (M_1: Pongamia leaves @ 4 t ha^{-1}, M_2: Polyethene mulch, M_3: Paddy straw @10 t ha^{-1} and M_4: No mulch) coupled with three biostimulants (N: Nano nitrogen @ 4 ml lit^{-1}, B: Brassinolide @ 5 ml lit^{-1} and C: Control). Three replications of the Factorial Randomised Complete Block Design (FRCBD) statistical method were utilized. Tomato seedlings are 20 days old and were transplanted after the application of mulching materials to respective treatment needs and placed in a 90 x 45 cm spacing distance with a depth of 3-5 cm and used a local high-yielding hybrid. Recommended package of practices were adopted for experimentation. The prescribed fertilizer dosage (250:250:250 kg NPK ha^{-1}) was administered in three separate doses. Biostimulants were applied as a foliar spray at 50 % flowering and peak fruiting stage. The data collected about growth and reproductive observations like plant height (cm), number of leaves, stem diameter (cm), number of flower clusters and total number of flowers were recorded. The experimental data on various parameters were subjected to statistical analysis using Fisher's method of analysis of variance (ANOVA), as described by Gomez & Gomez (1984)[6]. The significance levels used in the 'F' test were at p = 0.05. The critical difference values were calculated at a five percent probability level where the F test was significant and denoted as *. Using the statistical software program OPSTAT, which was created by Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana, India [15], Duncan's Multiple Range Test (DMRT) was used to evaluate whether the interaction effect was significantly different (p 0.05).

Results and discussion

The growth and reproductive characteristics of tomato were significantly influenced by mulching materials and biostimulants and experimental results in detail were discussed in the following paragraphs and represented in table 1 and 2.

Growth parameters

Growth of tomato *i.e.*, plant height, number of leaves and stem diameter were significantly influenced by mulching materials, biostimulants and nonsignificant interaction was observed. Among the mulching materials paddy straw mulch applied at a rate of 10 t ha^{-1} recorded significantly recorded higher growth parameters followed by polythene mulch sheet, pongamia leaves at 4 t ha^{-1} and lower in no mulch. Paddy straw application reduces weed competition in vegetative stages, conserves soil moisture by reducing water and nutrient leaching and also maintains an ideal soil temperature in early and late stages, creating a favorable microclimate that promotes increased plant growth, as measured by plant height and similar results were noticed by Biswas *et al*. (2015) [5], Arun Kumar *et al.* (2021) [3] and Islam *et al.* (2021) [7]. The slow rate of decomposition may be the reason for higher moisture retention with paddy straw mulch which could be attributed to better crop growth in terms of plant height, number of tillers, leaf length and width which more intercepted light in turmeric crop by Kumar *et al*. (2008) [9]. Vegetative growth parameters and plant chemical constituents are significantly increased due to the application of micronutrients and seaweed (Shehata *et al*., 2019) [14]. Among the biostimulants brassinolide at 5 ml lit^{-1} spray recorded significantly higher growth parameters followed by nano nitrogen at 4 ml lit^{-1} and lower in control. The increase in growth parameters due to aids with higher uptake and the use of soil moisture and chemical fertilizers helps in the rise of growth hormones that drive cell division, elongation, and enlargement of cells in stems. Similar results were recorded by Biradar (2021) [4] and Sridhara *et al.* (2021) [16] and Junior *et al*. (2022) [8].

Reproductive parameters

Mulching materials and biostimulants influence a number of flower clusters and a total number of flowers was found significant and nonsignificant in interaction represented in table 2. Among the mulching materials a significantly higher number of flower clusters and number of flowers were noticed in paddy straw mulch at 10 t ha^{-1}, followed by nano nitrogen at 4 ml lit^{-1} and lower in control. Paddy straw enhances soil biological condition, aeration and porosity for enhanced crop performance. It also has a significant impact on nutrient uptake because it creates an environment that is more conducive to greater root growth by raising the temperature of the soil and maintaining an appropriate level of soil moisture in the plant's rhizosphere. Rao *et al.* (2016) [13], Tswanya *et al.* (2017) [17] and Mishra *et al.* (2020) [11] study reports also agree with their results. Brassinolide exhibits a hormonal influence at a 5 ml lit^{-1} spray concentration on improved vegetative growth with high photosynthates diversion to reproductive portions of plants by causing early flowering with more fertile and less mortal flowers in flower clusters. Brassinolide at 5 ml lit^{-1} spray during the pre-blooming stage enhances flowering and more flowers per cluster with more fertile blooms, displaying larger flowers with longer petals and stigmas. By altering the pattern of metabolism and nutrient distribution, brassinolide has an impact on flowering and ramification. Similar results were recorded by Aiman *et al.* (2014) [1], Biradar (2021) [4] and Nidia *et al.* (2021) [12].

Table 1: Vegetative growth characters of tomato as influenced by mulching materials and biostimulants at different stages

Treatments	Plant height (cm)			Number of leaves			Stem diameter (cm)		
	60 DAT	90 DAT	At harvest	60 DAT	90 DAT	At harvest	60 DAT	90 DAT	At harvest
Mulching materials (M)									
M_1: Pongamia leaves @ 4 t ha^{-1}	143.73	147.36	147.89	138.14	162.00	78.00	1.23	1.84	1.89
M_2: Polythene sheet	146.40	153.44	154.13	141.13	168.86	84.86	1.29	1.93	1.99
M_3: Paddy straw @ 10 t ha^{-1}	150.40	157.11	157.98	143.09	170.99	87.10	1.33	2.00	2.07
M_4: No Mulch	132.00	140.27	141.20	131.86	139.84	55.84	1.15	1.82	1.87
F test	*	*	*	*	*	*	*	*	*
S.Em.±	3.52	3.79	3.80	2.14	2.94	2.58	0.03	0.04	0.04
CD (p=0.05)	10.39	11.20	11.21	6.32	8.68	7.61	0.09	0.11	0.12
Biostimulants (B)									
C: Control	135.91	141.51	141.94	134.62	155.08	71.08	1.20	1.84	1.89
NN: Nano nitrogen @ 4 ml lit^{-1} [at 50 % flowering and peak fruiting stage]	144.63	150.93	151.91	139.02	161.96	78.04	1.26	1.88	1.94
B: Brassinolide @ 5 ml lit^{-1} [at 50 % flowering and peak fruiting stage]	148.85	156.20	157.04	142.04	164.23	80.23	1.30	1.97	2.03
F test	*	*	*	*	*	*	*	*	*
S.Em.±	3.05	3.29	3.29	1.85	2.55	2.23	0.03	0.03	0.04
CD (p=0.05)	9.00	9.70	9.71	5.47	7.51	6.59	0.08	0.09	0.10
M X B (Interactions)									
M_1 X C	136.81^{ab}	142.72^{bcd}	143.02^{bcd}	134.92^{abcd}	157.61^{b}	73.61^{c}	1.20^{bcd}	1.81^{bc}	1.85^{c}
M_1 X NN	145.97^{ab}	148.55^{abcd}	149.53^{abcd}	136.71^{abcd}	163.35^{ab}	79.35^{abc}	1.23^{abcd}	1.84^{bc}	1.89^{bc}
M_1 X B	148.39^{ab}	150.81^{abcd}	151.11^{abcd}	142.80^{abc}	165.05^{ab}	81.05^{abc}	1.25^{abcd}	1.87^{bc}	1.92^{bc}
M_2 X C	137.20^{ab}	142.80^{bcd}	143.11^{bcd}	135.67^{abcd}	161.34^{ab}	77.34^{bc}	1.22^{bcd}	1.86^{bc}	1.91^{bc}
M_2 X NN	147.55^{ab}	154.49^{abcd}	155.14^{abcd}	142.95^{abc}	172.02^{ab}	88.02^{abc}	1.30^{abcd}	1.92^{bc}	1.96^{bc}
M_2 X B	154.44^{a}	163.04^{ab}	164.14^{ab}	144.77^{ab}	173.23^{ab}	89.23^{ab}	1.35^{ab}	2.01^{ab}	2.09^{ab}
M_3 X C	140.83^{ab}	142.76^{bcd}	143.06^{bcd}	137.82^{abcd}	163.76^{ab}	79.76^{abc}	1.25^{abcd}	1.90^{bc}	1.97^{bc}
M_3 X NN	154.18^{a}	160.28^{abc}	161.58^{abc}	144.53^{ab}	172.47^{ab}	88.80^{ab}	1.34^{abc}	1.95^{bc}	2.04^{abc}
M_3 X B	156.18^{a}	168.30^{a}	169.29^{a}	146.92^{a}	176.73^{a}	92.73^{a}	1.41^{a}	2.15^{a}	2.21^{a}
M_4 X C	128.81^{b}	137.74^{d}	138.59^{d}	130.06^{d}	137.61^{c}	53.61^{d}	1.12^{d}	1.78^{c}	1.84^{c}
M_4 X NN	130.80^{b}	140.40^{cd}	141.37^{cd}	131.87^{cd}	140.01^{c}	56.01^{d}	1.16^{cd}	1.82^{bc}	1.87^{bc}
M_4 X B	136.40^{ab}	142.66^{bcd}	143.63^{bcd}	133.66^{bcd}	141.90^{c}	57.90^{d}	1.18^{bcd}	1.85^{bc}	1.90^{bc}
S.Em.±	6.10	6.57	6.58	3.71	5.09	4.47	0.05	0.06	0.07
CD (p=0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Note: DAT- Days after transplanting; NS- Non significant; *- significant; Interaction- Mean values in each column followed by different lower-case are significantly different by DMRT test

Table 2: Reproductive growth characters of tomato as influenced by mulching materials and biostimulants at different stages

Treatments	Number of flowers clusters			Total no. of flowers
	30 DAT	60 DAT	90 DAT	
Mulching materials (M)				
M_1: Pongamia leaves @ 4 t ha^{-1}	0.50	10.94	29.93	192.89
M_2: Polythene sheet	0.69	13.18	31.72	218.00
M_3: Paddy straw @ 10 t ha^{-1}	0.78	14.71	33.89	230.89
M_4: No Mulch	0.35	9.82	26.47	164.56
F test	*	*	*	*
S.Em.±	0.02	0.33	0.89	6.21
CD (p=0.05)	0.05	0.96	2.62	18.33
Biostimulants (B)				
C: Control	0.51	11.30	28.60	177.33
NN: Nano nitrogen @ 4 ml lit^{-1} [at 50 % flowering and peak fruiting stage]	0.58	11.30	30.48	203.00
B: Brassinolide @ 5 ml lit^{-1} [at 50 % flowering and peak fruiting stage]	0.65	11.30	32.43	224.42
F test	*	*	*	*
S.Em.±	0.01	0.28	0.77	5.38
CD (p=0.05)	0.04	0.83	2.27	15.88
M X B (Interaction)				
M_1 X C	0.45^{ef}	10.54^{de}	28.38^{cd}	174^{efg}
M_1 X NN	0.50^{de}	10.92^{de}	30.10^{bcd}	197^{cdef}
M_1 X B	0.55^{d}	11.34^{cde}	31.31^{bc}	208^{cde}
M_2 X C	0.57^{d}	11.98^{cd}	29.51^{bcd}	186^{defg}
M_2 X NN	0.72^{c}	12.96^{bc}	31.39^{bc}	219^{bcd}
M_2 X B	0.81^{ab}	14.59^{b}	34.28^{ab}	249^{ab}
M_3 X C	0.72^{c}	13.06^{bc}	31.14^{bc}	200^{cdef}

M_3 X NN	0.77^{bc}	14.32^{b}	33.74^{ab}	230^{abc}
M_3 X B	0.85^{a}	16.76^{a}	36.82^{a}	263^{a}
M_4 X C	0.30^{h}	9.63^{e}	25.38^{d}	150^{g}
M_4 X NN	0.35^{gh}	9.74^{e}	26.71^{cd}	166^{fg}
M_4 X B	0.41^{fg}	10.11^{e}	27.33^{cd}	178^{efg}
S.Em.±	0.03	0.56	1.54	10.76
CD (p=0.05)	NS	NS	NS	NS

Note: DAT- Days after transplanting; NS- Non significant; *- significant; Interaction- Mean values in each column followed by different lower-case are significantly different by DMRT test

Conclusion

In the present study, the application of paddy straw as a mulching material at 10 t ha^{-1} combination with brassinolide at 5 ml lit^{-1} during 50 % flowering and peak fruiting stage gives better growth parameters of tomato compared to other mulch materials and biostimulants This agriculture practice gives better profit with lower cost inputs, which is a very beneficial practice for farmer wellbeing.

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