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Radha Yadav
M.Sc. Scholar, Department of
Horticulture, Suresh Gyan Vihar
University, Jaipur, Rajasthan,
India

Manoj Kumar Bhundela
Assistant Professor, Department of
Horticulture, Suresh Gyan Vihar
University, Jaipur, Rajasthan,
India

Dipayan Sarkar
Professor and Head Department of
Horticulture, Suresh Gyan Vihar
University, Jaipur, Rajasthan,
India

Indra Raj Yadav
Assistant Professor, Department of
Soil Science, Suresh Gyan Vihar
University, Jaipur, Rajasthan,
India

Usha Shukla
Assistant Professor, Department of
Horticulture, Suresh Gyan Vihar
University, Jaipur, Rajasthan,
India

Simran Priya
M.Sc. Scholar, Department of
Horticulture, Suresh Gyan Vihar
University, Jaipur, Rajasthan,
India

Corresponding Author:
Radha Yadav
M.Sc. Scholar, Department of
Horticulture, Suresh Gyan Vihar
University, Jaipur, Rajasthan,
India

Effect of mulching practices and foliar application of calcium on growth, yield and quality of Tomato (*Solanum lycopersicum* L.)

Radha Yadav, Manoj Kumar Bhundela, Dipayan Sarkar, Indra Raj Yadav, Usha Shukla and Simran Priya

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Abstract

A field experiment entitled “Effect of Mulching Practices and Foliar Application of Calcium on Growth, Yield and Quality of Tomato (*Solanum lycopersicum* L.)” was conducted during Rabi season to evaluate the effect of different mulching practices and calcium foliar sprays on growth, yield and quality parameters of tomato. The experiment was laid out in Factorial Randomized Block Design with four mulching treatments viz., control (no mulch), straw mulch, black polythene mulch and white polythene mulch along with three levels of calcium foliar spray viz., control, 0.25% Ca spray and 0.5% Ca spray. The results revealed that black polythene mulch significantly improved growth and yield attributes of tomato. Maximum plant height (81.63 cm), number of branches per plant (7.85), earliest flowering (44.16 days) and highest fruit yield (69.20 t ha⁻¹) were recorded under black polythene mulch (M₂). Among calcium treatments, foliar spray of 0.5% calcium (C₂) recorded significantly higher plant height (77.95 cm), branches per plant (7.13), earliest flowering (46.24 days) and fruit yield (63.31 t ha⁻¹). Quality parameters were also significantly influenced by mulching and calcium application. Black polythene mulch recorded maximum TSS (5.23 °Brix), shelf life (12.45 days), calcium content (15.02 mg/100 g) and acidity (0.48%). Similarly, 0.5% calcium spray recorded higher TSS (5.12 °Brix), shelf life (11.52 days), calcium content (15.54 mg/100 g) and acidity (0.47%). Overall, the study concluded that application of black polythene mulch along with 0.5% foliar calcium spray proved effective in improving growth, yield and quality of tomato under semi-arid conditions.

Keywords: Calcium, growth, mulching, tomato, quality and yield

Introduction

Vegetable crops occupy a vital place in the agricultural economy and human nutrition due to their rich content of carbohydrates, proteins, vitamins, minerals, antioxidants and dietary fibre. They are regarded as “protective foods” because of their important role in maintaining human health and preventing several deficiency diseases. In addition to their nutritional importance, vegetables provide higher productivity per unit area and greater economic returns to farmers compared to many field crops. Globally, vegetable cultivation contributes significantly to food and nutritional security, while in India it forms a major component of the horticultural sector. India is the second largest producer of vegetables in the world after China owing to its diverse agro-climatic conditions that support year-round cultivation of a wide range of vegetable crops (FAO, 2023; NHB, 2024) [3].

Among vegetable crops, tomato (*Solanum lycopersicum* L.) is one of the most important and widely cultivated crops belonging to the family Solanaceae. Tomato is extensively consumed both as fresh vegetable and processed product in the form of puree, paste, ketchup, soup and sauce. It is highly valued for its nutritive and medicinal properties as it contains vitamins A, C and E, minerals, organic acids and antioxidants, particularly lycopene, which plays an important role in reducing the risk of cardiovascular diseases and certain cancers (Rai *et al.*, 2021; Sharma *et al.*, 2023) [11, 14]. Owing to its high nutritional value, wide adaptability and continuous market demand, tomato occupies a prominent place among vegetable crops grown throughout the world.

In India, tomato is cultivated under diverse climatic conditions and contributes significantly to vegetable production and farmers’ income. However, productivity of tomato is often limited by

several biotic and abiotic stresses such as moisture stress, nutrient imbalance, weed competition, high temperature and poor soil fertility. Among these factors, improper soil moisture management and nutrient deficiency are major constraints affecting growth, yield and quality of tomato under semi-arid conditions (Yadav *et al.*, 2022; Meena *et al.*, 2023) ^[18, 8].

Mulching is an important agronomic practice that involves covering the soil surface with organic or inorganic materials in order to conserve soil moisture, regulate soil temperature and suppress weed growth. Organic mulches such as straw improve soil structure and microbial activity through decomposition, whereas inorganic mulches like black polythene effectively reduce evaporation losses and weed emergence. Mulching creates favourable hydrothermal conditions in the root zone, resulting in improved nutrient uptake, enhanced vegetative growth and higher crop productivity. Several researchers have reported significant improvement in growth, yield and quality of tomato under mulching practices due to better moisture conservation and efficient utilization of nutrients (Patel *et al.*, 2021; Sarker *et al.*, 2023; Staropoli *et al.*, 2024) ^[10, 12, 15].

Calcium is an essential plant nutrient required for cell wall development, membrane stability and various physiological processes. In tomato, calcium plays a crucial role in improving fruit firmness, reducing physiological disorders such as blossom end rot and enhancing shelf life and fruit quality. Since calcium movement within plants is largely dependent upon transpiration, its deficiency frequently occurs in rapidly developing fruits. Foliar application of calcium has been found effective in supplying calcium directly to plant tissues, thereby improving fruit development, yield and quality parameters (Haider *et al.*, 2024; Wu *et al.*, 2025) ^[4, 17].

Considering the importance of mulching and calcium nutrition in improving tomato productivity and quality, the present investigation entitled “Effect of Mulching Practices and Foliar Application of Calcium on Growth, Yield and Quality of Tomato (*Solanum lycopersicum* L.)” was undertaken to evaluate the effect of different mulching practices and calcium foliar sprays on growth, yield and quality parameters of tomato under semi-arid conditions.

Materials and methods

The field experiment was conducted during the 2024 at the Agricultural Research Farm of Suresh Gyan Vihar University, Jaipur (Rajasthan), on loamy sand soil. The study was laid out in factorial randomized block design with two factors viz. control (no mulch), straw mulch, black polythene mulch and white polythene mulch along with three levels of calcium foliar spray viz., control, 0.25% Ca spray and 0.5% Ca spray with three replication. The experimental farm is located in the south-eastern part of Rajasthan at an elevation of 548 m above mean sea level (26°92' N latitude and 75°77' E longitude) under agro-climatic zone III-A (Semi-Arid Eastern Plain). The region has a semi-arid climate with wide temperature variation, receiving an average annual rainfall of 400–450 mm, about 80–85% of which occurs during the south-west monsoon (July–September). During the cropping period, maximum and minimum temperatures ranged from 31.41–38.71 °C and 20.71–27.85 °C, respectively, while relative humidity reached up to 91%. Average sunshine hours varied from 0.68 to 5.01 hours and wind velocity ranged between 0.88 and 2.82 km/ha.

Results and Discussion

Effect of mulching practices

Growth parameters

The data presented in Table 1 revealed that mulching practices

significantly influenced growth parameters of tomato. Among the treatments, black polythene mulch (M₂) recorded significantly maximum plant height (81.63 cm) and number of branches per plant (7.85), whereas minimum values were recorded under control (M₀) with 70.25 cm plant height and 5.86 branches per plant. The increase in vegetative growth under black polythene mulch may be attributed to better soil moisture conservation, favourable soil temperature and enhanced nutrient availability due to increased microbial activity in the rhizosphere. Moreover, mulching effectively suppressed weeds, thereby reducing competition for nutrients and moisture. Similar findings were reported by Sarker *et al.* (2023) ^[12], Staropoli *et al.* (2024) ^[15] and Adamczewska-Sowińska *et al.* (2025) ^[1]. The earliest flowering (44.16 days) was also recorded under black polythene mulch, while delayed flowering (48.75 days) was observed under control. Earliness under mulched conditions may be due to improved hydrothermal conditions and enhanced physiological activities, which accelerated crop growth and flowering.

Fruit yield

Mulching practices significantly influenced fruit yield of tomato (Table 2). Among the treatments, black polythene mulch (M₂) recorded significantly highest fruit yield per plant (3.85 kg), fruit yield per plot (23.54 kg) and fruit yield per hectare (69.20 t ha⁻¹), whereas minimum yield was observed under control (M₀). The increase in fruit yield under black polythene mulch may be attributed to efficient moisture conservation, better nutrient uptake, reduced weed competition and enhanced photosynthetic activity, which collectively improved fruit set and fruit development. Similar findings were also reported by Di Mola *et al.* (2023) ^[2], Sarker *et al.* (2023) ^[12] and Staropoli *et al.* (2024) ^[15].

Quality parameters

The quality parameters of tomato were significantly affected by mulching practices (Table 3). Black polythene mulch (M₂) recorded significantly higher TSS (5.23 °Brix), shelf life (12.45 days), calcium content (15.02 mg/100 g) and acidity (0.48%) compared to control. Improvement in fruit quality under mulching may be attributed to improved moisture availability, better nutrient absorption and enhanced synthesis and translocation of carbohydrates towards fruits. Similar observations were reported by Zhang *et al.* (2023) ^[19], Kozak *et al.* (2023) ^[6] and Adamczewska-Sowińska *et al.* (2025) ^[1].

Effect of calcium foliar spray

Growth parameters

Foliar application of calcium significantly affected growth parameters of tomato (Table 1). Among the treatments, 0.5% calcium spray (C₂) recorded maximum plant height (77.95 cm) and number of branches per plant (7.13), which remained statistically at par with 0.25% calcium spray (C₁). The minimum values were recorded under control (C₀). Improved vegetative growth due to calcium application may be attributed to its role in cell division, membrane stability and activation of various enzymatic processes. Calcium also enhances root development and nutrient uptake, thereby improving overall plant growth. Similar findings were reported by Sharma *et al.* (2022) ^[13], Kumari *et al.* (2023) ^[7] and Haider *et al.* (2024) ^[4].

The earliest flowering (46.24 days) was recorded under 0.5% calcium spray, whereas delayed flowering (48.49 days) was observed under control. Earliness in flowering due to calcium application may be associated with improved physiological efficiency and better translocation of assimilates.

Fruit yield

Foliar application of calcium significantly enhanced fruit yield parameters of tomato (Table 2). Maximum fruit yield per plant (3.50 kg), fruit yield per plot (21.35 kg) and fruit yield per hectare (63.31 t ha⁻¹) were recorded under 0.5% calcium spray (C₂). The increase in fruit yield due to calcium application may be attributed to improved fruit set, reduced flower drop and enhanced fruit development due to better cell wall formation and membrane stability. Calcium also reduced physiological disorders like blossom end rot, thereby improving marketable yield. Similar results were reported by Tongali *et al.* (2024) [16], Haider *et al.* (2024) [4] and Wu *et al.* (2025) [17].

The interaction effect between mulching practices and calcium foliar spray significantly influenced fruit yield of tomato (Table 2 a, b and c). Among different treatment combinations, black polythene mulch along with 0.5% calcium spray (M₂C₂) recorded the highest fruit yield per plant (4.05 kg), fruit yield per plot (24.91 kg) and fruit yield per hectare (73.37 t ha⁻¹), which remained statistically superior over other treatment combinations. The increase in yield under this treatment combination may be

attributed to the combined beneficial effect of black polythene mulch in conserving soil moisture, regulating soil temperature and suppressing weeds along with calcium spray improving cell division, fruit development and reducing physiological disorders like blossom end rot. Better nutrient uptake and enhanced photosynthetic activity under favourable soil conditions might have also contributed towards higher fruit production.

Quality parameters

Calcium foliar spray significantly improved quality parameters of tomato (Table 3). The highest TSS (5.12 °Brix), shelf life (11.52 days), calcium content (15.54 mg/100 g) and acidity (0.47%) were recorded under 0.5% calcium spray (C₂). Improvement in fruit quality due to calcium application may be attributed to enhanced membrane stability, delayed fruit softening and improved accumulation of sugars and organic acids in fruits. Calcium also improves fruit firmness and storage quality by stabilizing pectin substances in cell walls. Similar findings were reported by Karlsons *et al.* (2023) [5], Haider *et al.* (2024) [4] and Wu *et al.* (2025) [17].

Table 1: Effect of foliar spray of calcium and mulching on growth parameters of tomato

Treatments	Growth parameters		
	Plant height (cm)	Number of branches/plant	Days to 50% flowering
Mulching practices			
M ₀ : Control (No mulch)	70.25	5.86	48.75
M ₁ :Straw mulch	76.85	6.83	47.67
M ₂ :Black polythene mulch	81.63	7.85	44.16
M ₃ :White polythene mulch	76.47	6.75	47.72
SEm±	0.67	0.15	0.97
CD (P=0.05)	2.01	0.44	2.90
Calcium foliar spray			
C ₀ : Control (no spray)	73.16	6.15	48.49
C ₁ : 0.25% Ca spray	77.42	7.05	46.50
C ₂ : 0.5% Ca spray	77.95	7.13	46.24
SEm±	0.65	0.14	0.83
CD (P=0.05)	1.97	0.42	2.48
C.V. (%)	9.29	8.38	7.54

Table 2: Effect of foliar spray of calcium and mulching on fruit yields of tomato

Treatments	Fruit yields		
	kg/plant	kg/plot	t/ha
Mulching practices			
M ₀ : Control (No mulch)	2.79	16.86	50.56
M ₁ :Straw mulch	3.30	19.77	58.45
M ₂ :Black polythene mulch	3.85	23.54	69.2
M ₃ :White polythene mulch	3.27	19.74	58.34
SEm±	0.12	0.42	1.25
CD (P=0.05)	0.35	1.27	3.74
Calcium foliar spray			
C ₀ : Control (no spray)	2.92	17.76	52.52
C ₁ : 0.25% Ca spray	3.47	20.82	61.58
C ₂ : 0.5% Ca spray	3.50	21.35	63.31
SEm±	0.10	0.36	1.07
CD (P=0.05)	0.30	1.08	3.21
C.V. (%)	7.58	8.41	8.53

Table 2 (a): Interaction effect of calcium and mulching on fruit yield (kg/plant) of tomato

	C ₀	C ₁	C ₂	Mean
M ₀	2.4	2.96	2.99	2.79
M ₁	2.92	3.47	3.5	3.30
M ₂	3.47	4.02	4.05	3.85
M ₃	2.9	3.44	3.47	3.27
Mean	2.92	3.47	3.5	
SEm±	0.12			
CD (P=0.05)	0.36			
C.V. (%)	8.71			

Table 2 (b): Interaction effect of calcium and mulching on fruit yield (kg/plot) of tomato

	C ₀	C ₁	C ₂	Mean
M ₀	14.61	17.7	18.23	16.86
M ₁	17.55	20.61	21.14	19.77
M ₂	21.32	24.38	24.91	23.54
M ₃	17.5	20.58	21.11	19.74
Mean	17.76	20.82	21.35	
SEm±	0.59			
CD (P=0.05)	1.71			
C.V. (%)	8.08			

Table 2 (c): Interaction effect of calcium and mulching on fruit yield (t/ha) of tomato

	C ₀	C ₁	C ₂	Mean
M ₀	43.9	53	54.73	50.56
M ₁	51.83	60.89	62.62	58.45
M ₂	62.58	71.64	73.37	69.2
M ₃	51.7	60.78	62.51	58.34
Mean	52.52	61.58	63.31	
SEm±	2.22			
CD (P=0.05)	6.42			
C.V. (%)	9.22			

Table 3: Effect of foliar spray of calcium and mulching on quality of tomato

Treatments	Quality parameters			
	TSS (°Brix)	Shelf life (days)	Calcium content (mg/100 g)	Acidity (%)
Mulching practices				
M ₀ : Control (No mulch)	4.59	9.09	12.09	0.37
M ₁ :Straw mulch	4.97	11.53	14.21	0.44
M ₂ :Black polythene mulch	5.23	12.45	15.02	0.48
M ₃ :White polythene mulch	4.92	11.44	14.16	0.42
SEm±	0.07	0.21	0.25	0.01
CD (P=0.05)	0.21	0.62	0.72	0.03
Calcium foliar spray				
C ₀ : Control (no spray)	4.62	9.59	12.53	0.39
C ₁ : 0.25% Ca spray	5.02	11.45	15.15	0.43
C ₂ : 0.5% Ca spray	5.12	11.52	15.54	0.47
SEm±	0.06	0.19	0.23	0.008
CD (P=0.05)	0.18	0.57	0.66	0.024
C.V. (%)	3.76	4.08	3.48	3.19

Conclusion

The present investigation concluded that both mulching practices and foliar application of calcium significantly influenced the growth, yield and quality of tomato. Among mulching treatments, black polythene mulch (M₂) proved superior by recording maximum plant height, number of branches, fruit yield, TSS, shelf life and calcium content, along with early flowering and harvesting. Similarly, foliar spray of calcium at 0.5% (C₂) significantly improved growth, yield and quality parameters over control. Therefore, the combined use of black polythene mulch and 0.5% calcium foliar spray may be recommended for obtaining higher productivity and better quality fruits of tomato under

Rajasthan conditions.

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