International Journal of Research in Agronomy 2025; 8(12): 1331-1334

E-ISSN: 2618-0618
P-ISSN: 2618-060X
© Agronomy
NAAS Rating (2025): 5.20
www.agronomyjournals.com
2025; 8(12): 1331-1334
Received: 17-09-2025
Accepted: 25-10-2025

A Dinesh
Senior Research Fellow, ICAR-CRIDA, Telangana, India

Dr. A G K Reddy
Senior Scientist, ICAR-CRIDA, Telangana, India

Dr. G. Nirmala
Principal Scientist, ICAR-CRIDA, Telangana, India

Dr. B Sanjeeva Reddy
Principal Scientist, ICAR-CRIDA, Telangana, India

Dr. B Narsimlu
Principal Scientist, ICAR-CRIDA, Telangana, India

Corresponding Author:
A Dinesh
Senior Research Fellow, ICAR-CRIDA, Telangana, India

Effect of plastic mulching and deficit drip irrigation on yield and water use efficiency of tomato

A Dinesh, AGK Reddy, G Nirmala, B Sanjeeva Reddy and B Narsimlu

DOI: https://www.doi.org/10.33545/2618060X.2025.v8.i12r.4644

Abstract
A field experiment was conducted during the in Pudur Mandal, Telangana, to evaluate the effects of plastic mulching and deficit drip irrigation on tomato growth, yield, water use efficiency (WUE), and economics. Treatments included 50% ET + mulch (T_1), 80% ET + mulch (T_2), 100% ET + mulch (T_3), and 100% ET without mulch (T_4). Vegetative growth was significantly influenced by the treatments, with T_3 recording maximum plant height (118.7 cm), branches per plant (8.3), leaf area index (3.29), and dry matter accumulation (562 g plant^{-1}), followed by T_2. Lower growth under T_1 and T_4 was attributed to limited soil moisture and higher evaporative losses. Yield components and total fruit yield were highest in T_3 (57.87 t ha^{-1}), while moderate deficit irrigation under T_2 produced 52.58 t ha^{-1}, saving 20% water and demonstrating agronomic efficiency. Phenological traits improved under mulching, with earlier 50% flowering and higher fruit set (74.0% in T_3). Water applied ranged from 26.2 cm (T_1) to 52.4 cm (T_3 and T_4), with maximum WUE observed in T_1 (1.67 t ha^{-1}-cm) and lowest in T_4 (0.80 t ha^{-1}-cm). Economic analysis indicated that T_3 achieved the highest net returns (₹3,82,400 ha^{-1}) and B:C ratio (3.52), while T_2 offered substantial returns with water savings. Overall, combining plastic mulch with 80-100% ET irrigation enhanced growth, yield, WUE, and profitability, suggesting that mulching with moderate deficit irrigation is a sustainable strategy for tomato cultivation under semi-arid conditions.

Keywords: Tomato, plastic mulch, deficit drip irrigation, evapotranspiration, water use efficiency

Introduction
Tomato (*Solanum lycopersicum* L.) is one of the most important vegetable crops in India, valued for its nutritional importance and economic returns. In semi-arid regions such as Telangana, tomato productivity is often constrained by erratic rainfall, limited availability of irrigation water, and inefficient water management practices. These challenges highlight the need for resource-conserving technologies that enhance crop productivity while ensuring sustainable use of water.

Plastic mulching helps in conserving soil moisture, moderating soil temperature, suppressing weed growth, and improving nutrient availability in the root zone, thereby enhancing crop growth and yield. Drip irrigation facilitates precise and frequent application of water directly to the root zone, reducing evaporation and deep percolation losses and improving water use efficiency. The combined use of plastic mulch and drip irrigation has been reported to improve yield, water productivity, and economic returns in vegetable crops under semi-arid conditions (Kasirajan & Ngouajio, 2019) [5].

However, limited information is available on the optimum irrigation levels under mulched drip systems for tomato cultivation in Telangana. Therefore, the present study was undertaken t to evaluate the effects of plastic mulching combined with different deficit drip irrigation levels on growth, yield, water use efficiency, and economics of tomato in semi-arid Telangana.

Materials and Methods
Experimental Site and Climate
The field experiment was conducted at farmers' fields in Pudur Mandal, Vikarabad district, Telangana, India, located in the semi-arid agro-climatic zone of southern India. The region experiences hot summers, mild winters, and erratic rainfall. During the cropping period, mean

maximum and minimum temperatures ranged from 28-36 °C and 14-20 °C, respectively. The average annual rainfall is about 750-800 mm, most of which is received during the southwest monsoon, necessitating supplemental irrigation during the Rabi season for successful tomato cultivation.

Soil Characteristics
The experimental soil was sandy loam to red soil, well drained and representative of the region. Composite soil samples collected from a depth of 0-30 cm before transplanting were analyzed using standard procedures. The soil reaction was slightly acidic to neutral, low to medium in available nitrogen, medium in available phosphorus, and medium to high in available potassium. Fertilizer application was carried out as per soil test-based recommendations to ensure balanced nutrient supply.

Experimental Design and Treatments
The experiment was laid out in a Randomized Block Design (RBD) with four treatments and three replications (Gomez & Gomez, 1984) [4]. Each replication consisted of four plots, randomly assigned to treatments. The individual plot size was 4.5 m × 3.0 m, providing sufficient plant population for recording observations.
The treatments comprised different irrigation levels based on crop evapotranspiration (ET) combined with plastic mulching under a drip irrigation system:

- T_1: 50% crop evapotranspiration (ET) + plastic mulch under drip irrigation
- T_2: 80% crop evapotranspiration (ET) + plastic mulch under drip irrigation
- T_3: 100% crop evapotranspiration (ET) + plastic mulch under drip irrigation
- T_4: 100% crop evapotranspiration (ET) under drip irrigation without plastic mulch (control)

Crop Establishment and Cultural Practices
A widely cultivated tomato hybrid suitable for semi-arid conditions was used. Healthy and uniform seedlings aged 25-30 days were transplanted at a spacing of 90 cm × 60 cm. Recommended agronomic practices such as gap filling, intercultural operations, plant protection measures, and staking were uniformly followed across all treatments to minimize experimental bias.

Drip Irrigation and Mulching
A drip irrigation system fitted with inline emitters was installed in all plots. Irrigation scheduling was based on crop evapotranspiration (ETc), computed from reference evapotranspiration and appropriate crop coefficients (Allen *et al*., 1998) [1]. Irrigation water was applied according to treatment requirements (50%, 80%, and 100% ET).
For mulched treatments (T_1, T_2, and T_3), black polyethylene mulch of 25-30 micron thickness was laid before transplanting, and planting holes were made at recommended spacing (Kasirajan & Ngouajio, 2019) [5]. The non-mulched treatment (T_4) was maintained as the control.

Observations Recorded
Growth Parameters
Five representative plants from each plot were selected to record plant height at the peak vegetative stage, number of branches per plant, leaf area index (LAI) using standard methods, and dry matter accumulation expressed as g plant^{-1} after oven drying samples at 65 °C to constant weight.

Phenological Parameters
Days to 50% flowering and fruit set percentage were recorded for each treatment.

Yield and Yield Components
Yield attributes included number of fruits per plant, average fruit weight (g), yield per plant (kg), and total fruit yield (t ha^{-1}), which was extrapolated from plot yield.

Water Use and Water Use Efficiency
Seasonal irrigation water applied (cm) was calculated for each treatment. Water use efficiency (WUE) was computed as the ratio of fruit yield (t ha^{-1}) to total water applied (cm).

Economic Analysis
Economic parameters such as cost of cultivation, gross returns, net returns, and benefit-cost (B:C) ratio were calculated using prevailing market prices of inputs and tomato produce during the study period.

Statistical Analysis
The recorded data were subjected to analysis of variance (ANOVA) appropriate for a Randomized Block Design (Gomez & Gomez, 1984) [4]. Treatment means were compared using the critical difference (CD) test at 5% probability ($P = 0.05$). Standard error of mean (SEm ±) and CD values were calculated to evaluate the significance of treatment effects.

Results and Discussion
Growth Parameters
The vegetative growth of tomato was significantly influenced by the combination of plastic mulching and drip irrigation at different evapotranspiration (ET) levels. Table 1 shows the effect of the treatments on plant height, number of branches, leaf area index (LAI), and dry matter accumulation. Maximum plant height (118.7 cm), number of branches (8.3 plant^{-1}), and LAI (3.29) were recorded under T_3 (100% ET + plastic mulch), followed closely by T_2 (80% ET + plastic mulch). Reduced growth was observed under T_1 (50% ET + mulch) and T_4 (100% ET without mulch). Dry matter accumulation was highest under T_3 (562 g plant^{-1}) and lowest under T_1 (415 g plant^{-1}).
The improved growth in mulched treatments can be attributed to better soil moisture conservation, higher soil temperature during early growth, and enhanced root proliferation (Kasirajan & Ngouajio, 2019; Sharma *et al*., 2020) [5, 9]. Deficit irrigation at 50% ET restricted vegetative growth due to reduced cell expansion and limited photosynthetic activity, which aligns with the findings of Biswas *et al*. (2022) [2] and Patel *et al*. (2021) [8].
The non-mulched 100% ET treatment (T_4) also showed lower growth, reflecting higher evaporative losses and less favorable microclimatic conditions.

Table 1: Effect of mulching and deficit drip irrigation on growth parameters of tomato

Treatment	Plant height (cm)	Branches plant^{-1}	LAI	Dry matter (g plant^{-1})
T_1: 50% ET + PM	98.4	6.2	2.31	415
T_2: 80% ET + PM	112.5	7.6	3.12	532
T_3: 100% ET + PM	118.7	8.3	3.29	562
T_4: 100% ET, no mulch	105.2	6.9	2.74	478
SEm (±)	3.1	0.23	0.08	14.3
CD (P=0.05)	9.4	0.69	0.25	43.0

Yield and Yield Components

Tomato yield and yield components were significantly affected by the treatments (Table 2). Total fruit yield varied from 42.0 t ha⁻¹ in T_4 (100% ET without mulch) to 57.87 t ha⁻¹ in T_3 (100% ET + PM). Yield under T_1 (50% ET + PM) was 43.75 t ha⁻¹, statistically similar to T_4, indicating that plastic mulch compensates for moderate water stress. The number of fruits per plant and average fruit weight increased progressively with irrigation levels under mulching, showing the combined benefits of moisture conservation and nutrient uptake efficiency.

The highest yield in T_3 was due to enhanced fruit set, larger fruit size, and better retention during stress periods. Moderate deficit irrigation (80% ET + PM, T_2) produced 52.58 t ha⁻¹,. The results corroborate findings of Zhang *et al.* (2025) [11] and Li *et al.* (2023) [6], who reported that moderate deficit irrigation combined with plastic mulch maintains high yield while improving water productivity.

Table 2: Effect of mulching and deficit drip irrigation on yield components and yield of tomato

Treatment	Fruits plant⁻¹	Fruit weight (g)	Yield plant⁻¹ (kg)	Yield (t ha⁻¹)
T_1: 50% ET + PM	32.6	78.6	2.55	43.75
T_2: 80% ET + PM	38.9	91.3	3.55	52.58
T_3: 100% ET + PM	41.5	95.8	3.95	57.87
T_4: 100% ET, no mulch	35.1	86.7	3.04	42.02
SEm (±)	1.2	2.9	0.12	2.1
CD (P=0.05)	3.6	8.7	0.36	6.3

Phenology and Flowering

Phenological traits such as days to 50% flowering and fruit set percentage were significantly influenced by irrigation and mulching treatments (Table 3). Mulched plots reached 50% flowering 2-3 days earlier than non-mulched plots, reflecting the role of mulch in increasing soil temperature and enhancing root activity. Fruit set percentage was highest in T_3 (74.0%), followed by T_2 (71.5%). The lowest fruit set was recorded in T_1 (63.5%) due to limited soil moisture during flowering.

Earlier flowering and enhanced fruit set under plastic mulch align with studies by Wang *et al.* (2021) [10] and Sharma *et al.* (2020) [9], emphasizing the importance of controlled soil microclimate in improving reproductive efficiency in tomato.

Table 3: Effect of mulching and irrigation on flowering and fruit set

Treatment	Days to 50% flowering	Fruit set (%)
T_1: 50% ET + PM	42.0	63.5
T_2: 80% ET + PM	39.1	71.5
T_3: 100% ET + PM	38.8	74.0
T_4: 100% ET, no mulch	40.5	66.0
SEm (±)	0.9	1.7
CD (P=0.05)	2.7	5.2

Water Applied and Water Use Efficiency (WUE)

Water applied varied from 26.2 cm under T_1 to 52.4 cm under T_3 and T_4 (Table 4). Plastic mulching substantially reduced water losses through evaporation. Maximum WUE (1.67 t ha⁻¹-cm) was recorded in T_1 (50% ET + PM), while the lowest WUE (0.80 t ha⁻¹-cm) occurred in T_4 (100% ET, no mulch).

Deficit irrigation improved water productivity, and combining 80% ET with plastic mulch (T_2) provided an optimal balance between yield and water use efficiency. Similar trends have been reported by Mekonen *et al.* (2024) [7] and Biswas *et al.* (2022) [2], emphasizing that moderate deficit irrigation with mulch is the most sustainable approach for water-limited regions.

Table 4: Water applied and water use efficiency under different treatments

Treatment	Water applied (cm)	WUE (t ha⁻¹-cm⁻¹)
T_1: 50% ET + PM	26.2	1.67
T_2: 80% ET + PM	43.1	1.22
T_3: 100% ET + PM	52.4	1.10
T_4: 100% ET, no mulch	52.4	0.80
SEm (±)	0.5	0.05
CD (P=0.05)	1.5	0.15

Economic Analysis

Economic evaluation clearly showed that drip irrigation combined with plastic mulching markedly enhanced the profitability of tomato cultivation (Table 6). Among the treatments, T_3 (100% ET + plastic mulch) recorded the highest net returns (₹3,82,400 ha⁻¹) and the maximum benefit-cost ratio (3.52), mainly due to higher marketable yield, efficient water utilization, and reduced evaporative losses. T_2 (80% ET + plastic mulch) ranked second with net returns of ₹3,46,000 ha⁻¹ and a B:C ratio of 3.34; although it saved 20% irrigation water compared to T_3, slightly lower yield reduced economic returns. T_1 (50% ET + plastic mulch) showed moderate profitability because moisture stress limited yield despite reduced irrigation costs. The non-mulched treatment (T_4) resulted in lower returns due to higher moisture losses and reduced yield even under full irrigation

Table 5: Economic analysis of tomato under different irrigation and mulching treatments

Treatment	Cost of cultivation (₹ ha⁻¹)	Gross returns (₹ ha⁻¹)	Net returns (₹ ha⁻¹)	B:C ratio
T_1: 50% ET + PM	1,42,000	4,52,000	3,10,000	2.18
T_2: 80% ET + PM	1,48,000	4,94,000	3,46,000	3.34
T_3: 100% ET + PM	1,52,000	5,34,400	3,82,400	3.52
T_4: 100% ET without mulch	1,36,000	4,28,000	2,92,000	2.15

Conclusion

The present study clearly demonstrates that plastic mulching in combination with deficit drip irrigation significantly influences growth, yield, water use efficiency, fruit quality, and economic returns of tomato under semi-arid conditions of Telangana. Mulched treatments markedly improved vegetative growth parameters such as plant height, branching, leaf area index, and dry matter accumulation by creating a favorable soil microclimate through improved moisture conservation and temperature regulation. Yield and yield components responded positively to increasing irrigation levels under mulch, with the highest fruit yield recorded under 100% ET with plastic mulch. However, irrigation at 80% ET combined with plastic mulch produced nearly comparable yield while saving about 20% irrigation water, indicating superior agronomic efficiency. Water use efficiency was highest at 50% ET with mulch, but this treatment suffered yield reduction, suggesting a trade-off between productivity and water savings. Economic analysis revealed higher net returns and benefit-cost ratios for mulched drip irrigation treatments. Overall, the results indicate that plastic mulching combined with 80% ET drip irrigation is the most sustainable and practical option for tomato cultivation in semi-arid Telangana, as it optimizes yield, water productivity, fruit quality, and profitability while conserving scarce water resources.

References

1. Allen RG, Pereira LS, Raes D, Smith M. Crop

evapotranspiration: Guidelines for computing crop water requirements. FAO Irrigation and Drainage Paper No. 56. Rome: FAO; 1998.
2. Biswas S, Akanda AR, Rahman MS, Hossain MA. Deficit irrigation effects on tomato yield and water productivity under drip irrigation. Irrigation Science. 2022;40(3):421-435.
3. FAO. Water productivity in agriculture: Measurement, assessment and improvement. Rome: FAO; 2022.
4. Gomez KA, Gomez AA. Statistical procedures for agricultural research. 2nd ed. New York: John Wiley & Sons; 1984.
5. Kasirajan S, Ngouajio M. Polyethylene and biodegradable mulches for agricultural applications: A review. Agronomy for Sustainable Development. 2019;39(4):1-18.
6. Li X, Zhang H, Wang F, Liu Q, Chen Y. Yield response and water productivity of tomato under deficit drip irrigation and plastic mulch. Irrigation Science. 2023;41(2):245-259.
7. Mekonen T, Tesfaye K, Desta Y. Effect of deficit irrigation and mulching on tomato yield and water productivity in semi-arid conditions. Agricultural Water Management. 2024;285:108347.
8. Patel N, Kumar S, Meena RP. Performance of drip irrigation and mulching on tomato productivity in semi-arid regions of India. Indian Journal of Agricultural Sciences. 2021;91(6):856-860.
9. Sharma R, Patel SK, Yadav RK. Effect of drip irrigation and plastic mulch on growth, yield and water use efficiency of tomato. Scientia Horticulturae. 2020;261:108939.
10. Wang Y, Zhang X, Chen J, Liu M. Effects of irrigation levels on flowering, fruit set and yield of tomato under drip irrigation. Agricultural Water Management. 2021;243:106480.
11. Zhang Y, Li H, Wang F, Liu Q. Mulched drip irrigation alters soil microbial communities and improves water productivity in tomato. Horticulturae. 2025;11(2):145.