

Off-Season Cultivation of Tomato During *Kharif* Season using Plastic Mulch

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ABSTRACT

An experiment was conducted during *kharif* season to investigate the performance of tomato cultivation under plastic mulch and without mulch condition. Five different treatments were designed in which T₁ - Lakshmi, T₂ - Swaraksha, T₃ - Swarna Sampda, T₄ - Vidya and T₅ - Ashok varieties were sown under drip irrigated fertigation system with four replications. The mortality rate of T₁, T₂ and T₃ were 22.5%, 24.2% and 25.3% more as compared to without plastic mulch condition. It was observed that mulch condition that weeds was found to be very low in comparison to without mulch condition which was 42 g/m² and 1665 g/m² respectively. The highest yield of 19.2 t/ha was recorded for treatment T₁ (Lakshmi) under plastic mulch condition. The statistical analysis revealed that during *kharif* season cultivation of tomato crops under mulch condition is more profitable in comparison to without mulch condition.

Keywords Fertigation, *Kharif*, Tomato, Yield, Temperature, Mulch.

INTRODUCTION

Tomato is second most important crop grown globally (FAO 2009) and India has second position in production after China and its consumption is more in Mediterranean countries (Chaudhary *et al.* 2018). From economic point of view, vegetables comprise a major part in our agricultural production (Tomar *et al.* 2019). According to National Horticultural Board, India the total estimated production of tomato was 20573 MT from the area about 812 Hectares in 2019–2020.

The tomatoes contain lycopene which is the most important anti-oxidant and its intake results in decreased incidence of cancer disease, coronary heart diseases and macular degeneration (Dillingham and Rao 2009). The average consumption rate of tomatoes in Indian diet is very high as they form an integral part of ingredient (Kaur *et al.* 2013).

According to APEDA 2021-2022 report the highest production of tomato is in Madhya Pradesh followed by Andhra Pradesh and lowest production is in Arunachal Pradesh and Jharkhand holds 16th position in overall production. According to Ministry of Agriculture and Farmers Welfare report productivity of tomato in Jharkhand was 13.19 MT/Ha in during 2017-18. The productivity and quality of tomato depends upon genetic material, crop management and environmental management.

The price of tomato per kg varies widely throughout the year and it varies from Rs 2-5 per kg to Rs

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60-140 per kg respectively during peak season and off-season. As per Department of Consumer Affairs, India's highest price of tomato was Rs 100 per kg in year 2022. According to Kumari (2023) the price of tomato varied from Rs 180-200 per kg in capital city of Jharkhand during off-season and there is high variation of prices during off-season.

There are many challenges associated with cultivation of tomato during *kharif* season due to diseases like bacterial wilt, leaf curl. The production of tomato is low during *kharif* season due to the excess rain and high relative humidity which increases leaf diseases due to humid conditions (Kalibbala 2011). The drip irrigation with plastic mulching maintains the required moisture content which is less prone to root-rot diseases and also helps in better weed management (Diver *et al.* 1999).

Despite the low production during *kharif* season, there are several challenges in supply and demand which needs to be addressed. The demand of tomato is throughout the year but due low availability the market price for tomato during rainy season is high as production is low due to the above challenges discussed above. Rainy seasons are the lean periods for tomato production and in order to avoid over supply and spoilage during winter season attention is required for off-season tomato cultivation to increase profit and fulfill demand round the year (Maharana *et al.* 2014).

To mitigate the production challenges plasticulture can play a vital role during off-season cultivation. Covering the ground with mulch saves water by preventing surface evaporation and maintains the soil temperature as well as it significantly reduces the propagation of weeds, which results in high water use efficiency (Shilpa *et al.* 2021). The plastic mulching improves the characteristics of fruit quality and provides favorable condition for growth and development of plants (Kaur and Singh 2009). Besides, leaching of fertilizers can be reduced by fertigation system for precise application of nutrients so plants can utilize it while avoiding the overdose application of fertilizers (Rai *et al.* 2017).

Keeping above challenges in view the aim of this study was to access the effectiveness of plasticulture

technologies for off-season cultivation of tomato.

MATERIALS AND METHODS

An experiment was conducted during *kharif* season for tomato cultivation under mulch and without mulch condition in five different treatments at research farm (longitude: 85.318°E, latitude: 23.448°N) of the AICRP on Plastic Engineering in Agriculture Structure and Environment Management (PEASEM), Department of Agricultural Engineering, Birsa Agricultural University, Kanke, Ranchi, Jharkhand. The crops were sown on 09.07.2019 with spacing of 0.4 m × 0.4 m in a Statistical Randomized Block Design. The fertilizer dose of N : P : K 111 : 67 : 133 kg/ha were given through fertigation and crop was irrigated through drip irrigation system as per requirement. For the treatments varieties taken were, T₁- Lakshmi (BASF-Nunhems Pvt Ltd India), T₂- Swaraksha (Namdhari Pvt Ltd), T₃- Swarna Sampda (HARP, Ranchi), T₄- Vidya (Known-You seed (India) Pvt Ltd) and T₅- Ashok (Seed and Plant Science). The silver/black plastic mulch (25 micron) was used for mulching and total four replications were done for the entire experiment. Soil thermometer (Dimple 76 mm) was used to measure the temperature below soil surface at 5 cm and 10 cm under both mulch and without mulch condition at 7 AM and 2:30 PM. The flow chart of experimental condition is shown in Fig. 1.

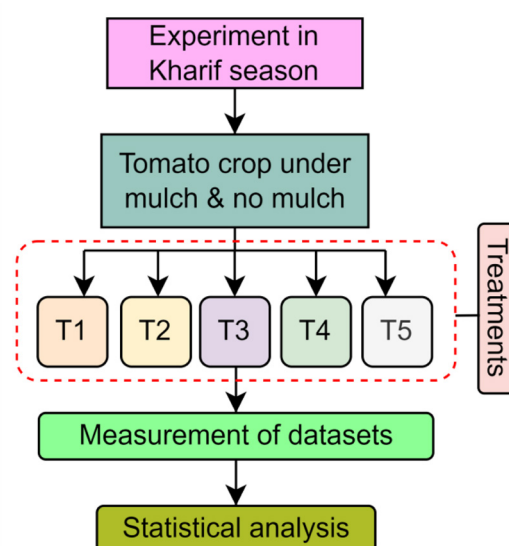


Fig. 1. Flowchart of experiment.

RESULTS AND DISCUSSION

Plant mortality, soil temperature and weed growth

The crop growing conditions directly influence the plant mortality, soil temperature and weed growth of crops. The percentage mortality of tomato crops are shown in Table 1 and it is clear that the plant mortality under plastic mulch are 37%, 33.5%, 30.8%, 26% and 12.3% respectively for treatments T₁, T₂, T₃, T₄ and T₅ and is higher than mortality recorded under without mulch condition. The plastic mulch conserves the soil moisture better than open field condition but during *kharif* season depending upon rainfall pattern when rainfall is regular and intense the rainwater which goes through holes made for transplanting sometimes creates excess soil moisture in root zone which is not very conducive for plant growth.

The Table 2 shows the soil temperature at 5 cm and 10 cm for mulch and without mulch condition and there is marginal difference in soil temperature. Soil temperature provides optimal condition for the development of roots and soil microorganism which are beneficial for plant growth and plastic mulch protect from extreme soil temperature (Shilpa *et al.* 2021). The other advantage was observed in mulch condition was low weed growth in comparison to without mulch condition as shown in Table 2 and it was 42 g/m² and 1665 g/m² respectively under mulch and without mulch condition. The weed growth affects

Table 1. Percentage mortality of tomato after transplantation.

Treatments	Without mulch	With mulch
T ₁ : Lakshmi	14.5%	37.0%
T ₂ : Swaraksha	9.3%	33.5%
T ₃ : Swarn Sampada	5.5%	30.8%
T ₄ : Vidya	22.5%	26.0%
T ₅ : Ashok	6.8%	12.3%

Table 2. Soil temperature (°C) at 5 cm and 10 cm and weed growth.

Month	Soil temperature (°C) at 5 cm				Soil temperature (°C) at 10 cm				Weed growth	
	Without mulch		With mulch		Without mulch		With mulch		Without mulch	With mulch
	10 AM	2.30 PM	10 AM	2.30 PM	10 AM	2.30 PM	10 AM	2.30 PM		
July	26.6	29.88	27.2	30.29	25.8	28.2	25.80	28.88	1665 g/m ²	42 g/m ²
August	24.3	26.08	25.1	27	26.6	29.88	27.25	30.29		

the overall crop development and similar observation was reported for tomato crop (Angmo *et al.* 2018). The rainy season intensifies the weed growth and it utilizes the available nutrients for the growth of plants which has significant impact on yield (Lindquist *et al.* 2010, Kubiak *et al.* 2022).

Crop growth parameters and yield

The crop growth parameters i.e. plant height, stem girth, number of nodes per plant, number of fruits and yield are given in Table 3. The plant height is highest for treatment T₅ under with mulch and without mulch condition and is 85 cm and 99.4 cm respectively and significantly superior to other treatments. The plant height is higher under plastic mulch because it provides good environment (Tomar *et al.* 2019). Mulches provide adequate conditions for crop plant to extend its root system far away from the main trunk as compared to the crops grown in without mulch as a result, mulched plant gains more height (Burgess *et al.* 1997, Watson 1988). The variation in plant height among the treatments may be due to the genetic difference between seeds. Similar observation was recorded for stem girth, number of nodes per plant and total number of fruits and these growth parameters under plastic mulch were superior to without mulch condition.

The statistical analysis revealed that highest coefficient of variation (CV) with 27.19% is observed for number of nodes per plant and high variability from mean value is observed in mulch crops. This implies that it could be result of plant phenotype. Besides, it is observed that the plant height of crops under mulch and without mulch condition has lowest CV as it indicates lower level of dispersion from mean of plant height. The standard error of the mean of stem girth in mulch and without mulch is low from the sample size and it revealed the higher accuracy



Fig. 2. Field condition of tomato without mulch.



Fig. 3. Field condition of tomato with mulch.

Table 3. Crop growth parameters and yield of tomato.

Treatments	Without mulch					With mulch				
	Plant height (cm)	Stem girth (mm)	Number of nodes/plant	Total fruits	Yield (t/ha)	Plant height (cm)	Stem girth (mm)	Number of nodes/plant	Total fruits	Yield (t/ha)
T ₁ : Lakshmi	65.3	12.6	27.3	13.0	7.3	84.6	15.6	57.0	31.9	19.2
T ₂ : Swaraksha	65.3	11.5	24.8	13.0	6.0	77.0	14.4	42.6	28.5	15.2
T ₃ : Swarn Sampada	66.5	12.2	27.5	16.3	6.2	82.4	14.6	68.3	41.5	14.3
T ₄ : Vidya	66.5	12.8	24.8	13.3	6.5	84.0	14.2	50.0	31.8	17.2
T ₅ : Ashok	85.5	11.9	20.5	9.3	4.9	99.4	13.7	44.5	28.4	10.4
SEm±	4.25	1.01	2.96	1.46	0.22	4.76	0.74	7.13	3.77	0.71
CD (p=0.05)	13.25	NS	NS	NS	0.69	NS	NS	NS	NS	2.20
CV (%)	12.19	16.64	23.73	22.52	7.19	11.13	10.27	27.19	23.25	9.26

of overall population.

The yield of tomato varies between 4.9 t/ha to 7.3 t/ha and 10.4 t/ha to 19.2 t/ha respectively for without mulch and plastic mulch condition. The yield of tomato for variety Lakshmi (T₁) is significantly superior to other treatments both under without mulch and plastic mulch condition. The yield under plastic mulch is substantial higher than not only for variety Lakshmi but is equally higher for other varieties. The higher yield under plastic mulch is due to a physical barrier between the soil surfaces which improves the water use efficiency (Bahadur *et al.* 2013). Angmo *et al.* (2018) reported that less susceptibility to attack of soil pathogens and breakdown of phytotoxic substances results in higher yield of the plants which are grown on mulched condition. Similar observation was reported for tomato yield under plastic mulch in comparison to without mulch condition (Sarmah

et al. 2022). Other associated problems in without mulch condition was high leaching of fertilizer in soil due rainy season, however mulched crop were mitigated from direct impact or erosive force from rain and adequate nutrients were available to tomato (Rai *et al.* 2017). The field condition in without mulch and mulch for tomato crop is shown in Figs. 2–3 respectively.

Though plant mortality was higher under plastic mulch condition in comparison to without mulch condition for all the treatments but more than 100% difference in yield is found under plastic mulch in comparison to without mulch condition. The highest yield of 19.2 t/ha was found for Lakshmi (T₁) under plastic mulch condition among the all treatments and substantially higher than yield found under without mulch condition. The selling price realization during *kharif* season is very high in comparison to price

realized during *rabi* season, so tomato cultivation using plasticulture technology is highly profitable in comparison to tomato cultivated during *rabi* season. The better screening of tomato variety for *kharif* season and disease management, the mortality of tomato can be further reduced, which will further enhance the profitability of tomato cultivation.

CONCLUSION

The experiment was conducted during the *kharif* season for tomato cultivation using varieties i.e. Lakshmi, Swaraksha, Swarna Sampda, Vidya and Ashok under mulch and without mulch condition. The plastic mulch reduced the weed growth and leaching of fertilizer which provided better nutrient for plant growth. Though plant mortality was higher under plastic mulch in comparison to without mulch condition but yield recorded under plastic mulch was substantially higher than without mulch condition and highest yield of 19.2 t/ha was found for Lakshmi variety. The yield recorded during *kharif* season was similar as reported for *rabi* tomato crop for Jharkhand. The profitability of *kharif* tomato is substantially better than *rabi* tomato due to higher price realization. By proper screening of tomato variety for *kharif* season and disease management and cultivating tomato under drip fertigation with plastic mulch further yield can be improved and higher profitability can be realized.

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