*Int.J.Curr.Microbiol.App.Sci* (2018) Special Issue-7: 4528-4535

*International Journal of Current Microbiology and Applied Sciences*
*ISSN: 2319-7706* **Special Issue-7 pp. 4528-4535**
Journal homepage: http://www.ijcmas.com

**Original Research Article**

# Impact of Fertigation through Drip on the Cultivation of Tomato

**Narendra Agrawal*, S. K. Tamrakar and R. B. Tiwari**

DKS College of Agriculture & Research Station, Bhatapara-493 118 (C.G.), India
**Corresponding author*

**A B S T R A C T**

A Field experiment was conducted at village Paraswani of Mahasamund district during 2012-13 and 2013-14 to study the impact of drip fertigation with different grades of water soluble fertilizer on growth and yield of tomato. The sustainability of any production system requires optimum utilization of resources be it water, fertilizer or soil. Because of its highly localized application and the flexibility in scheduling water and chemical applications, drip irrigation has gained widespread popularity as an efficient and economically viable method for fertigation. The efficient use of water by modern irrigation systems is becoming increasingly important in semi-arid regions with limited water resources. Application of different grades of water soluble fertilizer through drip was found better than without fertigation. Maximum yield (426.75q/ha) was observed under drip fertigation in comparison to non-fertigation condition (230.72q/ha). Fertilizer requirement and time taken for fertigation was found lower under recommended practice, while maximum in farmers practice. Net seasonal income indicated that drip irrigation in combination with water soluble fertilizer resulted in higher return (Rs. 1,12,320/ha) as compared to without fertigation (Rs. 74,360//ha). The benefit cost ratio (3.95) was also observed higher in drip irrigation with water soluble fertilizer as compared to farmer practice (1.79). In total, water soluble fertilizer with proper fertigation schedule in tomato showed much better performance than conventional method of crop management.

**Keywords**

Fertigation through Drip, Cultivation of Tomato

## Introduction

Tomato (*Lycopersicon esculantum* L.) is one of the most important vegetable crops successfully grown in Chhattisgarh. Liberal supply of water and nutrients is the prime need for its successful cultivation. However, the availability of vegetable per capita per day is very low (only 120 g), looking at the present scenario there is an urgent need to increase the production of vegetable by manipulating the production technology. Drip irrigation is a modern and efficient method of irrigation and also facilitates judicious nutrient supply to the plants. This helps in obtaining more yield of crop with less amount of water applied (Gorantiwar *et al.*, 1991).

The drip irrigation effects a saving of water and is a solution to problems of water scarcity. Because drip irrigation system is a very efficient method of supplying water to plant precisely very close to the root zone of plants. In drip method of irrigation, water is carried out through an extensive pipe network and allow to drip slowly through the emitters at a low pressure directly near to the root zone by considering evaporative demand of the crop (Bankar *et al.*, 1993).

The process of application of fertilizers through irrigation water is called fertigation. Pre-dissolved soluble fertilizers are injected into the feeder line of drip irrigation system in this process. The traditional fertilizers available in the markets are not fully soluble in water and contain insoluble impurities and therefore these fertilizers cannot be applied through drip irrigation system. Also these traditional fertilizers are applied in bulk, lot of fertilizers go waste due to leaching, evaporation and fixation in the soil. Moreover these fertilizers get transmitted to area beyond the active root zone and are no longer useful to the plants. The effective utilization by the plant is in many cases less than 50% of the fertilizers applied (Shirgure *et al.*, 1999).

Fertigation is an efficient method of applying fertilizer through drip irrigation as a carrier and distributor of crop nutrients holds key under these circumstances. It is well-established fact that fertilizer use can be minimizing through drip application. In India not much information is available on different aspects of fertigation on closely grown crops like tomato. Therefore, the present investigation was carried out to generate data regarding irrigation and fertigation on growth and yield of tomato in comparison with traditional method of application.

## Materials and Methods

The investigation was conducted at village-Paraswani, District-Mahasamund. The experimental site is situated in the central part of Chhattisgarh in India. In this location the mean minimum and maximum temperature ranges from 12.2$^{o}$C to 25.8$^{o}$C to 20.6$^{o}$C to 48.2$^{o}$C, respectively and relative humidity ranges from 22.3 to 52 per cent and 55.7 to 73.2 per cent, respectively. The experimental site has sandy-loam soil and falls under the semiarid zone. The properties of the soil such as field capacity, wilting point, bulk density and soil depth were determined by usual standard methods. The moisture content was taken at 0.15, 0.30 and 0.45 m depths of soil in each plot. The experimental field was 50 m long and 30 m wide. The experimental plots of 30 x 2m were prepared for transplantation of the seedlings of tomato. The row-to-row and plant-to-plant spacing were 0.60 and 0.45 m respectively. Recommended cultural practices were followed in raising the crops. This field experiment was conduct to see the effect of irrigation and fertigation on the yield and yield attributing parameters of Tomato. The experiment were carried out using two treatments were as Farmers Practice i.e. Flood irrigation + Local available fertilizer and Recommended Practice i.e. Drip irrigation + Water soluble fertilizer.

### Estimation of Irrigation Water Requirement (V)

Reference crop evapotranspiration ($ET_0$) was calculated using Modified Penman Method (Doorenbos, J and Pruitt, 1977). The crop co-efficient (Kc) for different growth stages of tomato was selected. The actual crop evapotranspiration was estimated by multiplying reference crop evapotranspiration, crop co-efficient, area under each plant and wetting fraction. The crop water requirement of tomato crop was estimated by using the following equation:

$$V = ETo \times Kc \times Ap - Ap \times Re$$

Where,

V = Net depth of irrigation (litre/day/plant)

ETo = Reference crop evapotranspiration (mm/day)

Kc = Crop co-efficient

Ap = A x W = Effective area to be irrigated (Sq.m)

A = Area allocated to each plant (Sq.m)

W = Wetting fraction

Re = Effective rainfall (mm/day).

The water requirement was estimated for the growing season of Tomato. Daily time of operation of drip irrigation system was worked out. Drip irrigation was scheduled on alternate days; hence total quantity of water delivered was cumulative water requirement of two days minus effective rainfall (if rain occurred).

The lateral lines of 12 mm diameter LDPE pipes were laid along the crop rows and each lateral served each row of crop. The laterals were provided with 'in line' emitters of 2 lph discharge capacity in such a manner that water emitting out of emitter wet the entire root zone of the plant. HDPE pipes of 75 mm diameter were used for main and 50 mm diameter was used for sub-main lines. The main line was directly connected to a 2-HP centrifugal pump installed to lift water from the tank.

The manifold unit consisted of a screen filter, pressure gauge and control valve. The duration of delivery of water to each treatment was controlled with the help of gate valves provided at the inlet end of each lateral. In case of surface irrigation, irrigation was scheduled at weekly interval.

The cumulative depth of water required for seven days was estimated and supplied to each plant. The water (through surface method of irrigation) was directly applied in the furrow with the help of PVC pipes.

## Benefit-Cost Analysis

Benefit-cost analysis was carried out to determine the economic feasibility of using drip irrigation with fertigation. The cost of drip irrigation system includes depreciation, prevailing bank interest rate, repair and maintenance of the system. The interest rate and repair and maintenance cost of the system were 12 and 1% per anum of the fixed cost respectively. The useful life of drip system was considered to be 10 years. The cost of cultivation includes expenses incurred in field preparation, cost of seedlings, fertilizer, weeding, crop protection measures, irrigation water and harvesting with labour charges. The income from produce was estimated using prevailing average market price. The benefit–cost ratio, total cost of production and net return from cultivation of Tomato over 1 ha were then estimated.

## Results and Discussion

The observations on growth and yield parameters of tomato in each treatment were taken in order to know the effect of drip irrigation and fertigation. The results obtained from the study are discussed below:

### Effect of irrigation and fertigation on growth parameters

Growth parameters, like plant height, number of primary, stem thickness, days required to first and 50% flowering, number of flowers per cluster and number of locules are presented in Table-1 and Fig-1, which shows the drip irrigated crop with fertigation to have a clear superiority. The height of plant (90.74 cm), number of primary branches (7.31), stem thickness (1.87), number of flowers per cluster (7.02) and number of locules (5.17) were recorded

maximum but the days required to first flowering (45.18) and days required to 50% flowering (64.13) were recorded minimum under fertigation treatment and same characters were recorded lower in farmers practice. The results indicated that the flowering started earliest in drip coupled with fertigation as compared to farmers practice. Drip irrigation water with fertigation takes minimum days to flower initiation and flood irrigation along-with no fertigation takes long time to initiate flowering.

These results may be due to regular and efficient supply of irrigation and nutrition directly into root zone and makes better availability of nutrients through drip. The optimum moisture in the vicinity of root zone throughout the crop growth period which enhances the vegetative growth of the crop thereby increases the photosynthesis and efficient translocation of photosynthesis towards the reproductive organ. This may also be due to complete solubility, mobilization and availability of nutrients at regular interval in required quantity. Similar findings were reported by (Khan *et al.*, 2010).

## Effect of irrigation and fertigation on yield and its attributes

Two years pooled data on yield and yield attributing characters were recorded and presented in Table-2 and Fig-2. The yield of tomato of 426.75 q/ha was obtained maximum in recommended practice and the same was lowest in farmers practice (230.72 q/ha). These results also showed that in recommended practice increased the yield by 84.96 % over flood irrigation without fertigation. This increase in yield may be due to the efficient utilization of water through drip, better nutrients uptake and retardation of losses of evaporation and transpiration. The reasons of low yields in flood irrigated crops may be due to the crop has to undergo water stress during last few days before next irrigation, coupled with aeration problem during first few days immediately after irrigation. Moreover, due to heavy application of irrigation water the nutrients must have got leached down the root zone. Another possible reason was the high weed infestation observed between the crop rows. The reason explained by Singh and Singh (1978), Mane *et al.*, (1989) and Banker *et al.,* (1993).

Similarly the yield attributing parameters like no of fruits per cluster (6.89), fruit diameter (6.73 cm), pericarp thickness (0.64 cm), number of fruits per plant (30.10) and weight of fruit (38.28 g) was found maximum under the same treatment and recorded minimum under no fertigation condition with flood irrigation.

Yield and yield attributing characters were significantly increased by drip irrigation and fertigation due to continuous water and nutrient supply as per the requirement of the crop and promoted more nutrient uptake, retained more water in the root zone and increased crop water use efficiency thereby increasing growth and yield of the crop. Similar results were reported by Ashworth and Harrison (1983).

## Water Use Efficiency, Fertilizer Use Efficiency, Water Savings and Fertilizer Savings

It is clear from the Table-2 that in recommended practice the water use efficiency was observed more (0.88 q/ha mm) as compared to farmers practice (0.21 q/ha mm). With the highest water application it recorded the lowest water use efficiency. Similar findings were reported by Shrivastava *et al.*, 1999.

**Table.1** Effect of fertigation on the growth and flowering characters of tomato

| Treatments | Farmers Practice | Recommended Practice |
|---|---|---|
| Plant Height (cm) | 75.67 | 90.74 |
| No. of primary branches | 4.02 | 7.31 |
| Stem thickness (cm) | 0.94 | 1.87 |
| Days reqd. to first flowering | 55.24 | 45.18 |
| Days reqd. to 50 % flowering | 83.26 | 64.13 |
| No of flower per cluster | 5.16 | 7.02 |
| No of locules | 4.14 | 5.17 |

**Table.2** Effects of fertigation on the yield and yield attributing characters of tomato

| Treatments | Farmers Practice | Recommended Practice | (%) Saving / Change |
|---|---|---|---|
| No of fruit per cluster | 5.04 | 6.89 | - |
| Dia. of fruits (cm) | 5.04 | 6.73 | - |
| Paricarp thickness (cm) | 0.44 | 0.64 | - |
| No of fruits per plant | 24.60 | 30.10 | - |
| Weight of fruits (g) | 25.32 | 38.28 | - |
| Yield (q/ha) | 230.72 | 426.75 | 84.96 |
| Water Used (mm) | 1058.4 | 484.5 | 54.22 |
| WUE (q/ha-mm) | 0.21 | 0.88 | - |
| Fertilizer Used (kg/ha) | 765 | 380 | 50.32 |
| Fertilizer Use Efficiency | 30.16 | 112.30 | |

**Table.3** Cost economics of tomato

| Treatments | Farmers Practice | Recommended Practice | (%) Saving / Change |
|---|---|---|---|
| Cost of Irrigation (Rs./ha) | 9,500 | 5,500 | 42.10 |
| Cost of Weeding (Rs./ha) | 15,000 | 4,500 | 70.00 |
| Net Returns (Rs./ha) | 74,360 | 1,12,320 | - |
| B : C Ratio | 1.79 | 3.95 | - |

**Fig.1** Effect of fertigation on plant height and flower initiation of tomato

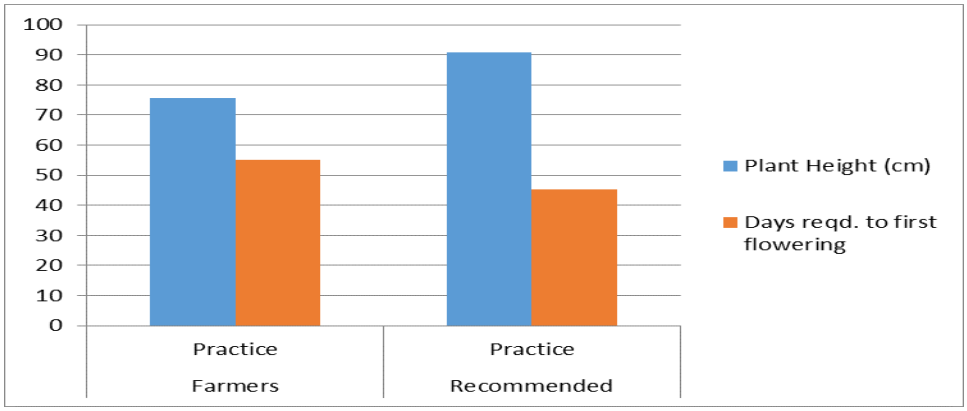


**Fig.2** Effect of fertigation on weight of fruit and yield of tomato

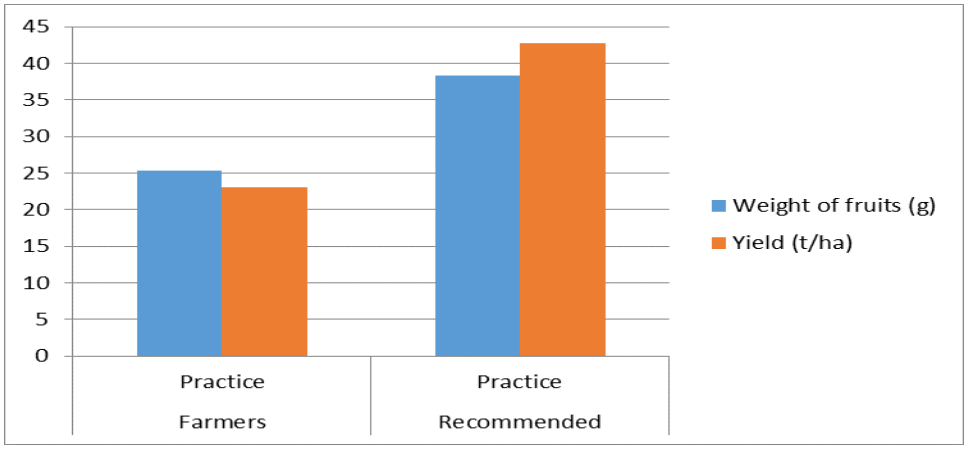



**Fig.3** Comparison between cost of irrigation for farmers and recommended practice

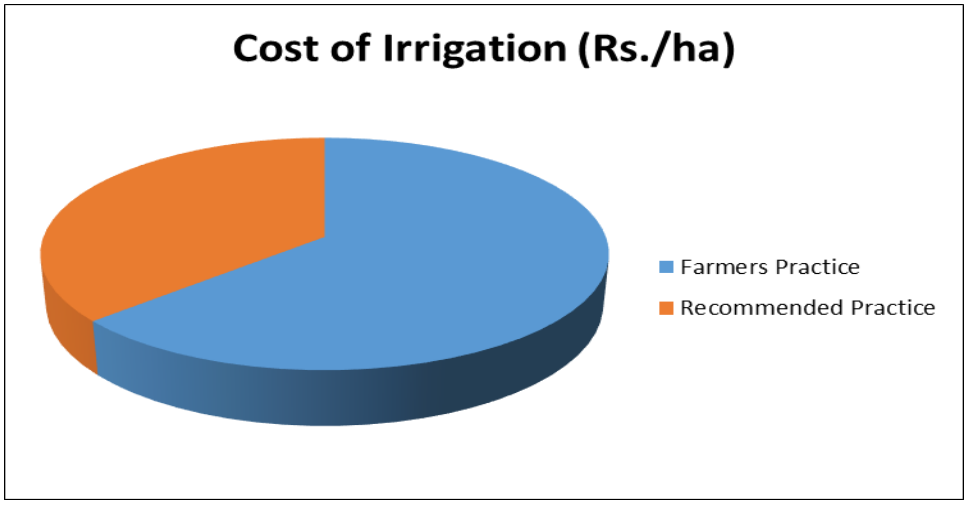
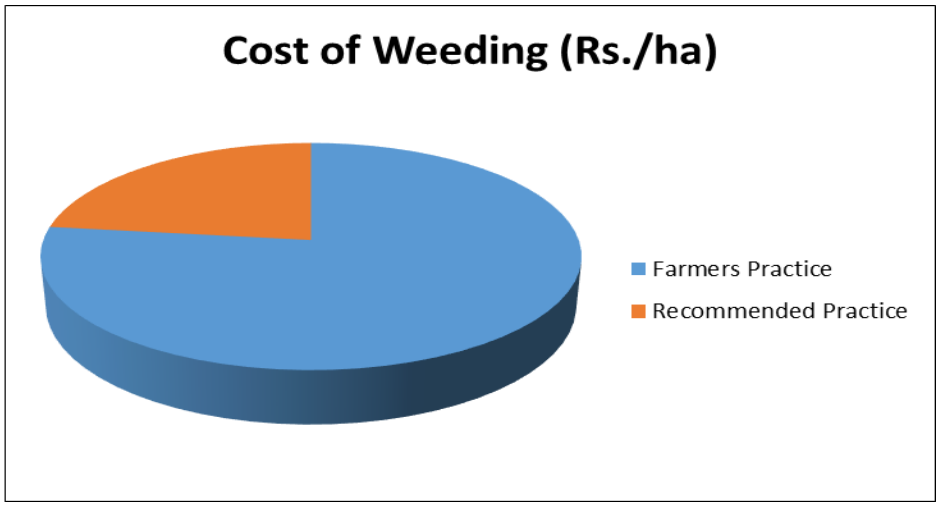



**Fig.4** Comparison between cost of weeding for farmers and recommended practice



Water saving percentage for drip treatment with fertigation was observed maximum while lowest in flood irrigation without fertigation, because drip irrigation helps in obtaining more yield of crop with less amount of water applied. Approximately 54.22 per cent water saving recorded in recommended practice as compared to farmers practice. Similarly fertilizer used and fertilizer use efficiency were found better under recommended practice as compared to farmers practice. About 50.32 per cent saving of fertilizer was recorded under recommended practice over farmers practice. Similar results were obtained by Kaushal *et al.,* (2012), where they reported that the drip irrigation adoption increases water use efficiency (60-200%), saves water (20-60%), reduces fertilization requirement (20-33%) through fertigation, produces better quality crop and increases yield (7-25%) as compared with conventional irrigation.

## Cost Analysis

Result of Table-3 shows that the cost economics comparison of Tomato among recommended practice and farmers practice. The net return of Rs. 1,12,320/ha was obtained maximum in recommended practice and the same was lowest in farmers practice (Rs 74,360/ha). The benefit cost ratio was also obtained maximum in fertigation with drip (1:3.95) and minimum in no fertigation with flood irrigation (1:1.79). Similarly cost of irrigation and cost of weeding was observed maximum in fertigation with drip and lower in farmers practice (Fig-3 & Fig-4). Due to poor quality of fruits in flood irrigated control, the market prices of fruits were less as compared to recommended practice treatments. Similar findings were reported by Gupta *et al.,* (2010), where they concluded that by adopting drip irrigation system, the highest income could be generated in capsicum as against realized under conventional method. Benefit cost ratio was also noticed maximum with the same treatment combination i.e. 80% ET through drip + 80% recommended NPK through fertigation.

Farmers were agreed the advantages of fertigation through drip on the cultivation of tomato. They also agreed the advantages of drip irrigation as compared to conventional irrigation.

Adaptation of fertigation with drip increased the yield of tomato approximately 1.85 times over conventional method of cultivation.

The water use efficiency, water savings, fertilizer use efficiency and fertilizer savings were found maximum in fertigation treatment with drip.

The net return and benefit cost ratio were also recorded maximum in recommended practice.

## References

Ashworth, S. and Harrrison, H. (1983). Evaluation of mulches for use in the home garden. *Hort. Sci*., 18:180-180.

Banker, M.C., Mane, M.C. Khade, K.K. and Kanjle S.T. (1993). Comparative performance of drip vs conventional method of irrigation on banana. *Proceedings of All India Symposiums on Sprinkler and Drip Irrigation,* 9-10 IEI, 89-92.

Doorenbos, J., and Pruitt, W. O. (1977). Guidelines for predicting crop water requirements. *Irrigation and Drainage paper No. 24 (Revised)*, FAO, Rome.

Gupta, A. J., Ahmed, M. F. and Bhat, F. N. (2010). Studies on yield, quality, water

and fertilizer use efficiency of capsicum under drip irrigation and fertigation, *Indian J Hort*, *67*, 213-218.

Kaushal, A., Patole, R. and Singh, K. G. (2012). Drip irrigation in sugarcane*:* A review, *Agri Rev*, *33*, 211–219.

Khan, M. S., Roy, S. S. and Pall, K. K. (2010). Nitrogen and phosphorus efficiency on the growth and yield attributes of capsicum, *Acad J Plant Sci*, 3, 71-78.

Mane, T.A., Khade, V. and Dhotrey, V. (1989). Studies on performance of drip irrigation and surface water application methods in banana. Proc. Silver Jubilee Convention ISAE, Udaipur: 185.

Shirgure, P. S., Lallan Ram, Marathe, R. A. and Yadhav, R. P. (1999). Effect of nitrogen fertigation on vegetative growth and leaf nutrient content of acid lime (Citrus aurantifolia Swingle) in Central India. *Indian J. Soil Conservation*, 27(1): 45-49.

Shrivastava, P.K., Parikh, M.M., Sawani, N.G and Raman, S. (1999). Response of banana to drip irirgtion mulches and irrigation scheduling in South Gujrat. *Agril. Engg. Today*, 23: 23-28.

Singh, S.D. and Singh, Punjab (1978). Value of drip irrigation compared with conventional irrigation for vegetable production in hot and arid climate. *Agronomy Journal*, 70 (6): 23-27.