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RESPONSE OF HYBRID TOMATO TO DRIP IRRIGATION SCHEDULING AND PLASTIC MULCHING

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Summary

An experiment was conducted to study the effect of drip irrigation quantity and mulching on crop growth, yield and water use efficiency (WUE) of tomato grown during the rabi seasons of 2007 and 2008. Two levels of drip irrigation (I1, irrigation with V volume of water; I2, with 0.5V volume of water) and four types of plastic mulch (M0, without mulch; M1, yellow polythene; M2, transparent polythene; M3 black polythene) treatments were applied to tomato planted on a sandy loam soil. Results indicated that the photosynthetic traits such as; chlorophyll content, initial fluorescence (F0), and maximum quantum yield of photosystem II (Fv/Fm) were significantly higher under I1 and black polythene mulch. Dry matter production under drip irrigation with V (~100% PE) quantity of water was 33.2% more than with 0.5V. Polythene mulching remarkably improved the plant biomass, and plants mulched with black polythene registered 94.7% higher dry matter over unmulched control. Drip irrigation with V quantity of water (I1) resulted in significantly higher fruit yield (2.71 kg/plant and 847.52 q/ha). Maximum fruit yield (2.66 kg/plant and 851.59 q/ha) was recorded with black polythene mulch. Weed growth under 0.5 V (I2) was significantly lower (25% less) than I1. All kinds of plastic mulches gave significant weed control, however, the highest weed reduction (89% over control) was observed with black polythene mulch. Maximum WUE of 49.60 kg/mm-ha was obtained in I2, whereas, among mulches WUE was maximum with black polythene (46.03 kg/mm-ha).

सारांश

संकर टमाटर में ड्रिप सिंचाई एवं पालीथीन पलवार पर वर्ष 2007 एवं 2008 में प्रयोग किया गया। ड्रिप सिंचाई के 2 स्तर (100% पैनवाष्पीकरण एवं 50% पैन वाष्पीकरण पर सिंचाई) तथा पालीथीन पलवार प्रयोग किए गये। प्रयोग में पाया गया यदि ड्रिप सिंचाई 100 प्रतिशत पी.ई. पर किया जाता है तो प्रकाशसंश्लेषण क्रियाएं, शुष्क पदार्थ उत्पादन तथा उपज 10.50 प्रतिशत पी.ई. की अपेक्षा अधिक मिलता है। पलवार में सबसे अच्दा प्रभाव काली पालीथीन में देखा गया जो उपज 2.66 कि.ग्रा./पौधा या 851.59 कु./है. रहा। ड्रिप सिंचाई एवं पलवार का परस्पर सहयोग काफी बहुत लाभप्रद पाया गया। सबसे अधिक जल उपयोग क्षमता एवं खरपतवार की कमी 50 प्रतिशत पी.ई.एवं काली पालीथीन के साथ दर्ज किया गया।

Introduction

The use of plastic materials for mulching is a very common practice in vegetable production. Black polyethylene is most widely used due to its excellent properties and low cost. Plastic films or mulches are used to moderate soil temperature, suppress weeds, control soil-borne pathogens, conserve soil water and induce earlier and higher total yield of different vegetables. Furrow and flood irrigation is the conventional method widely used to irrigate most of the vegetable crops grown in India; however, this system has low irrigation or water use efficiency as compared to micro-irrigation system. In contrast, drip irrigation has higher water and nutrient-use-efficiency, enhances plant growth and development, yield and quality, and has flexibility in scheduling water application. A combination of drip irrigation and plastic mulching further improves the water use efficiency by curtailing the amount of water as well as the number of irrigations applied. Therefore, the present investigation was undertaken to study the effect of variable quantity of water applied through drip irrigation system with or without plastic mulch on crop growth, yield and water use efficiency of tomato.

Materials and methods

The investigation was carried out during Rabi season of year 2007 and 2008 on hybrid tomato cv. Shaktiman. Treatments comprised of two levels of drip irrigation (I1, irrigation with V volume of water; I2, with 0.5V volume of water) and four types of plastic mulch (M0, without mulch; M1, yellow polythene; M2, transparent polythene; M3 black polythene). Split-plot design was followed; wherein the drip irrigation scheduling was placed in main blocks and mulches in sub-blocks replicated 5 times. The soil of experimental plot was sandy loam with pH 7.2, E.C. 0.32 dS/m, organic carbon 0.39% and available N, P

and K was 258, 20.5 and 185 kg ha-1, respectively. Moisture content (0.30 m depth) at 0.33 bars (field capacity) and at 15 bars (wilting point) was 22.6% and 6.1%, respectively, whereas bulk density of the soil was 1.38 g cm-3. For mulching, films of 25ì thickness having holes of about 7.0 cm diameter at distance of 50 cm was spread over the prepared field and 25 days old seedlings were transplanted in the holes. Laterals of 12 mm diameter having turbo-key type emitters with discharge rate of 2 lph were placed below the polythene mulch.

The calculations for the quantity of water applied in terms of volume (V) have been given under Table 1 as described by Raina *et al.,* (1999). The crop factor values (Kc) for different crop growth stages were taken from Doorenbos *et al.,* (1984). The pan factor (Kp) of

Table 1. Calculation of amount of water under drip irrigation#

Month	Monthly PE (mm/day)	Crop factor (Kc)	Pan factor (Kp)	Effective rainfall (Re)	Re * A	Water volume (V*; L/ha)	Water depth** (mm)
November*	2.00	0.5	0.75	0.00	0.0	172522	17.3
December	1.77	0.85	0.75	0.00	0.0	349840	35.0
January	1.98	1.1	0.75	02.5	28.1	481445	48.1
February	2.55	0.95	0.75	0.00	0.0	508789	50.9
March	4.40	0.7	0.75	0.00	0.0	646881	64.7
+ Water required for plants establishment =						408940	40.9
Total amount of water given under 1.0V* =						2568416	257

Drip irrigation was started from 7 November and stopped on 28 March.

0.75 was considered as suggested for USDA Class A Pan Evaporimeter.

Leaf area was measured with Portable Area Meter Li-3000 A (LiCOR Ins, Nebraska, USA). Chlorophyll content index (CCI) of leaf was measured with the CCM-200 Portable Chlorophyll Meter (Opti-Sciences, Tyngsboro, MA). Leaf fluorescence was measured from Plant Efficiency Analyzer (Hansatech Instrument Co. Norfolk, UK). Both these parameters were taken on fully expanded leaves, fourth to fifth from the top at active growth stage (75 DAT). Dry matter partitioning was measured at active growth stage (75 DAT) by oven drying the leaves, stems and roots at 65°C for 24 hours. Weeds of 1m x 1m area in each replication were removed and oven dried till constant weight to get dry weight of weeds.

Results and discussion

Growth and yield parameters: The data on the growth and yield parameters of the crop has been presented

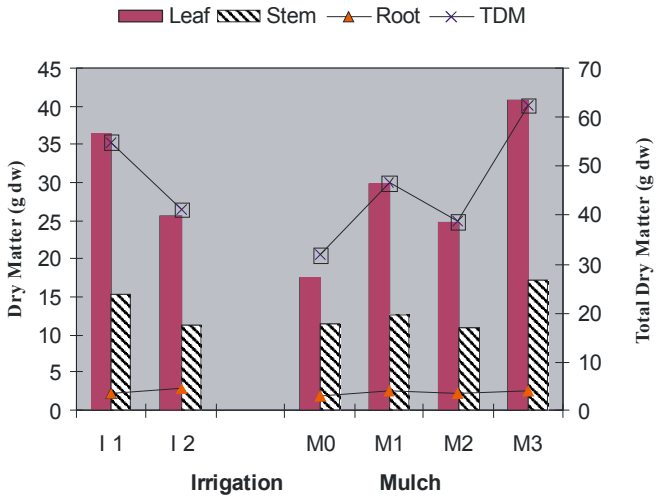

Figure 1. Dry matter partitioning as affected by irrigation and mulch

in Table 1. Plant height was significantly affected with use of plastic mulch, particularly use of black polythene mulch (73.8 cm); however, it was at par under both the levels of drip irrigation. Number of branches/plant was not significantly different either with drip irrigation schedulings or various kinds of polythene mulch. Dry matter production (Fig. 1) showed that plants under drip irrigation with V (˜100% PE) quantity of water had 33.2% more dry matter than 0.5V (41.3 g/plant). Polythene mulching remarkably improved the plant biomass, and plants mulched with black polythene registered 94.7% higher dry matter over unmulched control. Similarly, yellow polythene and transparent polythene mulched plants recorded about 45% and 21% more dry matter accumulation, respectively than unmulched control (32 g/plant). Leaf area analysis of whole plant (Table 2) indicated that this parameter was unaffected irrespective of the quantity of water applied under drip irrigation; whereas with mulching, more particularly with black polythene, the plants registered maximum leaf area (0.501 m^2/plant) followed by yellow polythene mulch (0.404 m^2/plant). The improvement in growth traits under drip irrigation with 100% PE (V) and polythene mulching could be attributed to enhanced water and nutrients utilization, better soil-water-air relationship, negligible weed competition and better soil hydrothermal regime (Bahadur and Singh 2005; Bahadur *et al.,* 2006; Singh 2005; Raina *et al.,* 1999).

Photosynthetic traits such as chlorophyll content, initial fluorescence (F0), maximum primary yield of photochemistry of photosystem II (Fv/F0) and

Table 2. Effect of amount of water and polythene mulching on growth and yield traits of tomato

Treatment	Plant height (cm)	Leaf fluores. (Fv/Fm)	CCI	Leaf area (m^2)	Fruits (no.)	Fruit weight (g)	Fruit yield/ plant (kg)	Fruit yield (q/ha)	Weed dry wt. (g/m^2)
I1	69.2a	0.752a	32.7a	0.411a	31.3a	76.7a	2.71a	847.52a	18.22a
I2	68.2a	0.715b	23.8b	0.383a	24.8b	71.1b	1.92b	671.15b	13.62b
CD 0.05	NS	0.033	3.25	NS	3.91	2.83	0.10	17.06	2.74
M0	64.6c	0.663c	24.8b	0.304c	23.2c	66.5c	1.83c	670.79c	29.62a
M1	66.5b	0.761ab	26.3b	0.404b	28.7b	77.9b	2.39ab	761.73b	12.37c
M2	69.9ab	0.731b	25.7b	0.381b	31.5a	67.8c	2.37b	753.23b	18.46b
M3	73.8a	0.779a	36.3a	0.502a	28.8b	83.6a	2.66a	851.59a	3.24d
CD 0.05	5.16	0.035	4.43	0.036	2.66	3.91	0.27	25.36	3.58
Interaction (I x M)	NS	NS	NS	S	NS	NS	NS	NS	S

maximum quantum yield of photosystem II (Fv/Fm) are good indicators to assess the physiological potential of plant under stress. In present study (Table 2), the chlorophyll content index (CCI) was highest under drip irrigation with V quantity (32.7), and among the mulch it was maximum under black polythene mulch (36.3). The interaction of I x M was non-significant. Maximum quantum yield of photosystem II (Fv/Fm) was significantly higher (0.752) under I1, and among the polythene mulches the highest fluorescence yield (0.779) was estimated using black polythene mulch. Earlier, similar findings in tomato were also reported by Rao et al., (1999).

Drip irrigation as well as polythene mulching significantly improved the yield attributes like; number of fruits/plant, fruit weight and fruit yield (Table 2). Significantly higher number of fruits was recorded under I1 (31.3/plant) than I2. Among the mulch materials, maximum number of fruits (31.5/ plant) were obtained with transparent polythene while it was at par in case of plants mulched with yellow or black polythene. Considerably and significantly higher fruit weight (83.6 g) was obtained with black polythene mulch as compared to other mulch materials. Significantly higher fruit weight of 76.7 g was also registered with I1). Drip irrigation with V quantity of water (I1) recorded significantly higher fruit yield (2.71 kg/plant and 847.52 q/ha) over 0.5 V (I2). Polythene mulching had highly significant effect on tomato fruit yield. Maximum fruit yield (2.66 kg/plant and 851.59 q/ha) was recorded with black polythene mulch. This treatment registered about 27%, 12% and 13% more fruit yield per hectare basis, respectively over M0, M1 and M2. Similar to our findings, Raina et al (1999) had also noticed that drip irrigation at 100% PE and 60% PE along with black polythene mulching enhanced tomato fruit yield by 49.6% and 25.8%, respectively over surface irrigation. This improvement in yield attributes may be due to better soil moisture in rhizosphere, better nutrients utilization due to fertigation, higher photosynthesis and negligible weed growth and better soil hydrothermal properties due to black polythene mulching. The higher tomato yield with black polythene mulch may be attributed to complete elimination of weeds, higher soil moisture and nutrient availability and better soil temperature during crop season (Singh, 2005).

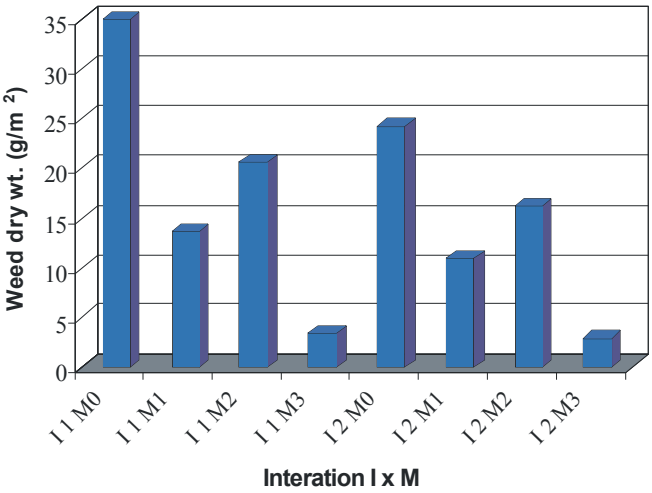

Figure 2. Interaction effect of irrigation and mulching on weed growth

Weed growth: Weed growth under 0.5 V (I2) was significantly lower (25% less) than I1. All kinds of plastic mulches used in the present investigation gave significant weed control; however, under black polythene mulch the highest weed reduction (89% less than unmulched control) was observed followed by yellow (58%) and transparent polythene (38%).

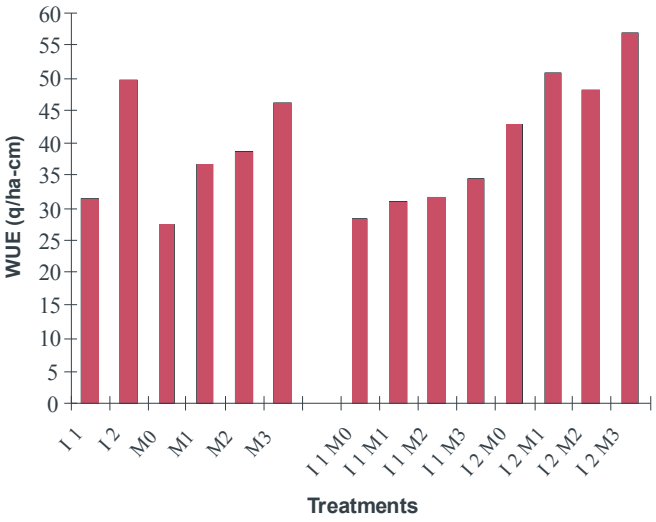

Figure 3. Effect of irrigation and mulching on water use efficiency (WUE) in tomato

Shrivastava *et al.* (1994) and Singh (2005) also reported that plastic mulching remarkably reduced weed growth in tomato over bare soil. In present study, the least weed growth under black polythene mulch (3.24 g dw/m^2) may be attributed to restricted weed growth resulting from poor light penetration beneath the mulch as black polythene reflects about 90% of the incident solar radiation. Interaction of drip irrigation and mulch was also found significant. The least weed dry weight (about 3 g/m^2) was recorded in I1M3 followed by I2 M3 (Fig. 2).

Water use efficiency (WUE): WUE is the ratio of yield obtained and the quantity of water applied to get that particular yield. Among the drip irrigation scheduling, the maximum WUE of 49.60 kg/mm-ha was obtained in I2, whereas the maximum WUE was registered with black polythene (46.03 kg/mm-ha) among the mulches (Fig. 3). The interaction of I x M was also found highly significant. The maximum WUE was recorded under I2 M3 (56.8 kg/mm-ha); however drip irrigation at 0.5V and mulching with any kind of plastic also registered higher WUE. Since the water loss through evaporation from soil surface was much lower under drip irrigation coupled with black polythene mulch, hence WUE was higher under I2 M3 as compared to the others. Similar findings were also reported in tomato earlier by Bahadur and Singh (2005) and Raina *et al.,* (1999).

References

Bahadur A and Singh KP (2005). Optimization of spacing and drip irrigation scheduling in indeterminate tomato (Lycopersicon esculentum). Indian J. Agric. Sci. 75: 563-65.

Bahadur A, Singh KP and Rai M (2006). Effect of fertigation on growth, yield and WUE in Tomato (Lycopersicon esculentum Mill.). Veg. Sci. 33: 26-28.

Doorenbos J, Pruitt W O, Aboukhaled A and Dastane AB (1984). Guidelines for predicting crop water requirements. FAO Irrigation and Drainage Paper No. 24, FAO Rome.

Raina JN, Thakur BC and Verma ML (1999). Effect of drip irrigation and polythene mulch on yield, quality and water use efficiency of tomato. Indian J. Agric. Sci. 69: 430-433.

Rao Srinivasa NK, Bhatt RM, Naren A and Mascarenhas JBD (1999). Influence of moisture stress on leaf water status, osmotic potential, chlorophyll fluorescence and solute accumulation in field grown tomato cultivars. Veg. Sci. 26: 129-132.

Shrivastava PK, Parikh MM, Sawani NG and Raman S (1994). Effect of drip irrigation and mulching on tomato yield. Agric. Water Manage. 25: 179-184.

Singh Rajbir (2005). Influence of mulching on growth and yield of tomato (Solanum lycopersicum L.) in north Indian plains. Veg. Sci. 32: 55-58.