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Response of deficit drip irrigation on production and growth parameters of capsicum (*capsicum annuum*) inside naturally ventilated polyhouse

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Abstract. A field experiment was conducted during March-August 2017 at Plasticulture farm College of Technology & Engineering, Udaipur. Randomized block design (RBD) was adopted for conducting field trial with six levels of irrigation viz., 100, 90, 80, 70, 60 and 100% (control without mulch) of crop evapotranspiration and 4 replication. Capsicum (shimla mirch locally known in Udaipur) cv Indra was irrigated with drip irrigation (also known as trickle irrigation) technique. Measurements of crop biometric parameters namely plant height, number of leaves and individual fruit weight was done at pre scheduled time throughout the crop season. Results revealed that biometric parameters found maximum in case of 80% irrigation level while minimum in 60% irrigation level treatment. The highest yields (42.64 t/ha) was also recorded in the same treatment. Therefore, it can be concluded that by scheduling irrigation to meet 80% of crop ET will result in optimum crop yields and enhances crop water use efficiency of capsicum grown inside naturally ventilation polyhouse (NVPH).

1 Introduction

Capsicum is a vegetable crop grown throughout the world in wide range of climatic conditions. South Korea and Saudi Arabia are leading importers of capsicum [1]. Plastic mulches minimise the losses occurred due to the weed, trash and also used in crop cultivation [2]. Maximum net-return found by the use of silver-black mulch and also very economical [3]. The trickle irrigation use, increases water use efficiency (60-200 %), water saving (20-60%), fertilization requirement reduction (20-30 %) and (7-25 %) yield increases than traditional method of irrigation [4]. Estimation of crop evapotranspiration and determination of crop water demand enable proper irrigation scheduling which could enhance water use efficiency and crop production [5].

Deficit irrigation (DI) is the water saving technique in which crops are exhibited to a some level of water stress either during a particular period or throughout the complete growing season [6]. Deficit irrigation as technique through which crop root zone partially met the water than that of required evapotranspiration [7]. DI is an adequate strategy for sunflower and irrigation is excessively important



between flowering and maturity stage of sunflower [8]. During 2014-2015 shimla mirch production of the India was 172 thousand tonne from 30 thousand hectare [9].

There is few information reported on shimla mirch response to different irrigation water levels. Therefore, present study was carried out to determine the response of shimla mirch under trickle irrigation in naturally NVPH.

2 Methods and materials

2.1 Experimental site

Udaipur is located at South side of the Rajasthan at 24° 35'31.5" to 24° 35'38.5" N-latitude, 73° 44'18.2" to 73° 44'21.1" E-longitude at the elevation 582.17 m above mean sea level, average annual rainfall of this place is 654.3 mm, the maximum and minimum temperatures are 46 °C and 5 °C respectively [10].

The daily irrigation water requirement was estimated using Food and Agriculture Organization Penman- Monteith equation. The flow requirement per plant was estimated using given formula:

$$W_r = \frac{\text{Crop area} \times ET_0 \times K_c \times W_a}{E_u \times 10,000} \quad (1)$$

Where,

W_r = water requirement, (lit/hour/plant), Crop area = row to row spacing (cm) × plant to plant spacing (cm) of the crop, ET_0 = reference evapotranspiration, (mm/day), K_c = crop coefficient, W_a = percent wetted area of total crop area, E_u = uniformity coefficient of drip system, decimal

$$t = W_r / q \quad (2)$$

Where, q = the average emitter flow rate, liter/hr, t = the time of irrigation, hr.

3 Physiological parameter and yield of crop

3.1 Biometry measures

3.1.1 Mean plant height & mean number of leaves per plant. 5 plants were selected randomly and marked in each treatment for the observing of average plant height, and mean of number of leaves per plant were work out at 30, 60, 90, 120 and 150 DAT (days after transplanting of shimla mirch to the polyhouse).

3.2 Procreation parameters

3.2.1 Per plant count of flowers. Fully opened flowers were counted, summed, mean was calculated at 30, 60, 90, 120, and 150 days for each selected plant.

3.2.2 per plant count of fruits. Mature fruits that were harvested from the selected plants in each picking were recorded until the final harvest.

3.2.3 Percent fruit sets. Number of fruit sets were counted and recorded at regular interval during the growing season and % fruit sets were estimated by formula:

$$\text{Per cent fruit sets} = \frac{\text{No. of fruit sets}}{\text{No. of flower tagged}} \times 100 \quad (3)$$

3.3 Yields parameters

3.3.1 Individual fruit weight (gm). Individual fruits weight from the tagged plants weighed and average readings were recorded in grams.

3.3.2 Fruit yields (kg). The weight of marketable fruits harvested from all treatment was quantified till last harvest and overall yield of fruits per plant was expressed in kilograms.

3.3.3 Fruit yields (tonnes/hectare). Fruit yields for each treatment were obtained by choosing plant in each replication.

4 Statistical analysis

The statistical analyses of data were carried out by statistical method known as “Analysis of variance” (ANOVA) appropriate for the “Randomized Block Design.” The standard error (SE) for each factor and their interaction was found out. Wherever, the outcomes vary significantly, critical difference (CD) at five % level of significance was calculated.

5 Results & discussion

5.1 Biometry measures

5.1.1 Mean plant height and mean no. of leaves per plant. Plant height and leaves data were affected by irrigation treatments as shown in Figure 1 & 2. At 30 DAT, plant height and no. of leaves were observed maximum 73.25 cm and 20 in T₃ (trickle irrigation with 80 % of ET_c with mulch) treatment, which is significantly good than rest five irrigation treatments. The minimum height of plant and no. of leaves, 65.05 cm, & 16 were recorded in T₅ treatment. Similar trends were noticed at 60 DAT, 90 DAT, and 120 DAT and at the 150 DAT. The result data clearly indicates impact of the irrigation treatments were obtained significant at 5% level of significance.

Mulch application increases the soil temperature results in increased microbiological activity of the crop root zone which increases the availability of nutrients to the plant. The results of higher growth rate in T₃ treatment were also reported by Arya *et al.*, [11] for shimla mirch crop. Count of no. of leaves per plant were highest (57.28) in treatment T₃ at 150 DAT. Sharma *et al.*, [12] also found the same trend for tomato crop.

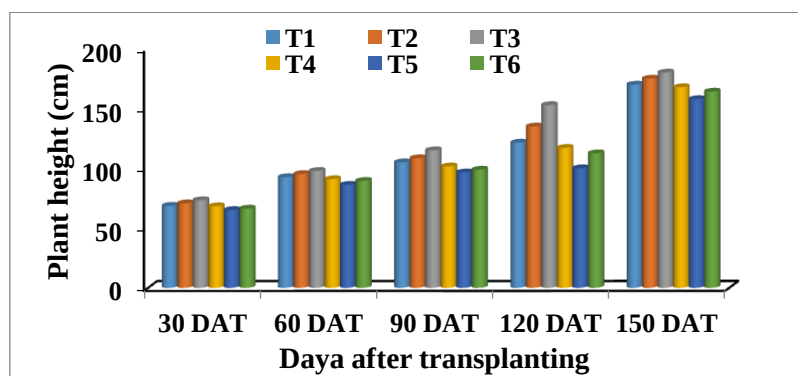


Figure 1. Plant height affected by deficit irrigation.

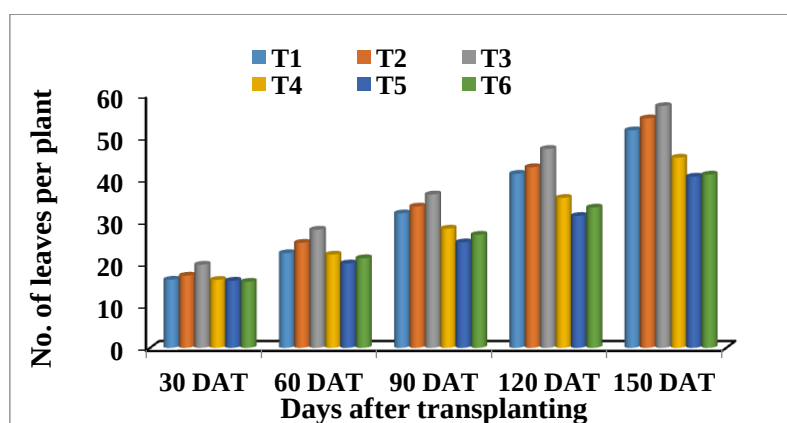


Figure 2. Number of leaves affected by deficit irrigation.

5.2 Procreation parameters

5.2.1 Per plant flowers count. Average cumulative per plant flowers count at different growth stages of crop were affect by different irrigation treatments as shown in Figure 3. At 60 DAT, among the six

irrigation treatments, maximum 9.21 in T₃. Lowest per plant flower count 6 was observed in T₅ treatment.

5.2.2 Per plant fruit count and percent sets of fruits. Graphical representation of mean values per plant fruit count and percent sets of fruits is shown in Figure 4 and 5. At last harvesting (150 DAT), among the six different irrigation treatments, cumulative per plant fruit count were observed highest 11.31 in T₃ treatment, which is significantly good over in the all rest treatments.

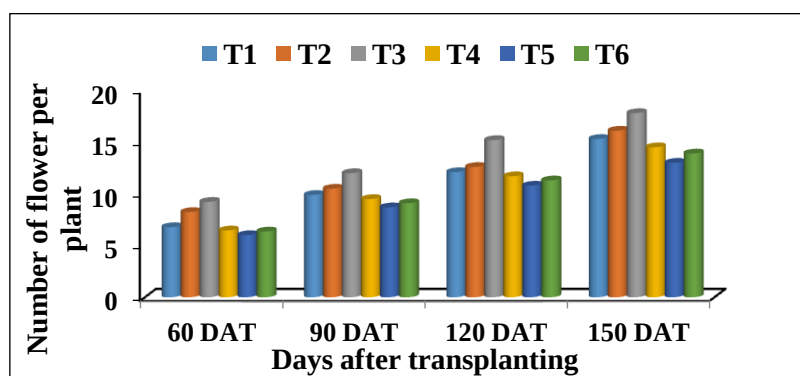


Figure 3. Flowers/ plant affected by deficit irrigation.

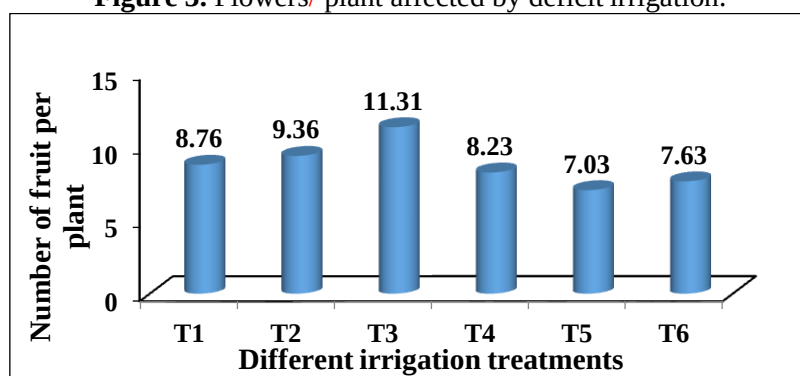


Figure 4. Number of fruits/plant influenced by deficit irrigation.

The highest percent fruit sets (51.07 %) was recorded in treatment T₃, followed by treatment T₂ (47.16%). This could be results of increased fruit production per plant due to higher fruit sets percent under the polyhouse because of less interference of adverse climatic conditions.

5.2.3 Yields Parameters. Mean values of single weight of fruit and fruit yields per hectare (t/ha) is represented in Figure 6 and Figure 7, respectively. ANOVA table of fruit yield (t/ha) shown in table 1. Among the different irrigation treatments, maximum single weight of fruit (94.33 gm) was recorded under treatment T₃ and minimum (42.53 gm) was recorded under treatment T₅.

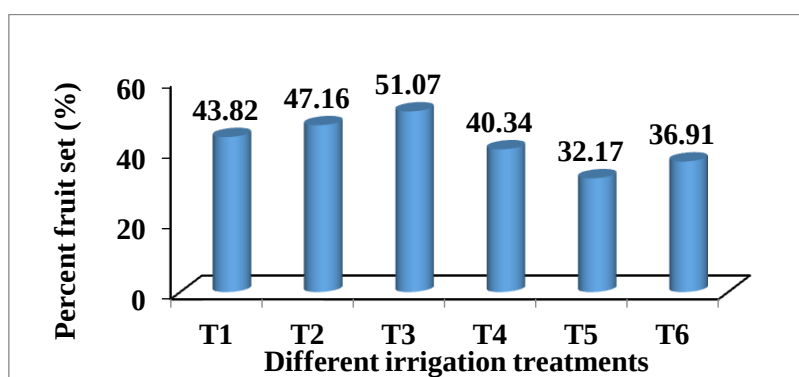


Figure 5. Percent sets of fruit influenced by deficit irrigation.

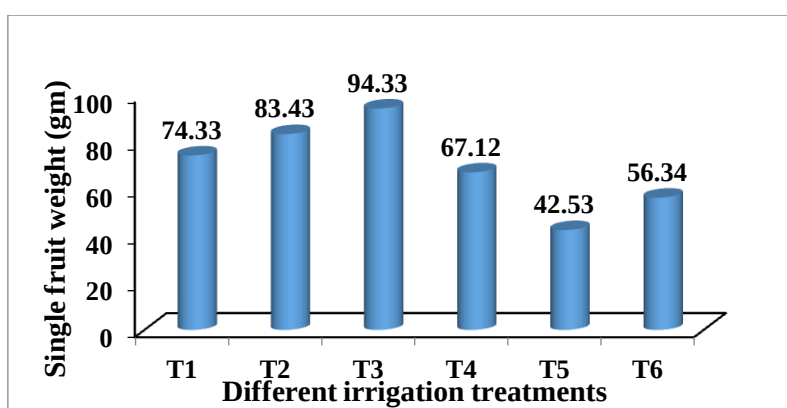


Figure 6. Single weight of fruit affected by deficit irrigation.

Table 1. Statistical values of fruit yield (t/ha).

SOV*	Df**	SS***	MSS****	F-cal	F-tab
Replication	3	439.11	146.37	12.21	
Treatment	5	2361.43	472.29	39.39	2.90
Error	15	179.84	11.99		
Total	23	2980.38	129.58		

$SE_m=1.73$, Critical difference (5%) = 5.22, Coefficient of variance (%) = 13.74

*Source of variation

**Degree of freedom

***Sum of squares

****Mean squares

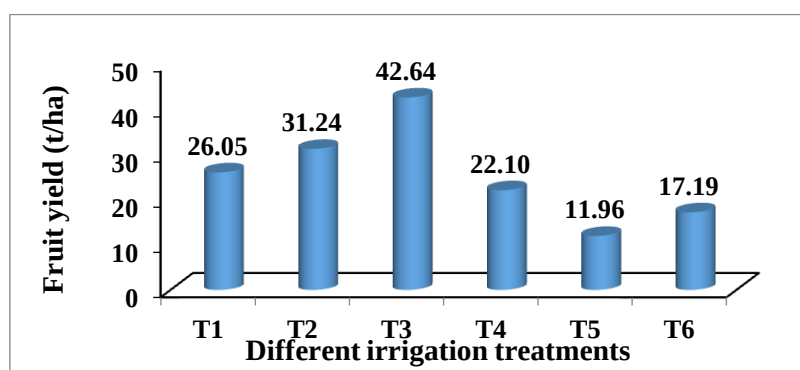


Figure 7. Effect of deficit irrigation on fruit yields.

The fruit weight influences total production of shimla mirch. Average fruit weight obtained in treatment T_3 was more than what had been found in treatment T_5 . This increment in the crop yield is due to increase dimension that is was largely due to the increased length and breadth and ultimately volume of the fruit. This enhancement of fruit size is due to optimum absorption of essential nutrients and existence of favourable environment in the crop root zone for better growth. Harmanto *et al.*, [13] have also mentioned similar kind of results for tomato crop. The marketable fruit yields of shimla mirch was higher (1065.98 gm/plant and 42.64 t/ha) in treatment T_3 as compared to treatment T_5 (298.98 gm/plant and 11.96 t/ha).

6 Conclusions

Deficit irrigation is an advance and recent water saving approach appropriate in water scarce regions. It has a vast scope to enhance crop water productivity in the dry, sub-humid agro-climatic conditions of Udaipur. This study concluded that saving of 10-20 per cent of water can be achieved using deficit irrigation technique. Statistical analysis depicted that irrigation treatment T_3 found best and treatment T_5 least reproductive in terms of both crop growth and yields production of plant. Trickle irrigation applied with 80 per cent of ET_c was found to be the optimum irrigation amount. The maximum shimla mirch yields of 42.64 tonnes/ha was obtained under this treatment.

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