Study of different soil moisture regime on the yield attributes of tomato during *rabi* season in Baster region

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ABSTRACT

Efficient water management is fast becoming more important as multipurpose uses of water are increasing. A field experiment was conducted to study the response of different available soil moisture regime over the yield and growth parameters of tomato crop. Eight treatments of irrigation at seven different available soil moisture level of 70, 60, 50, 40, 30, 20 and 10 per cent along with one treatment of irrigation at different vegetative stages of tomato was tested during *rabi* season in Bastar region of Chhattisgarh state. Results showed that treatment T_2 with irrigation at 60% available soil moisture level gave the best yield with 42.39 t/ha whereas the best WUE was shown by treatment T_1 with 1.87 t/ha-cm. Result also showed that there was a significant reduction in the yield of tomato from treatment T_5 of irrigation at 30% available soil moisture. The stress limit of tomato crop survives the moisture deficiency by 60 per cent and thereafter reasonable reduction can be observed in the yield of the crop. A simple guideline based on the moisture condition was developed for the tribal farmers so that they can analyze their field condition and irrigate the crop when required.

Key words : Available soil moisture, Irrigation, Yield attributes, Tomato response.

INTRODUCTION

Bastar plateau, the tribal enriched zone of chhattisgarh state, encompassing geographical area of 3.906 million hectares, is bounded with the ill practice of mono cropping system. Only 3.60 per cent of the total cropped area is under irrigation. The tribal farmers of region depend entirely on rainfall for farming and practice only paddy cultivation during *kharif* season with no intention to have *rabi* season crop. The average annual rainfall of the region varies between 1200-1400 mm. Blessed with good amount of rain water, the tribal farmer of the region is not utilizing this precious natural resource for the second crop. Under many development activities, the tribal farmers are motivated to take vegetables during *rabi* season with proper utilization of the harvested water. Tomato is one of the mainly grown vegetable crops with 20% share in total vegetable production of the state. Tomato being a good yielding *rabi* crop is also very sensitive to water application (Helyes *et al.*, 1999). Irrigation management based on crop physiological stages has been most practical criterion (Michael and Pandey, 1970). Under and over irrigation, both are undesirable for proper growth of the crop. Every crop takes its nourishment from the available moisture of the soil. Appropriate level of soil moisture is very essential for proper growth and good yield. But due to lack of awareness and knowledge, the tribal farmer cannot judge on their field condition about the appropriate time for water application so as to achieve profitable returns. The present study was carried out to determine the optimal Irrigation schedule for tomato crop during *rabi* season in Bastar region along with to determine the potentially lowest irrigation resistant limit of these crops on water stress.

MATERIALS AND METHODS

The experiment was carried out in two consecutive years at the research farm of Shaheed Gundadhoor College of Agriculture and Research Station, IGKV, Jagdalpur, Bastar, Chhattisgarh, India, during the *rabi* season of 2005-06 and 2006-07. Details of the soil physical properties of the experiment plot are given in Table 1. The experiment consisted of eight treatments of Irrigation at seven different level of 70, 60, 50, 40, 30, 20 and 10 per cent available soil moisture along with one treatment of irrigation at different vegetative growth stages of the crop. The treatments were tested for Swaraksha variety of tomato crop on ridge and furrow method of irrigation in Randomized block design with three replications. The size of the experimental plot taken was 18 m^2 (6x3 m) net and 2550 m^2 (50x51 m) gross along with sufficient spacing for irrigation and drainage channels. Recommended dose of fertilizer was applied in the crop. Daily soil moisture readings were taken by calibrated tensiometers (vacuum gauge and mercury manometer), gypsum blocks and was even validated by digital soil moisture meter. Depth of water application was measured precisely, as only the amount of irrigation water required for replenishing the soil to its field capacity was delivered at a time. Soil moisture contents were measured at 10 and 15 cm depths. As it's always difficult for layman to evaluate the moisture status of the soil, simple indigenous method was identified to know the available soil moisture

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status of the soil which in turn will lead to maximize the yield. Depth of irrigation was calculated by the given empirical formula (Acharya *et al.*, 1989)

D = (FC-WP).SMD.BD.RD.10

where, D = depth of irrigation (mm), FC = Field capacity (%), WP = Wilting point (%), SMD = Soil moisture deficit in fraction, BD = Bulk density (gm/cc), RD = Root zone depth (meter).

RESULTS AND DISCUSSION

The analysis of variance for different treatments showed that there was significant difference among all the treatments. The yield and growth parameter data revealed that the crop receiving irrigation at 60% available soil moisture (ASM) gives the maximum yield with 42.39 t/ha (Table 2). The fruit girth and fruit weight were also found to be best at 60% ASM with 15.70 cm and 65.02 gm, respectively. There was an exception with plant height

Table 1: Soil physical properties of the experimental site

Soil texture	Bulk density (gm/cc)	Basic infiltration rate (cm/hr)	Field capacity (%)	Wilting point (%)
Sandy loam	1.48	2.20	22.10	10.5

which was found to be best at 70% ASM with 66.83 cm. Although the water use efficiency of treatment with 70% ASM showed the best result with 1.87 t/ha-cm but its yield (40.62 t/ha), is less in comparison with yield of treatment with irrigation at 60% ASM, which showed a WUE of 1.74 T/ha-cm. Treatment T_1 receives 8 number of irrigations whereas treatment T_2 receives 7 number of irrigation at an interval of days as shown in Table 3 and the moisture depletion pattern at 60% ASM of the field is shown in Fig. 1. In this experiment the moisture received by rainfall is eliminated as the area receives insignificant

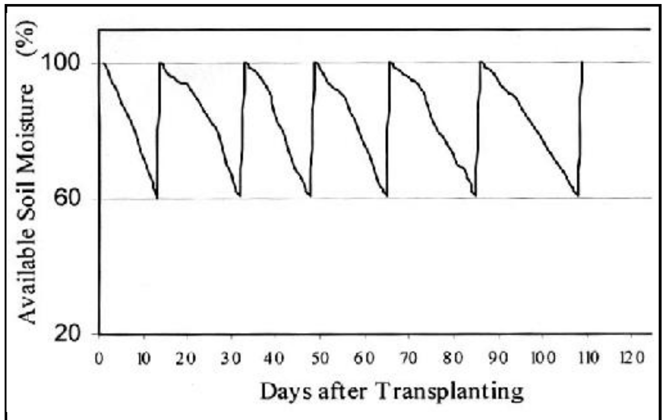

Fig. 1: Moisture depletion pattern at 60% ASM

amount of rainfall during the whole growth period of the crop. The depth of water was estimated to bring the field from its deficit moisture status to its field capacity.

On reviewing the two years cumulative yield and growth parameters data in Table 2, significant reduction in the yield of tomato was visualized after 40 per cent ASM regime. This leads to conclude that if the crop is not irrigated beyond 60% of moisture deficiency then the farmer will have to face strategic loss in respect to the yield. Over irrigation also leads to the reduction of yield even though the WUE of the treatment was higher than that of treatment of irrigation at 60% ASM. If the tomato crop is irrigated more than 7 times then the yield will reduce and face economic losses due to application of more number of irrigation. If the water available is limited then depending on the available amount of irrigation water, the number of irrigation can be reduced with increased interval of days so as to supply irrigation at 50 per cent or 40 per cent ASM. From the experiment, it can be stated that where water is in abundance but resources are low to exploit this water then also appreciable yield can be obtained by irrigating at even 50 per cent or 40 per cent ASM with 6 and 5 numbers of irrigation, respectively.

Table 2: Yield parameters of tomato in response to different soil moisture regime

Treatment	Plant height (cm)	Fruit girth, (cm)	Fruit weight, (gm)	Yield, (tonne/ha)	WUE (T/ha-cm)	No. of irrigation	Total water used (cm)
T_1	66.83	15.14	64.14	40.62	1.87	8	22.5
T_2	63.77	15.70	65.02	42.39	1.74	7	24.8
T_3	57.80	15.19	60.70	38.01	1.54	6	24.6
T_4	51.63	15.17	57.70	33.57	1.34	5	25.0
T_5	49.13	13.74	54.63	26.37	1.13	4	23.4
T_6	45.70	13.57	55.24	21.74	1.10	3	19.8
T_7	41.33	11.58	51.84	16.18	0.85	2	15.0
T_8	49.50	14.30	54.35	26.20	1.09	5	24.0
S.E. $\pm$	1.585	0.413	0.986	1.216	0.051		
C.D. (P=0.05)	4.81	1.251	2.99	3.69	0.155		
CV	5.16	4.997	2.95	6.875	6.65		

Table 3: Recommended irrigation interval for Bastar region

Irrigation	Days After Transplanting	Interval
1st	0	
2nd	13	13
3rd	33	20
4th	48	15
5th	65	17
6th	85	20
7th	108	23

This will help in improving the socio-economic condition of framers of tribal regions like Bastar to adopt vegetable cultivation practices in *rabi* season by adopting simple technique of ridge and furrow method of irrigation along with minimum number of economically acceptable number of irrigations.

The tribal farmers of this region lack knowledge and awareness about the calculation of proper timing for irrigation by just visual interpretation of the field. Therefore, a simple and indigenous hand tool and guideline were experimented for analyzing the status of available soil moisture of the field. The experiment included mixing up of measured quantity of water with 100 gm soil and enhancing the plastic property of the soil. The quantity of water to be mixed in soil is given in Table 4. The soil water mixture is rolled into thin wire by applying pressure in between the palms. The breaking up of this thin wire like roll during the process indicates the good time to irrigate the field. The experiment also indicated that tomato crop is susceptible to disease with increased number of irrigation as the humidity within the micro climate of the field gets increased, which further leads to show loss in the yield.

Table 4 : Determination of moisture deficit in the field

Available soil moisture (%)	Soil moisture deficiency (%)	Soil sample (g)	Water added to soil to show plastic property (ml)
70	30	100	4.25
60	40	100	6.00
50	50	100	9.00
40	60	100	11.25
30	70	100	13.75
20	80	100	16.50
10	90	100	17.00

The study is very helpful in motivating the tribal farmers of Bastar region to grow vegetables in *rabi* season by judiciously utilizing the harvested rainfall water. The results will also play a vital role in managing the stored water by estimating their irrigation capacity and having appreciable yield with fewer inputs.

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