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Effect of modified crop geometry on tomato yield and capital cost of drip irrigation system in arid regions

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Abstract

A field experiment on the modification of crop geometry of tomato *(Lycopersicon esculentum* Mill.) was conducted at Agricultural Research Station, Bikaner during the year 2000-03 to evaluate different planting arrangements in comparison to the recommended crop geometry of tomato i. e. 60 x 45cm with laterals at 90 cm, drippers at 60cm having two plants per dripper costing about Rs. 1,68,000 per ha under drip irrigation system. This high initial capital cost of the system is the main constraint in the large-scale adoption and popularization of drip system in tomato. Therefore, three different planting arrangements viz. 60 x 30, 45 x 45 and 45 x 30cm were studied in addition to recommended one. The results revealed that the laterals at 120 cm, drippers at 90 cm and planting arrangement of 45cm x 45cm having four plants per dripper in paired row yielded maximum (367.63 q/ha) than that of recommended spacing of laterals- 90 cm, drippers- 60 cm and planting arrangement of 60 x 45cm, having two plants per dripper in normal planting i.e. 341.71 q/ha. By using this modified crop geometry, the cost of system was reduced by 27.5 per cent due to saving of 2900 meters of laterals costing about Rs 20300/- and drippers costing about Rs 26029/-, without affecting yield of tomato adversely.

Key words : Tomato, drip irrigation, capital cost, crop geometry

Introduction

Tomato is one of the important vegetable crops, grown in through out India with a total area of 3.4 lakh hectares and 14 t/ha average productivity. The maximum productivity of 25 t/ha is achieved in Himachal Pradesh and Karnataka while Rajasthan has minimum productivity level of 5 t/ha. The area under tomato cultivation is 14560 ha with an annual production of 52963 million tones in Rajasthan (1). Tomato is a rich source of vitamins and minerals. It is consumed as salad, processed food like ketchup, paste, soup and as an ingredient of vegetables.

Tomato plant can thrive well under adverse condition of salinity, which is a common phenomenon in command areas and the areas having brackish ground water. It requires large quantities of water for higher productivity. The response of tomato to irrigation is a function of soil type, season and genetic make up of plant. The increased understanding of the soil- plant relationship has given rise to the concept that the best use of available water resources and optimum plant performance can be realized by prevention of moisture stress. The drip or trickle system of irrigation has countered many of the problems faced by the conventional mode of irrigation and is becoming popular for horticultural crops as it could be the best alternative for efficient use of irrigation water, resulting in increased yield in addition to water saving in terms of labour and energy. However, due to higher capital and installation costs of drip irrigation system for vegetables, the farmers may not adopt this technology readily.

Keeping in view the above facts, a field experiment on the modification of crop geometry of tomato was conducted using different lateral spacing and row to row and plant to plant spacing along with different planting arrangements.

Material and method

The field experiment was conducted at Agricultural Research Station, Bikaner which lies in the hyper arid partially irrigated western plain (zone 1c) of Rajasthan and comes under agro climatic zone M2 (Major

Region) and Sub Region M9E1 as per NBSS and LUP. The average annual rainfall varies from 141mm to 325 mm. The mean daily maximum temperature goes up to 42°C during summers and 23.6°C in winters, with relative humidity less than 4% during summer. The soil is sandy having 92.0% sand, 2.08% silt, less than 0.1 per cent organic carbon and 6.40% clay. The average infiltration rate of the field is determined to be 19.7 cm/hr.

The experiment was carried out on Hybrid Gotiya (S-41) that is one of the popular hybrids of the zone The manures 'and fertilizers were applied as per recommendation for the zone i.e. 20t FYM, 180 kg N, 120 kg P_2O_5 and 80 K_2O per ha. The drip irrigation system consisted of 63mm main and sub main lines, 16mm laterals and 41ph drippers was used for the experimentation. There were four treatments of different lateral and dripper spacing having planting arrangement of 60 x 30, 45 x 45, 45 x 30cm and a recommended one i. e. 60 x 45 cm. The experiment was laid in RBD and replicated four times. The daily irrigation was applied as per plant requirement calculated on the basis of class 'A' pan evaporation data.. The volume of water required was calculated by multiplying the pan evaporation as observed from USWB class - A pan evaporimeter with the crop coefficient at different crop stages, pan coefficient, the plant to plant spacing, the row to row spacing and the per cent wetted area, using following formula.

$V = E_p.K_e.\ K_p.S_p.S_e.W_p.$

where,

- V = Volume of water required (liter/ day/ plant)
- E_p = Pan evaporation as measured by class 'A' pan evaporimeter (mm/ day)
- K_e = Crop coefficient (depends upon the crop/ plant grown stage)
- K_p = Pan coefficient
- S_p = Plant to plant spacing (m)
- S_e = Row to row spacing (m)
- W_p = Wetted area (0.3 for widely spaced crops and 0.9 to 1.0 for closely spaced crops).

The preventive measures were followed as per zonal recommendations i.e. two spray of 0.05 % monocrotophos for the control of pests.

Results and discussion

Effect of modified crop geometry on the yield

The results of the data presented in Table 1 revealed that the crop geometry of 45 x 45cm having four plants per dripper in paired row, with laterals at 120cm and drippers at 90cm distance gave maximum yield i. e. 367.63 qha^{-1}, followed by 60 x 30cm and 45 x 30cm planting distance which gave 340.82 and 324.27qha^{-1}, respectively as compared to the recommended spacing of laterals i.e. at 90cm and drippers at 60cm planting spacing 60 x 45cm in normal planting, having two plants per dripper (341.71 qha^{-1}).

Table 1. Effect of modified crop geometry on the yield of tomato

Lateral spacing (cm)	Dripper spacing (cm)	Plant spacing (cm x cm)	Yield (q/ha)
90	60	60x45	341.71
120	90	60x30	340.82
120	90	45x45	367.63
120	90	45x30	324.27

CV = 5.03% CD at 5% = 11.10

Table 2. Details of drip system under modified crop geometry

A. Recommended crop geometry under drip system	
No. of laterals/ha	112 (90 cm apart)
No. of drippers/lateral	166 (60 cm apart)
No. of drippers/ha	18592
No. of plants/dripper	02
No. of plants/ha	37184
Planting distance	60 cm x 45 cm
B. Modified geometry under drip system	
No. of laterals/ha	83 (120 cm apart)
No. of drippers/lateral	112 (90 cm apart)
No. of drippers/ha	9296
No. of plants/dripper	04 (paired row planting)
No. of plants/ha	37184
Planting distance	45 cm x 45 cm
C. Saving due to modification	
No. of laterals/ha	29 (2900 m, 100 m/lateral)
No. of drippers/lateral	54
No. of drippers/ha	9296
No. of plants/ha	Nil
D. Saving in terms of Rupees	
Lateral cost	20300/- @ Rs. 7/- per meter
Dripper cost	26029/- @ Rs. 2.80 per dripper
Total Cost	46329/- out of Rs. 168660/- i.e. 27.5% of the cost of drip system

Effect of modified crop geometry on the cost of drip system

The length of laterals and number of drippers for modified crop geometry i.e. 45 x 45 cm and recommended crop geometry i. e. 60 x 45cm were worked out as these two are the main components influencing the cost of the system, and are presented in Table 2. The data revealed that the cost of drip system may be reduced due to saving of 2900 meters of laterals costing about Rs 20300/- and 9296 drippers costing about Rs 26029/- per ha if the modified crop geometry of 45 x 45cm is adopted instead of 60 x 45 cm, resulting in 27.5 % saving of the cost of drip system.

Similar type of studies have also been reported at IARI New Delhi (2), PDC Raipur (3) on tomato and IIT Khargpur (4) on okra. They concluded that modification in the crop geometry might be helpful in minimizing the cost of drip system. Though the recommendations made by earlier workers was for different climatic zones than that of arid and semi arid partially irrigated zone of Rajasthan, hence, there was need to have some specific recommendation for this zone of Rajasthan also.

Based on the results obtained it is concluded that the higher yield may be obtained by adopting 45 x 45cm crop geometry, having four plants per dripper in paired row, with lateral spacing of 120cm and dripper spacing at 90cm, respectively, along with 27.50 per cent saving in the capital cost of drip system in the arid and semi arid regions of Rajasthan.

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