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Effect of quality of irrigation water and levels of N-fertigation on nitrogen use efficiency and water use efficiency of drip irrigated tomato

■ **NARENDER KUMAR, AMANDEEP SINGH, SANJAY KUMAR AND ARVIND**

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See end of the Paper for authors' affiliation

Correspondence to :

NARENDER KUMAR
Department of Soil Water Engineering, College of Agricultural Engineering and Technology, C.C.S. Haryana Agricultural University, HISAR (HARYANA) INDIA
Email : narender14300@gmail.com

■ **ABSTRACT :** Proper management of irrigation water and fertilizers is important for crop production. Drip irrigation method is known to have better water use as well as fertilizer use efficiency as compared to other methods of irrigation, particularly if poor quality water is to be used. This study was conducted to examine the effect of quality of irrigation water and level of fertigation on nitrogen use efficiency (NUE) and water use efficiency (WUE) on drip irrigated tomato crop. Experiments were conducted in micro plots (2 m x 2 m size) at Research farm of CCS Haryana Agricultural University, Hisar, Haryana (India). Irrigation for good quality (EC $\leq$ 0.5 dS m^{-1}) and marginal quality (EC = 2.5 dS m^{-1}) water was scheduled on alternate day with combination of three fertigation levels (N_1: 75 kg N/ha, N_2: 100 kg N/ha and N_3: 125 kg N/ha). The volume of irrigation water applied per plant during an irrigation event was calculated based on crop spacing, pan evaporation, crop co-efficient and per cent shaded area. A total of 948.4 litre of water was applied to each micro plot during the entire crop period.FYM @ 8 kg per plot, 1/3rd of nitrogen, 100% of P and K was applied before transplanting the tomato. Remaining dose of nitrogen was equally split in 11 doses at weekly interval. Maximum tomato yield (61.53 t/ha) and water use efficiency (26.0 kg /m^3) was obtained with good quality irrigation treatment receiving N-fertigation at the rate of 125 % of RDN. Maximum nitrogen use efficiency (594.9 kg /kg) was obtained with good quality irrigation treatment receiving N-fertigation at RDN. Minimum tomato yield (34.68 t/ha) and water use efficiency (14.3 kg/m^3) was obtained with marginal quality irrigation treatment receiving N-fertigation at the rate of 75 % of RDN. Maximum nitrogen use efficiency (594.9 kg/kg) was obtained with good quality irrigation treatment receiving N-fertigation at RDN. Minimum nitrogen use efficiency (404.3 kg/kg) was obtained with marginal quality irrigation treatment receiving N-fertigation at 125 % of RDN.

■ **KEY WORDS :** Drip irrigation, Tomato, Nitrogen use efficiency, Water use efficiency

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In the current water crisis situation, sufficiently available fresh water recourses are becoming the binding constraint for food production. Therefore, it is imperative to use marginal quality water for irrigation. However, it is important to know that development of excess soil salinity in the root zone, as result of use of

saline water, may also inhibit normal crop growth and development (Kelley, 1951). Use of saline water without drip irrigation decreases fruit yield by reducing both fruit weight and number (Malash *et al.*, 2008). Reduce the yield means reducing the water use efficiency and nitrogen use efficiency. Drip irrigation is also considered a suitable option to utilize marginal quality water for crop production due to movement of salt away from effective root zone. Irrigation with poor quality groundwater, if feasible, can reduce the demand of fresh water for irrigation. Drip irrigation is a new technique for irrigation, is being used for growing vegetable crops in poor quality water. Among different method of water application, drip/ micro irrigation is considered as one the most efficient method of water application under suitable conditions. As a result, drip irrigation is being promoted as a solution to the problems of irrigation water scarcity, irrigation water quality and fertilizer use efficiency. WUE in drip irrigation is high as compared to surface irrigation. It can further modify use mulching (Subba Reddy *et al.*, 2015). Fertigation gave the batter result as compared to soil application of water. It gave the higher yield with same amount of fertilizer with drip irrigation (fertigation) than soil application of fertilizer (Shedeed *et al.*, 2009). WUE was more in fresh water and less in marginally quality water and plant height and girth was more in fresh water than marginally quality water (Soomro *et al.*, 2012).

WUE was more sensitive to irrigation than to fertilization. NUE decreased with increasing Nitrogen levels but NUE increased with increase the amount of water applied. Increasing both water and N levels increased the foliar net photosynthetic rate (Ya-dan *et al.*, 2017).

METHODOLOGY

A field experiment was carried out in micro plots (2 m x 2 m) at Soil Science Research Farm of CCS HAU, Hisar during February, 2015 to May, 2015. Irrigation was applied on alternate days with two water quality treatment (*i.e.* good water (EC=0.4 dS/m) and marginal quality water (EC= 2.5 dS/m). Under each water quality treatment, three nitrogen fertigation levels (*i.e.* 75%, 100% and 125% of recommended dose of nitrogen) were imposed. During crop establishment for initial one month irrigation was applied with good quality water, thereafter the water quality treatment were imposed. A summary of different treatments is given in Table A.

Table A : Different treatment of nitrogen fertigation of tomato on utilizing good and .marginally quality water through drip irrigation system

Sr. No.	Treatments	Abbreviation
1.	Good quality water with 75% of RDN	GN_1
2.	Good quality water with 100% of RDN	GN_2
3.	Good quality water with 125% of RDN	GN_3
4.	Marginal quality water with 75% of RDN	MN_1
5.	Marginal quality water with 100% of RDN	MN_2
6.	Marginal quality water with 125% of RDN	MN_3

RDN- Recommended dose of nitrogen.

Recommended dose of nitrogen was 100 kg/ha (Anonymous, 2013).FYM @ 8 kg per plot, 100% of P and K were applied before transplanting the tomato. Basal dose of nitrogen was applied with 1/3rd amount of nitrogen. After one month of transplanting, remaining dose of nitrogen was equally split in 11 doses of per week interval. Drip discharge was also measured to work out the uniformity co-efficient. After transplanting the plants in micro plots, irrigation was imposed alternate day based on the previous two day pan evaporation, crop co-efficient, plant spacing and area shaded by crop. Value of crop co-efficient used for tomato given in Table B.

Table B : Crop co-efficient (Kc) for tomato (Doorenbos and Pruitt, 1977)

Sr. No.	Growth stages	Crop period	Crop co-efficient
1.	Initial stage	10 Feb. to 4 March	0.45
2.	Development stage	5 March to 7 April	0.75
3.	Mid season stage	8 April to 11 May	1.00
4.	Late season stage	12 May to 21 May	0.60

Water use efficiency (WUE) represents the relation between yield and irrigation water. WUE of different treatment was calculated in term of fruit yield per hectare to the amount of water used. Nitrogen use efficiency (NUE) represents the relation between yield and amount of nitrogen applied. NUE of different treatment was calculated in term of fruit yield per hectare to the amount of nitrogen applied.

RESULTS AND DISCUSSION

Tomatoes were picked and weighed from each plots during different picking. In good quality water irrigation treatment, highest crop yield (61.53 t/ha) was obtained in GN_3 treatment and lowest yield (43.25 t/ha) was found

in GN_1 treatment (Table 1). In marginal quality water (2.5 dS/m) irrigation treatment, highest crop yield (50.54 t/ha) was obtained in MN_3 treatment and lowest yield (34.68 t/ha) was obtained in MN_1 treatment.

Table 1 : Yield of tomato in different treatments

Treatments	Yield(t/ha)	Treatments	Yield(t/ha)
GN_1	43.25	MN_1	34.68
GN_2	59.49	MN_2	50.18
GN_3	61.53	MN_3	50.54
C.D. (P= 0.05)	2.7		2.7

Water use efficiency (WUE) and nitrogen use efficiency (NUE) is given in Fig. 1 and 2, respectively. Maximum WUE (26.0 kg/m^3) was observed in GN_3 treatment and minimum WUE (14.3 kg/m^3) was observed in MN_1 treatment. On the other hand, maximum NUE (594.9 kg/kg) was obtained in GN_2 and minimum NUE (404.3 kg/kg) was obtained in MN_3 treatment.

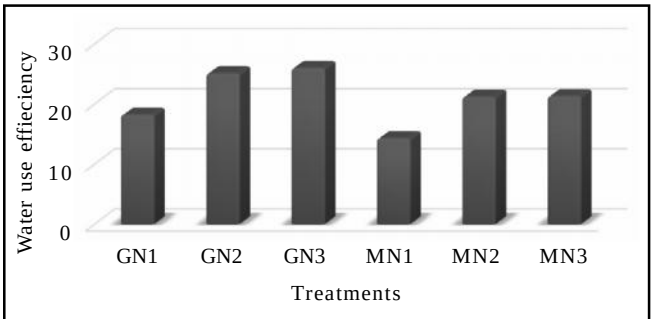

Fig. 1 : Water use efficiency of different irrigation and nitrogen levels treatments

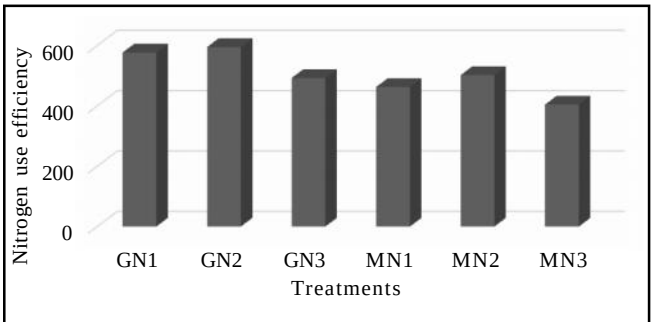

Fig. 2 : Nitrogen efficiency of different irrigation and nitrogen levels treatments

Similar amount of water was used in different treatments. Therefore, water use efficiency (WUE) is in direct proportion to the yield obtained under different treatments. Significant improvement in WUE was observed when N- fertigation level increased from 75 to 100 % of RDN. WUE increased by 37.5 and 48.3 %, when N- fertigation level increased from 75 to 100 % of RDN for irrigation with good and marginal quality water, respectively. Therefore, efficient water application method coupled with proper nutrient supply is essential to realize a higher level of WUE. At a given level of N-fertigation, WUE was higher for irrigation with good quality water as compared to irrigation with marginal quality water. Wang and Xing (2016) observed that increased irrigation level increased the fruit yield of tomatoes and decreased the WUE. The fruit yield and WUE increased with the increased fertilizer rate. Sharma *et al.* (2013) observed that as salinity increases from good quality (0.5 dS/m) to saline (3.0 dS/m) cabbage yield increases, which is proportional to WUE. Hence WUE increases after increases the salinity of water. Similar result as Sharma *et al.* (2013) observed Kumar *et al.* (2016) in okra crop. Mahajan and Singh (2006) observed the WUE with different strategies and fertigation level on tomato. At 100 % evaporation with 125 % of recommended dose of nitrogen gave batter WUE as compare to 100 % and 150 % of recommended dose of nitrogen. Similar to WUE, at a given level of N-fertigation, nitrogen use efficiency (NUE) was higher for irrigation with good quality water as compared to irrigation with marginal quality water. NUE increased when N-fertigation level increased from 75 to 100 % of RDN and thereafter it decreased as N-fertigation level increased from 100 to 125 % of RDN. Therefore, maximum NUE, for both good and marginal quality water was obtained at N-fertigation level corresponding to RDN. Badr *et al.* (2011) observed that after increasing N fertilizer from 200 kg/ha to 300 kg/ha in drip irrigated potato NUE decreases. WUE increased by 37.9 and 48.3 %, when N- fertigation level increased from 75 to 100 % of RDN for irrigation with good and marginal quality water, respectively. From 100 % to 125 %, 3.5 % increase in good quality water but in marginal quality water WUE decreases 0.5 %. Therefore, efficient water application method coupled with proper nutrient supply is essential to realize a higher level of WUE. WUE CD=2.7 at 5% significant level, in both qualities of water WUE was significantly increased from 75 % to 100 % RDN but from 100 % to 125 % RDN was not significant increase in both good and marginal quality water. NUE

increases 3.1 % and 8.1 % from 75 % to 100 % RDN in good and marginal quality water, respectively. NUE, CD=81.8 at 5% significant level, there is no significant difference in NUE from 75 % to 100 % RDN in both good and marginal quality water. From 100 % to 125 % RDN, NUE is significant decrease in both good and marginal quality water.

Conclusion :

Higher tomato yield was obtained under good quality water irrigation treatment as compared to the marginal quality water irrigation treatment. Maximum (61.53 t/ha) yield was obtained under good quality water irrigation with N-fertigation of 125 kg/ha. Minimum 34.68 t/ha yield was obtained under marginal quality water irrigation with N-fertigation of 75 kg/ha. The WUE and NUE was higher for irrigation with good quality water as compared to irrigation with marginal quality water. Significant improvement in WUE and NUE was observed when N-fertigation level increased from 75 kg/ha to 100 kg/ha. Increased N-fertigation level supply beyond 100 kg N/ha did not significantly improved the tomato yield and WUE but reduced the efficiency of NUE.

Authors' affiliations:
AMANDEEP SINGH AND SANJAY KUMAR, Department of Soil Water Engineering, College of Agricultural Engineering and Technology, C.C.S. Haryana Agricultural University, HISAR (HARYANA) INDIA
Email : singhamandeepmt@gmail.com; sanjay7228@yahoo.com
ARVIND, Haryana Space Application Centre, C.C.S. Haryana Agricultural University, HISAR (HARYANA) INDIA
Email : arvinddhaloiya@gmail.com

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