Himachal Journal of Agricultural Research 42(1): 12-16(2016)

Studies on effect of irrigation interval and fertigation frequency on crop growth, water use and productivity of summer brinjal

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Received: 2 May 2016; Accepted: 6 June 2016

Abstract

A field experiment was conducted for three consecutive summers (2013-15) to evaluate the effect of three drip irrigation intervals viz. one (Every alternate day irrigation), two (Every third day irrigation) and three days(Every 4th day irrigation) and three fertigation frequencies viz. once a week (Every 7th day with entire fertilizer dose in 13 equal splits), twice a week (Every 3th day fertigation with entire dose in 20 equal splits) and twice a month (Every 15th day with entire dose in 6 equal splits) along with a control arranged in factorial randomized block design with three replications. Results revealed that crop grown with 75 per cent of recommended NPK fertigation under gravity fed drip irrigation gave comparable brinjal yield and gross returns to crop grown with recommended package of practices i.e. fertilization with recommended NPK and surface irrigation of 5 cm at 7 day interval. B: C ratio was significantly lower in former case mainly due to higher cost of soluble fertilizers. Increase in irrigation interval did not have any significant effect on brinjal yield, gross returns, net returns and B: C ratio. Irrigation interval of two days resulted in significantly higher WUE than irrigation interval of either one day (8.68 %) or three day (4.28 %).Fertigation frequency of twice a month resulted in significantly higher brinjal yield (16.86 %) and water use efficiency (19.28 %) than fertigation frequencies of once a week and twice a week, respectively.

Key words: Irrigation interval, fertigation frequency, water use efficiency.

Increasing population demands more and more production of agricultural commodities including vegetables. Despite substantial increase in vegetable production from 12.06 lakh tones in 2009-10 to 12.69 lakh tones (Anonymous 2012) due to increase in irrigated area, the productivity of irrigated area has not reached the desired level. In vegetables production water and nutrients are two most critical and costly inputs and are interrelated in their effects on plant growth and yield. Their efficient management is most important for improving productivity (Nadiya *et al*., 2013). Every effort must be made to enhance water and fertilizer use efficiency by reducing their wastage. Drip irrigation is a modern irrigation method which not only saves water but also improve fertilizer use efficiency by allowing water to drip slowly on the surface of soil near to the plant roots or directly to the root zone, through a network of valves, pipes, tubing and emitters. This system recharges the root-zone and maintains the uniformity of seed-zone moisture throughout the planting area for a longer period as compared to conventional method of irrigation. It is eco-friendly irrigation system which not only saving precious irrigation water but also increases productivity to the tune of 30-40% over traditional methods of irrigation. The water saving is because maximum amount of water is stored in the root zone and deep percolation losses are minimized (Bhogi *et al*., 2011).

Fertigation refers to the application of dissolved fertilizer to crop through an irrigationsystem. Application of small amounts of soluble fertilizer through irrigation saves labour, reduces compaction of the field, thereby; enhance productivity (Jat *et al*., 2011). Drip irrigation along with fertigation reduces the wastage of water and chemical fertilizers and subsequently optimizes the water and nutrient use by making them available at the point of their use and as per crop demand, which finally increase water and nutrient use efficiency.

In India, Brinjal is grown in an area of about 0.72 million hectares with annual production of 13.88 million tonnes (FAO 2014). In Himachal Pradesh, it is grown in an area of 1030 hectares in low and mid hills with an annual production of 23520 tonnes (Anonymous, 2014). It is an important cash

crop of low and mid hills of the state and is mainly grown in Hamirpur, Una, Bilaspur, Kangra, Chamba, Mandi and Sirmour districts of Himachal Pradesh. There is no systematic study on micro-irrigation of summer brinjal.

Keeping these points in mind present investigation on the 'Effect of irrigation interval and fertigation frequencies on crop growth, water use and productivity of drip irrigated summer brinjal' was undertaken to standardize the time of irrigation and fertigation.

Materials and Methods

A field experiment was initiated at Water Management Farm, CSK HPKV, Palampur during *summer season of* 2013-14 and carried out for three consecutive summer seasons to standardize the time of irrigation and fertigation in drip irrigated brinjal crop (*Solanum melongena*). The experimental area is located at an elevation of 1290 m above mean sea level with 32°06´ 39.1" N latitude and 76°32´ 10.5" E longitude in Kangra district of Himachal Pradesh. The soil of the experimental field was silty clay loam in texture; acidic in reaction (pH 5.1). Nine treatment combinations consisting of three drip irrigation intervals viz. one (Every alternate day irrigation), two (Every third day irrigation) and three days (Every 4th day irrigation)and three fertigation frequencies viz. once a week (Every 7th day with entire fertilizer dose in 13 equal splits), twice a week (Every 3th day fertigation with entire dose in 20 equal splits)) and twice a month (Every 15th day with entire dose in 6 equal splits) along with a control were arranged in factorial randomized block design with three replications. The control consisted of application of recommended fertilizers (N:P:K::100 :60:50) and FYM as per package of practices for vegetables along with surface irrigation of 5 cm water depth at 7 day interval. FYM was applied to all the plots @10 Mg ha^{-1}. Except control all the plot were fertigated with 75 per cent of the recommended NPK (75: 45: 37.5) and irrigated with 0.8 CPE.

The irrigation was applied through gravity fed drip irrigation system consists of four laterals spaced at 45 cm with eight emitters per lateral spaced at 60 cm. The average discharge rate of each emitter is 2.5 l hr^{-1}. Mean evaporation rate of preceding 10 cropping seasons was calculated for estimation of irrigation requirement. Irrigation requirement was calculated by taking into account the difference of average evaporation of preceding 10 cropping seasons and rainfall (only positive values) and multiplying the cumulative average evaporation minus actual rainfall value with CPE ratios (0.8). Fertigation was given through fertigation tank using urea, soluble fertilizers 12:61:0 and 0:0:50 .

H-8 cultivar of brinjal was planted on raised bed in April at 45 cm x 60 cm spacing in 4.80 m x 1.8 m (8.64 m^2) plots. The treatments were applied after establishment period of ten days during which seedlings were irrigated every day. The productivity, irrigation water used and economics were recorded every year. Water use efficiency (Mg m^{-3}) was calculated by dividing the brinjal yield (Mg ha^{-1}) with irrigation water used (m^{-3}). Economics was calculated on the basis of prevailing market prices.

Results and Discussion

Control vs treatments

Brinjal crop grown with 75 per cent of recommended NPK fertigation under gravity fed drip irrigation had no effect on brinjal yield and gross returns than crop grown with recommended package of practices i.e. fertilization with recommended NPK and surface irrigation of 5 cm at 7 day interval. It might be due to improvement in nutrient use efficiency in response of better soil moisture regime. During 2013, brinjal crop grown with 75 per cent of recommended NPK fertigation under gravity fed drip irrigation had no effect on net returns than crop grown with recommended package of practices. However, during 2014, 2015 and on mean basis crop grown with 75 per cent of recommended NPK fertigation under gravity fed drip irrigation resulted in significantly lower (23.62, 21.68 and 15.69 %) net returns than crop grown with recommended package of practices. However, during all years and on mean basis, B: C ratio was significantly lower (34.76 41.71, 32.35 and 29.22 %) in brinjal grown with 75 per cent of recommended NPK fertigation than recommended practices mainly due to higher cost of soluble fertilizers (Table 1 and 2).

Further, during all years and on mean basis, the brinjal crop grown with 75 per cent of recommended NPK fertigation under gravity fed drip irrigation resulted in significantly higher water use efficiency (1.5, 2.0,1.9 and 1.8 times) due to lower irrigation water use (33.14, 52.33, 52.00 and 47.96 %) than recommended practices. Saroch *et al.* (2015) also reported saving of irrigation water (about 40 %) and increase in WUE in garden pea irrigated and fertigated with micro-sprinklers as compared to recommended practices of surface irrigation and

Table 1. Effect of different treatments on productivity and water use of brinjal

Treatment	Brinjal yield (Mg ha^{-1})				IWU (m^3 ha^{-1})				WUE (Mg m^{-3})			
	2013	2014	2015	Mean	2013	2014	2015	Mean	2013	2014	2015	Mean
Control vs treatments												
Rec. Practices	12.55	11.10	10.97	11.54	3.50(7)	6.00(6)	6.00(12)	5.17(8)	3.59	1.85	1.83	2.23
Treatments	12.90	10.62	10.37	11.30	2.34(25)	2.86(30)	2.88(32)	2.69(29)	5.53	3.72	3.60	4.20
CD (P = 0.05)	NS	NS	NS	NS					0.67	0.25	0.24	0.22
Irrigation interval (days)												
One	13.04	10.39	9.78	11.07	2.43(31)	2.86(30)	2.97(31)	2.75(36)	5.37	3.65	3.29	4.03
Two	13.38	10.82	10.33	11.51	2.28(26)	2.93(35)	2.82(39)	2.63(28)	5.87	3.87	3.67	4.38
Three	12.27	10.66	11.0	11.31	2.30(18)	2.80(26)	2.85(27)	2.70(23)	5.34	3.63	3.86	4.20
CD (P = 0.05)	NS	NS	0.57	NS					NS	0.19	0.19	0.17
Fertigation frequency												
Once a week	12.22	10.12	8.99	10.44	2.35(26)	2.86(30)	2.86(40)	2.69(29)	5.21	3.54	3.15	3.89
Twice a week	12.61	10.42	10.72	11.25	2.38(28)	2.93(35)	2.97(31)	2.76(34)	5.29	3.56	3.61	4.07
Twice a month	13.87	11.33	11.39	12.20	2.28(24)	2.80(26)	2.81(26)	2.63(24)	6.09	4.05	4.06	4.64
CD (P = 0.05)	1.22	0.56	0.57	0.46					0.52	0.19	0.19	0.17

* Value in the parenthesis indicate number of irrigations

Table 2. Effect of different treatments on economics of brinjal

Treatment	Gross returns (Rs. ha^{-1})				Net returns (Rs. ha^{-1})				B:C ratio			
	2013	2014	2015	Mean	2013	2014	2015	Mean	2013	2014	2015	Mean
Control vs treatments												
Rec. Practices	1,88,250	1,66,500	1,64,500	1,73,083	1,31,736	1,08,553	94,880	1,04,823	2.33	1.87	1.36	1.54
Treatments	1,93,461	1,59,333	1,55,528	1,69,441	1,16,842	82,913	74,309	88,373	1.52	1.09	0.92	1.09
CD (P = 0.05)	NS	NS	NS	NS	NS	10,780	11,069	8,937	0.31	0.14	0.14	0.11
Irrigation interval (days)												
One	1,95,617	1,55,833	1,46,633	1,66,028	1,18,781	79,159	65,079	84,672	1.55	1.03	0.80	1.04
Two	2,00,767	1,62,250	1,54,917	1,72,644	1,24,118	85,901	73,759	91,614	1.62	1.13	0.91	1.13
Three	1,84,000	1,59,917	1,65033	1,69650	1,07,627	83,680	84,088	88,833	1.41	1.10	1.04	1.10
CD (P = 0.05)	NS	NS	8,574	NS	NS	NS	8,574	NS	NS	NS	0.11	NS
Fertigation frequency												
Once a week	1,83,267	1,51,833	1,34,917	1,56,672	1,06,618	75,421	53,759	75,614	1.39	0.99	0.66	0.93
Twice a week	1,89,117	1,56,250	1,60,783	1,68717	1,12,368	79,651	79,272	87,446	1.46	1.04	0.97	1.08
Twice a month	2,08,000	1,69,917	1,70,883	1,82,933	1,31,539	93,667	89,896	1,02,059	1.72	1.23	1.11	1.26
CD (P = 0.05)	18246	8,350	8,574	6,922	18,246	8,350	8,574	6,922	0.24	0.11	0.11	0.09

fertilization. Kapur *et al*. (2014) also concluded that drip based irrigation scheduling resulted in higher water use efficiency (44.94 to 54.34 %) and saving in irrigation water (35.85 to 50 %) in comparison to conventional method of irrigation.

Irrigation interval (days)

During first two years and on mean basis, increase in irrigation interval did not have any significant effect on brinjal yield, gross returns, net returns and B: C ratio. However, during 2015, irrigation interval had significant effect on all these parameters. Irrigation interval of three day had significantly higher brinjal yield than irrigation interval of two (6.09 %) and one day (12.47 %). The respective percentages for gross returns, net returns and B:C ratio were, 6.52 & 12.54, 14.00 & 29.21 and 14.28 & 30.0, respectively. Increase in irrigation interval did not have any significant effect on water use efficiency during 2013. However, during 2014 and on mean basis, irrigation interval of two days resulted in significantly higher WUE than irrigation interval of either one day (6.02 & 8.68 %) or three day (6.61 & 4.28 %). During 2015, irrigation interval of three day had significantly higher water use efficiency than irrigation interval of two (5.17 %) and one day (17.32 %).

Fertigation frequency

Frequency of fertigation had significant effect on all these parameters. During all the years and on mean basis, twice a month fertigation resulted in significantly higher brinjal yield than fertigation at frequencies of once a week (13.50, 11.96, 26.70 & 16.86 %) and twice a week (9.99, 8.73, 6.25 & 8.44 %), respectively (Table 1). Fertigation ensures availability of fertilizer nutrients in the root zone in readily available form and therefore, minimize fertilizer application rate and increases fertilizer use efficiency. During all the years and on mean basis, twice a month fertigation resulted in significantly higher water use efficiency than fertigation at frequencies of once a week (16.89, 14.41, 28.89 &19.28 %) and twice a week (15.12, 13.76, 12.46 & 14.00 %), respectively. It was mainly due to lower water use by twice a month fertigation than once a week (2.98, 2.10, 1.75 & 2.23 %) or twice a week fertigation (4.20, 4.44, 5.39 & 4.71 %).

During all the years and on mean basis, twice a month fertigation resulted in significantly higher gross returns than fertigation at frequencies of once a week (13.50, 11.91, 26.66 & 16.76 %) and twice a week (9.98, 8.75, 6.28 & 8.43 %), respectively. Likewise, net returns were also significantly higher during all the years and on mean basis, when crops were fertigated at the frequency of twice a month than at the frequency of once (23.37, 24.19, 67.22 & 34.97 %) or twice (17.06, 17.60, 13.40 & 16.71 %) a week (Table 2). Sandal and Kapoor (2015) also observed that fertigation leads to saving of fertilizer by 25-40%, increased returns and reduced leaching of the nutrients.

During all the years and on mean basis, twice a month fertigation resulted in significantly higher B: C ratio than fertigation at frequencies of once a week (23.74, 24.24, 68.18 & 35.48 %) and twice a week (17.81, 18.27, 14.43 & 16.67 %).

Conclusion

For saving irrigation water (47.96 %) and increasing WUE (88.34 %), surface irrigation and fertilization with 100 per cent of recommended NPK of brinjal crop should be replaced with drip irrigation and fertigation with 75 percent of recommended NPK. It is better to drip irrigate the crop every third day to save irrigation water. For maximizing production, water use efficiency and economics gravity fed drip irrigated brinjal crop should be fertigated twice a month with 75 per cent of the recommended NPK.

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