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

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Abstract

A field experiment was conducted for three consecutive summers (2013-15) to evaluate the effect of three drip irrigation intervals viz. every alternate day irrigation, every third day irrigation and 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 3rd 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 at Palampur on a silty clay loam soil. Results revealed that crop grown with 75% of recommended NPK fertigation under gravity fed drip irrigation comparable brinjal fruit yield and gross returns than the 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 the former treatment 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 tonnes in 2009-10 to 12.69 lakh tonnes in 2010-11 (Anonymous 2012) due to increase in irrigated area, the productivity 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 only saves precious irrigation water but also increases productivity to the tune of 30-40% over traditional methods of irrigation. In this system the 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 irrigation system. Application of small amounts of soluble fertilizer through irrigation saves labours reduces compaction of the field, thereby, enhances 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 was undertaken to standardize the time of irrigation and fertigation.

Material 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 3rd 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 consisting 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 during April at 45 cm x 60 cm spacing in 4.80 m x 1.8 m (8.64 m²) plots. The treatments were applied after establishment period of ten days during which seedlings were irrigated every day. The productivity and irrigation water used were recorded every year. Water use efficiency (kg l⁻¹) was calculated by dividing the brinjal yield (Mg ha⁻¹) with irrigation water used (m³). Economics was calculated on the basis of prevailing market prices.

Results and Discussion

Control vs treatments

Brinjal crop grown with 75% recommended NPK fertigation under gravity fed drip irrigation had comparable brinjal fruit yield and gross returns as under the crop grown with recommended package of practices i.e. fertilization with recommended NPK and surface irrigation of 5 cm at 7 day interval during all the years as well as on mean basis (Table 1&2). It might be due to improvement in nutrient use efficiency in response of better soil moisture regime. During 2013, brinjal crop grown with 75% recommended NPK fertigation under gravity fed drip irrigation had also comparable net returns as from the crop grown with recommended package of practices. However, during 2014, 2015 and on mean basis crop grown with 75% 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% of recommended NPK fertigation than recommended practices mainly due to higher cost of soluble fertilizers.

Further, the brinjal crop grown with 75% 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 during all years and on mean basis. 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 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
### Table 1. Effect of different treatments on productivity and water use of brinjal

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Brinjal fruit yield (Mg ha⁻¹)</th>
<th>IWU (m³ ha⁻¹)</th>
<th>WUE (Mg m⁻³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control vs treatments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rec. Practices</td>
<td>12.55</td>
<td>11.10</td>
<td>10.97</td>
</tr>
<tr>
<td>Treatments</td>
<td>12.90</td>
<td>10.62</td>
<td>10.37</td>
</tr>
<tr>
<td>LSD (P = 0.05)</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Irrigation interval (days)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One</td>
<td>13.04</td>
<td>10.39</td>
<td>9.78</td>
</tr>
<tr>
<td>Two</td>
<td>13.38</td>
<td>10.82</td>
<td>10.33</td>
</tr>
<tr>
<td>Three</td>
<td>12.27</td>
<td>10.66</td>
<td>11.0</td>
</tr>
<tr>
<td>LSD (P = 0.05)</td>
<td>NS</td>
<td>NS</td>
<td>0.57</td>
</tr>
<tr>
<td>Fertigation frequency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Once a week</td>
<td>12.22</td>
<td>10.12</td>
<td>8.99</td>
</tr>
<tr>
<td>Twice a week</td>
<td>12.61</td>
<td>10.42</td>
<td>10.72</td>
</tr>
<tr>
<td>Twice a month</td>
<td>13.87</td>
<td>11.33</td>
<td>11.39</td>
</tr>
<tr>
<td>LSD (P = 0.05)</td>
<td>1.22</td>
<td>0.56</td>
<td>0.57</td>
</tr>
</tbody>
</table>

* Value in the parenthesis indicate number of irrigations
<table>
<thead>
<tr>
<th>Treatment</th>
<th>Gross returns (INR ha(^{-1}))</th>
<th>Net returns (INR ha(^{-1}))</th>
<th>B:C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control vs treatments</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Rec. Practices</td>
<td>1,88,250</td>
<td>1,66,500</td>
<td>1,64,500</td>
</tr>
<tr>
<td>Treatments</td>
<td>1,93,461</td>
<td>1,59,333</td>
<td>1,55,528</td>
</tr>
<tr>
<td>LSD (P = 0.05)</td>
<td>NS</td>
<td>NS</td>
<td>NS</td>
</tr>
<tr>
<td>Irrigation interval (days)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>One</td>
<td>1,95,617</td>
<td>1,55,833</td>
<td>1,46,633</td>
</tr>
<tr>
<td>Two</td>
<td>2,00,767</td>
<td>1,62,250</td>
<td>1,54,917</td>
</tr>
<tr>
<td>Three</td>
<td>1,84,000</td>
<td>1,59,917</td>
<td>1,65033</td>
</tr>
<tr>
<td>LSD (P = 0.05)</td>
<td>NS</td>
<td>NS</td>
<td>8,574</td>
</tr>
<tr>
<td>Fertigation frequency</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Once a week</td>
<td>1,83,267</td>
<td>1,51,833</td>
<td>1,34,917</td>
</tr>
<tr>
<td>Twice a week</td>
<td>1,89,117</td>
<td>1,56,250</td>
<td>1,60,783</td>
</tr>
<tr>
<td>Twice a month</td>
<td>2,08,000</td>
<td>1,69,917</td>
<td>1,70,883</td>
</tr>
<tr>
<td>LSD (P = 0.05)</td>
<td>18246</td>
<td>8,350</td>
<td>8,574</td>
</tr>
</tbody>
</table>
to 50%) in comparison to conventional method of irriga-

tion.

**Irrigation interval (days)**

Increase in irrigation interval did not have any sig-

nificant effect on brinjal yield, gross returns, net returns

and B: C ratio during first two years and on mean basis.

However, during 2015, irrigation interval had signifi-

cant effect on all these parameters. Irrigation interval of

days had significant higher brinjal fruit yield than

irrigation interval of two (6.09%) and one day

(12.47%). The respective percent increase for gross re-

turns, net returns and B:C ratio was 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 in-

terval of either one day (6.02 & 8.68%) or three day

(6.61 & 4.28%). During 2015, irrigation interval of

two days 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

the yield of brinjal. Fertigation twice a month resulted in

significantly higher brinjal yield than fertigation at fre-

quencies of once a week (13.50, 11.96, 26.70 & 16.86%

during 2013, 2014, 2015 and on mean basis, respec-


tively) and twice a week (9.99, 8.73, 6.25 & 8.44%)

(Table 1). Fertigation ensures availability of fertilizer

nutrients in the root zone in readily available form and

therefore, minimize fertilizer application rate and in-

creases fertilizer use efficiency. During all the years and

on mean basis, fertigation twice a month resulted in

significantly higher water use efficiency than fertigation

at frequencies of once a week (16.89, 14.41, 28.89 &

19.28 % during 2013, 2014, 2015 and on mean basis,

respectively) and twice a week (15.12, 13.76, 12.46 &

14.00 %). It was due to lower water use by fertigation

twice a month than once (2.98, 2.10, 1.75 & 2.23%) or

twice a week fertigation (4.20, 4.44, 5.39 & 4.71%).

Fertigation twice a month 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%). Likewise, net re-

turns 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. Owing to higher yield

and returns, fertigation twice a month resulted in signifi-


cantly 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%).

The findings of the present investigation conclu-

sively inferred that for saving irrigation water (47.96%)

and increasing WUE (88.34%), surface irrigation and

fertilization with 100% recommended NPK of brinjal

crop should be replaced with drip irrigation and ferti-

gation with 75% 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% recommended

NPK.

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