Studies on Crop Geometry, Irrigation and Fertigation in Brinjal under Drip System of Irrigation

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KEYWORDS
Crop geometry, drip irrigation, fertigation, brinjal, water use efficiency

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ABSTRACT

Three experiments were conducted to find out suitable crop geometry under drip irrigation, optimum irrigation schedule and optimum fertigation schedule for brinjal on sandy loam soil at Agricultural Research Station, Sriganganagar during Rabi 2009-10 to 2011-12. Brinjal (hybrid "Nishant") was taken as test crop. Drip lines having in line drippers at 30 cm distance with water discharge of 2 LPH were used in the study. Three years pooled data revealed that under drip irrigation system closer row spacing of 60 cm in brinjal gave the maximum fruit yield (547.37 q/ha), however it was at par with 75 x 60 cm paired row spacing (520.81 q/ha) and 120 x 60 cm paired row spacing (511.82 q/ha). The minimum fruit yield of brinjal was recorded with wider row spacing of 108 cm. The minimum drip cost was observed in paired row of 120 x 60 cm. Thus, 120 x 60 cm paired row spacing were found optimum for brinjal. The fruit yield of brinjal significantly increased with every increase in the level of applied water up to 1.0 ETc. When the water level further increased to 1.2 ETc over 1.0 ETc, the increase in the fruit yield was nonsignificant. The fruit yield of brinjal (814.03 q/ha) was recorded with drip irrigation at 1.0 ETc was statistically at par with that of 1.2 ETc (821.29 q/ha) and significantly higher than other treatments tested in the study. Thus drip irrigation at 1.0 ETc was found optimum irrigation schedule for brinjal. It gave 30.95 % higher fruit yield of brinjal and saved 24.62 % irrigation water over conventional surface irrigation. The water expense efficiency was higher in the drip-irrigated treatments as compared to flood irrigation. The maximum water expense efficiency of 119.04 kg/ha mm was recorded at 0.6 ETc followed by 114.74 kg/ha mm at 1.0 ETc by drip system. Under drip irrigation application of 80% of recommended dose of N and K gave significantly higher fruit yield of brinjal as compared to 60% recommended dose of fertilizer and recommended practice with flood irrigation. Increase in split application of N and K (9 to 12) did not affect the yield of brinjal significantly. The water expense efficiency was higher in the drip-fertigated treatments as compared to flood irrigation. The maximum water expense efficiency of 120.16 kg/ha mm was recorded under 80% RD in 12 splits followed by 114.41 kg/ha mm under 80% RD in 9 splits treatment. Thus application of 80 per cent recommended dose of N and K in 12 splits was found optimum fertigation schedule for brinjal. It saved 25 per cent N and K fertilizer and increased brinjal yield by 30.6 per cent in comparison to conventional method of irrigation and fertilizer application.

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having in line drippers at 30 cm distance with water discharge of 2 LPH were used in the study. Three years pooled data revealed that under drip irrigation system closer row spacing of 60 cm in brinjal gave the maximum fruit yield (547.37 q/ha), however it was at par with 75 x 60 cm paired row spacing (520.81 q/ha) and 120 x 60 cm paired row spacing (511.82 q/ha). The minimum fruit yield of brinjal was recorded with wider row spacing of 108 cm. The minimum drip cost was observed in paired row of 120 x 60 cm. Thus, 120 x 60 cm paired row spacing were found optimum for brinjal. The fruit yield of brinjal significantly increased with every increase in the level of applied water up to 1.0 ETc. When the water level further increased to 1.2 ETc over 1.0 ETc, the increase in the fruit yield was nonsignificant. The fruit yield of brinjal (814.03 q/ha) was recorded with drip irrigation at 1.0 ETc was statistically at par with that of 1.2 ETc (821.29 q/ha) and significantly higher than other treatments tested in the study. Thus drip irrigation at 1.0 ETc was found optimum irrigation schedule for brinjal. It gave 30.95 % higher fruit yield of brinjal and saved 24.62 % irrigation water over conventional surface irrigation. The water expense efficiency was higher in the drip-irrigated treatments as compared to flood irrigation. The maximum water expense efficiency of 119.04 kg/ha mm was recorded at 0.6 ETc followed by 114.74 kg/ha mm at 1.0 ETc by drip system. Under drip irrigation application of 80% of recommended dose of N and K gave significantly higher fruit yield of brinjal as compared to 60% recommended dose of fertilizer and recommended practice with flood irrigation. Increase in split application of N and K (9 to 12) did not affect the yield of brinjal significantly. The water expense efficiency was higher in the drip-fertigated treatments as compared to flood irrigation. The maximum water expense efficiency of 120.16 kg/ha mm was recorded under 80% RD in 12 splits followed by 114.41 kg/ha mm under 80% RD in 9 splits treatment. Thus application of 80 per cent recommended dose of N and K in 12 splits was found optimum fertigation schedule for brinjal. It saved 25 per cent N and K fertilizer and increased brinjal yield by 30.6 per cent in comparison to conventional method of irrigation and fertilizer application.

INTRODUCTION

Water is the most limiting factor in crop production in Irrigated North West Plain Zone of Rajasthan. The mean annual rainfall in the zone is 325 mm. Ground water is brackish. Canal water, the main source of irrigation, is also limited. Recently, the agro-techniques on drip irrigation for hirsutum and arborium cotton have been developed. There is the scope of vegetables in the zone after cotton on drip irrigation. Brinjal (Solanum melongena L.) is one of the important vegetable crop grown in the zone. There is a scope to enhance production by using proper and frequent irrigation scheduling in this crop. Vegetable crops are very sensitive to moisture stress, a little moisture stress in the soil can affect the plant growth and yield adversely. Frequent irrigation in vegetable crops is essential for optimum production, which is not possible by traditional methods. Drip irrigation is the only method to irrigate the crops frequently as per their water requirement. Drip irrigation has been proved very effective in saving irrigation water and increase in yield of vegetable crops with good quality of produce (Desai et al., 2008; Mishra and Paul, 2009). It was felt to optimize the crop geometry, irrigation schedule and fertigation schedule for brinjal under drip irrigation so that the drip system installed for cotton may be utilized for subsequent vegetable crop.

MATERIAL AND METHODS

Three experiments were conducted on crop geometry, irrigation scheduling and fertigation for successive three years during Rabi 2009-10, 2010-11 and 2011-12 at Agricultural Research Station, Sriganganagar. The soil of experimental site was sandy loam in texture, low in organic carbon (0.21%), medium in available phosphorus (36 kg P_2O_5/ha) and high in available potash (340 kg K_2O/ha). The average values for volumetric moisture content in the soil at field capacity and permanent wilting point were 0.198 and 0.072 m^3/m^3, respectively. In the first trial on crop geometry, five crop geometries (120 x 60 paired, 75 x 60 paired, 60, 90 and 108 cm single row) under drip irrigation system were tested to evaluate their performance. In paired planting drip line was placed within the pair and in single row planting, drip line was placed along the line. In all the treatments, drip irrigation was scheduled in such a way so that per unit area water application was given uniform. The irrigation was scheduled through drip at 1.0 ETc on alternate day. In the second trial on irrigation scheduling, four levels of drip irrigation (0.6, 0.8 1.0 and 1.2 ETc) with recommended practice of surface irrigation (IW/CPE 1.0) were tested for brinjal. The crop was sown in paired rows having 60 cm distance within pair and 120 cm distance between pair. Drip line having dripper to dripper distance 30 cm and discharge of each dripper 2 LPH was placed within the pairs. Irrigation through drip was applied on alternate day as per schedule. In the third trial on fertigation, a combination of two fertilizer levels (80 & 60% of the recommended dose of N and K) with two split applications (9 splits at 13 days interval and 12 splits at 10 days interval) under drip irrigation system were evaluated along with control treatment (recommended fertilizer application with flood irrigation). The irrigation was scheduled through drip at 1.0 ETc on alternate day in this trial.The recommended dose (RD) of N, P_2O_5 and K_2O

for brinjal was 120, 80 and 60 kg/ha, respectively. Nitrogen was applied in the form of urea and potash as murate of potash. The full dose of phosphorus was applied as basal through single super phosphate at the time of transplanting in all the treatments. Nitrogen and potash were applied as per treatments. Paired planting (120 x 60 cm) was done and the drip line was placed within the pair.

All the experiments were conducted in randomized block design with four replications. Brinjal hybrid "Nishant" was taken as test crop. The crop was transplanted in the first week of December during all the three years. In flood irrigation treatment recommended dose of N was applied half as basal at the time of transplanting, one fourth as top dressing at the time of first irrigation and remaining one fourth as top dressing at the time of flowering. The effective rainfall during crop period in 2009-10, 2010-11 and 2011-12 was 68.7, 99.5 and 35.2 mm in 13, 16 and 03 rainy days, respectively. The total pan evaporation during crop growth in respective years was 558.6, 725.8 and 764.3 mm. The treatment wise yield and yield attributing parameters were recorded. The data were statistically analyzed and inferences were drawn.

RESULTS AND DISCUSSION

Studies on optimum crop geometry under drip irrigation

Under drip irrigation system closer row spacing of 60 cm gave the maximum fruit yield (547.37 q/ha) of brinjal, however it was at par with 60 x 75 cm paired row spacing (520.81 q/ha) and 60 X 120 cm paired row spacing (511.82 q/ha). The minimum fruit yield of brinjal was recorded with wider row spacing of 108 cm (Table 1). The number of fruits per hectare was the maximum at 60 cm single row spacing which was at par with 90 cm row spacing. The length of drip line installed at 180 cm in paired planting of 120 x 60 cm was one third than the length of drip line installed at 60 cm in 60 cm row spacing treatment. Therefore, paired planting at 120 x 60 cm was found cost effective. The superiority of paired planting under drip irrigation was reported in tomato at Navsari in Gujarat (Desai et al., 2008). The maximum water expense efficiency of 71.2 kg/ha mm was also recorded under paired planting at 120 x 60 cm.

Table 1: Effect of crop geometry on fruit yield, water use & water expense efficiency in brinjal (pooled data)

Crop geometry	Fruit yield (q/ha)	No. of fruits/ha	Total water use(mm)	WEE (kg/ha mm)
120 x 60 cm paired row	511.8	25723	719.2	71.2
75 x 60 cm paired row	520.8	26183	719.2	69.1
60 cm single row	547.4	28714	719.2	76.1
90 cm single row	507.7	27053	719.2	70.6
108 cm single row	489.2	25043	719.2	68.0
S Ed	16.7	779	-	-
CD at 5%	36.4	1696	-	-

Studies on irrigation scheduling through drip

The fruit yield of brinjal significantly increased with every increase in the level of applied water up to 1.0 ETc (Table 2). When the water level further increased to 1.2 ETc over 1.0 ETc, the increase in the fruit yield was non significant. The fruit yield of brinjal (814.03 q/ha) was recorded with drip irrigation at 1.0 ETc was statistically at par with that of 1.2 ETc (821.29 q/ha) and significantly higher than other treatments tested in the study. Thus drip irrigation at 1.0 ETc was found optimum irrigation schedule for brinjal. It gave 30.95 % higher fruit yield of brinjal and saved 24.62 % irrigation water over conventional surface irrigation. The highest yield of brinjal under drip irrigation was recorded at 100 per cent irrigation requirement treatment on sandy loam soil in coastal Orissa (Mishra and Paul, 2009).

The water expense efficiency was higher in the drip-irrigated treatments as compared to flood irrigation. The maximum water expense efficiency of 119.04 kg/ha mm was recorded with 0.6 ETc, followed by 114.74 kg/ha mm with 1.0 ETc by drip system treatment. It is pertinent to mention here that brinjal under low tunnel started fruiting earlier about 15 to 20 days than the crop without low tunnel. Thus, picking of fruits started in advance under low tunnel crop which gave higher market sell price. Moreover, cotton may be grown timely after brinjal crop raised under low tunnel. The highest B:C ratio 4.97 was recorded when the irrigation was scheduled at 1.2 ETc closely followed by that

(4.92) at 1.0 ETc as against 4.44 under flood irrigation (Table 3). The incremental cost benefit ratio of irrigation scheduling at 1.0 and 1.2 ETc was 6.48 and 5.87, respectively.

Table 2: Effect of drip irrigation on fruit yield, water use & water expense efficiency in brinjal (pooled data)

Irrigation schedule	Fruit yield (q/ha)	Water Use (mm)	WEE (kg/ha mm)
0.6 ETc (Drip)	556.5	467.5	119.0
0.8 ETc (Drip)	657.4	588.6	111.7
1.0 ETc (Drip)	814.0	709.4	114.7
1.2 ETc (Drip)	821.3	790.4	103.9
Flood irrigation	621.6	1007.8	61.7
S Ed	22.1	-	-
CD at 5%	48.1	-	-

Table 3: Benefit cost analysis of irrigation scheduling in brinjal

S.No.	Cost/economics	0.6 ETc	0.8 ETc	1.0 ETc	1.2 ETc	Flood
1.	Fixed cost (Rs.)	115000	115000	115000	115000	
A	Life (Years)	15	15	15	15	0
B	Depreciation (Rs/Year)	7667	7667	7667	7667	0
C	Interest (8 %/Yearly)	9200	9200	9200	9200	0
D	Maintenance (Per Season)	3000	3000	3000	3000	0
2.	Cost of cultivation (Rs/ha)	76400	76400	76400	76400	80000
3.	Total cost (Rs/ha)	96267	96267	96267	96267	80000
4.	Yield of produce (q/ha)	556	657	814	821	622
5.	Selling price (Rs/q)	700	700	700	700	700
6.	Income from produce (Rs)	389200	459900	569800	574700	435400
7.	Additional area (ha)	49.6	37.1	24.6	12.2	0
8.	Additional cost (Rs)	47748	35715	23682	11745	0
9.	Total cost of production (Rs)	144015	131982	119949	108012	80000
10.	Additional income (Rs)	193043	170623	140171	70113	0
11.	Total income (Rs)	582243	630523	709971	644813	435400
12.	Net seasonal income (Rs)	438228	498541	590022	536802	355400
13.	B:C	3.04	3.78	4.92	4.97	4.44
14.	Extra cost of production (Rs)	64015	51982	39949	28012	0
15.	Extra net income (Rs)	82828	143141	234622	181402	0
16.	IB:C	1.29	2.75	5.87	6.48	0

Response of Brinjal to dose and time of fertilizer application

The maximum yield of brinjal was recorded with the application of 80% recommended dose of N and K in 12 equal splits at an interval of 10 days and it was at par with the same dose in 9 equal splits in 13 days (Table 4). The minimum yield of brinjal was recorded with flood irrigation at recommended dose of fertilizer, however it was at par with that obtained at 60 per cent recommended dose of N and K either in 9 or 12 equal splits. The increase in split application of N and K from 9 to 12 did not affect the yield of brinjal at 60 as well as 80 per cent recommended dose of N and K. Numerically highest yield of brinjal was recorded at 80% recommended dose of N and K in 12 equal splits at an interval of 10 days, thus, it is found the optimum dose for fertigation. The water expense efficiency was higher in the drip-irrigated treatments as compared to flood irrigation. The maximum water expense efficiency of 120.2 kg/ha mm was recorded under 80% RD in 12 splits, followed by 114.4 kg/ha mm under 80% RD in 9 splits treatment.

The maximum B:C ratio 6.43 was recorded with 80% recommended dose of N and K in 12 equal splits followed by that (6.08) recorded at the same dose of fertilizer in 9 equal splits as against 4.71 under flood irrigation with recommended fertilizer dose (Table 5). The incremental benefit cost ratio under fertigation at 80% recommended dose of N and K in 12 equal splits and 9 equal splits was 13.24 and 11.51, respectively.

Table 4: Effect of fertigation on fruit yield, water use & water expense efficiency in brinjal (pooled data)

Fertigation schedule	Fruit yield (q/ha)	Water Use (mm)	WEE (kg/ha mm)
80% RD (9)	811.6	709.4	114.4
80% RD (12)	852.4	709.4	120.2
60% RD (9)	697.7	709.4	98.4
60% RD (12)	675.6	709.4	95.2
Control (RP)*	652.7	1007.8	64.8
S Ed	22.9	-	-
CD at 5%	49.9	-	-

*Recommended practice of flood irrigation and fertilizer application

Table 5: Benefit cost analysis of drip fertigation in brinjal

S. No.	Cost/economics	80% (9)	80% (12)	60% (9)	60% (12)	Control
1.	Fixed cost (Rs.)	115000	115000	115000	115000	0
A	Life (Years)	15	15	15	15	0
B	Depreciation (Rs/Year)	7667	7667	7667	7667	0
C	Interest (8 %/Yearly)	9200	9200	9200	9200	0
D	Maintenance (Per Season)	3000	3000	3000	3000	0
2.	Cost of cultivation (Rs/ha)	76400	76400	75200	75200	80000
3.	Total cost (Rs/ha)	96267	96267	95067	95067	80000
4.	Yield of produce (q/ha)	812	852	698	676	653
5.	Selling price (Rs/q)	700	700	700	700	700
6.	Income from produce (Rs)	568400	596400	488600	473200	457100
7.	Additional area (ha)	24.6	24.6	24.6	24.6	0
8.	Additional cost (Rs)	23682	23682	23386	23386	0
9.	Total cost of production (Rs)	100082	100082	98586	98586	80000
10.	Additional income (Rs)	139826.4	146714	120196	116407	0
11.	Total income (Rs)	708226.4	743114	608796	589607	457100
12.	Net seasonal income (Rs)	608144.7	643033	510209	491021	377100
13.	B:C	6.08	6.43	5.18	4.98	4.71
14.	Extra cost of production (Rs)	20082	20082	18586	18586	0
15.	Extra net income (Rs)	231045	265933	133109	113921	0
16.	IB:C	11.51	13.24	7.16	6.13	0

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