The Journal of Rural and Agricultural Research Vol. 14 No. 2, 27-29 (2014)
Received April 2014; Acceptance October 2014

Studies on drip irrigation, fertigation and spacing in Bt cotton

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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 Bt cotton at Agricultural Research Station, Sriganganagar during Kharif 2009 to 2011. Paired row spacing of 60 X 120 cm & single row spacing of 90, 108 and 120 cm gave statistically at par seed cotton yield. When the row spacing of cotton was further increased to 135 cm, the yield of cotton was significantly reduced as compared to other closer row spacings tested in the study. The minimum drip cost was observed in paired row of 120 x 60 cm. Thus, 120 x 60 cm paired row spacing was found optimum for Bt cotton. The maximum seed cotton yield was recorded when drip irrigation was scheduled at 1.2 ETc, however, it was at par with seed cotton yield obtained at 1.0 ETc. Seed cotton yield at 0.8 & 0.6 ETc was significantly less than that of 1.0 & 1.2 ETc treatments. Thus, drip irrigation to Bt cotton at 1.0 ETc was found optimum. This treatment gave 31.0 % higher seed cotton yield and saved 32.9 % of irrigation water over conventional flood irrigation. The water expense efficiency was higher in the drip-irrigated treatments as compared to flood irrigation. The maximum water expense efficiency of 4.21 kg/ha mm was recorded at 1.0 ETc followed by 3.98 kg/ha mm at 0.8 ETc irrigation treatment with drip system. The maximum seed cotton yield was recorded at 120% RD of fertilizers, however, it was at par with 100% and 80% RD of fertilizer with 2% KNO_3 spray. Thus, 80% RD of NPK+ foliar spray of 2% KNO_3 at 90 and 105 DAS was found optimum for Bt cotton. This treatment gave 15.6 % higher seed cotton yield over conventional method of fertilizer application and irrigation. The maximum water expense efficiency of 3.95 kg/ha mm was recorded with120% of RD, followed by 3.87 kg/ha mm with100% of RD +2% KNO_3 as foliar spray at 90 & 105 DAS and 3.78 kg/ha mm with 80% of RD +2% KNO_3 as foliar spray at 90 & 105 DAS.

Key word : Bt cotton, drip irrigation, fertigation, crop geometry, yield, water use efficiency

Introduction

Cotton is the main Kharif crop in irrigated north-western plain zone of Rajasthan. The water requirement of cotton is the highest in comparison to other Kharif crops except paddy in this zone. This crop requires 700 to 900 mm water during its growth period. Time of the water application as well as its total requirement both are the important factors influencing crop production. Cotton is deep rooted crop and the time of application of first irrigation is very important from the point of view of its root development and subsequent water requirement. The first irrigation in American cotton is recommended at 30 to 35 days after sowing in this zone. Similarly, the last irrigation is recommended in the second fortnight of October. The application of irrigation at later stage results continuous growth and ultimately undeveloped bolls remains on the plants. The farmers of the zone grow cotton in limited area because of shortage of irrigation water. Land is not the constraint but water availability is the main constraint to increase the area under cotton in this zone. The introduction of Bt cotton in the zone further increased the productivity of cotton.

Drip irrigation can help to use water efficiently. Irrigation scheduling through drip can be managed precisely to meet crop water demands, holding the promise of increased yield and quality. A well-designed drip irrigation system looses practically no water to runoff, deep percolation or evaporation. Drip irrigation reduces water contact with crop leaves, stems, and fruit. Thus conditions may be less favourable for the onset of diseases. Agricultural chemicals can be applied more efficiently with drip irrigation. Since only the crop root zone is irrigated, nitrogen already in the soil is less

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subject to leaching losses, and applied fertilizer N can be used more efficiently. Nutrient applications can be better timed to meet plant needs. In the case of insecticides, less quantity is needed. These objectives can be achieved by following optimum irrigation & fertigation schedules for cotton by adopting efficient water application method. An effort has been made in the present investigation to generate information on optimum irrigation schedule, fertigation schedule & optimum crop geometry for drip irrigation in Bt cotton in irrigated North-western plain zone of Rajasthan.

Materials and Methods

The experiments on drip irrigation, drip fertigation & crop geometry in Bt cotton were conducted at Agricultural Research Station, Sriganganagar during kharif seasons from 2009 to 2011. The soil was sandy loam, low in organic carbon (0.20 %), medium in available phosphorus (34 kg P_2O_5/ha) and high in available potash (350 kg K_2O/ha) with a pH of 8.3. These experiments were laid out in randomized block design. Bt cotton (JKCH 1947) 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. In the experiment on crop geometry, five crop geometries (60 X 120 paired, 90, 108, 120 and 135 cm single row) for Bt cotton under drip irrigation system were tested to evaluate their performance. In paired planting drip line was placed between two lines and in single row plantings, drip line was placed along the line. In paired planting, drip running time was double than single row planting of 90 cm & in all other geometries water application was as per 100% area to make the water application uniform per unit area in all the crop geometries. Alternate day irrigation schedule was followed. In another experiment on irrigation scheduling four levels of drip irrigation (0.6, 0.8, 1.0, 1.2 ETc) with recommended practice of surface irrigation were tested for Bt cotton. Irrigation was applied on alternate day by drip irrigation as per treatment. In third experiment four fertilizer levels (120 % recommended dose of NPK, 100, 80 & 60% recommended dose of NPK + 2% KNO_3) for Bt cotton crop under drip irrigation system with control (recommended dose with flood irrigation) were evaluated. In this experiment water soluble fertilizer 0 : 52 : 34 N : P : K and urea were used for nutrient application. In all the drip treatments fertilizers were applied through drip in six equal splits at an interval of 15 days. In flood irrigation treatment nitrogen was applied in three splits (1/3 at sowing as basal, 1/3 at first irrigation and 1/3 at square formation) and full dose of phosphorus as single super phosphate and potash as muriate of potash as basal. Treatment wise yield, yield attributing parameters, water use and water use efficiency in all the experiments were recorded. The data were statistically analyzed and inferences were drawn accordingly.

Results and Discussion

Effect of planting method

Paired row spacing of 60 X 120 cm & single row spacing of 90, 108 and 120 cm gave statistically at par seed cotton yield (Table 1). When the row spacing of cotton was further increased to 135 cm, the yield of cotton was significantly reduced as compared to other closer row spacings tested in the study. Aujla *at al.*, (2005) reported superiority of paired planting in cotton than normal planting under drip irrigation at Bathinda in Punjab, however, Sidhpuria *at al.*, (2005) found planting of hybrid cotton at a spacing of 1 m x 1 m optimum under drip irrigation in loamy sand soil of Bawal, Haryana. The water expense efficiency (WEE) in the present investigation was also lowest at row spacing of 135 cm. The minimum drip cost was also observed in paired row of 120 x 60 cm. Thus, 120 x 60 cm paired row spacing was found optimum for Bt cotton in this zone.

Effect of drip irrigation

The maximum seed cotton yield was recorded when drip irrigation was scheduled at 1.2 ETc, however, it was at par with seed cotton yield obtained at 1.0 ETc (Table 2). Seed cotton yield at 0.8 & 0.6 ETc was significantly lesser than that of 1.0 & 1.2

Table 1: Effect of different crop geometry treatments on yield and water expense efficiency (average of three years)

Crop Geometry (cm)	Seed cotton yield (q/ha)	No of bolls/ plant	Plant population /ha	Totalwater use (mm)	WEE (kg/ha mm)
60 X 120X 60	30.85	70.10	17593	759	4.06
90 X 60	31.65	68.33	17562	759	4.17
108 X 60	31.36	73.23	14609	759	4.13
120 X 60	30.71	74.73	13102	759	4.05
135 X 60	26.42	74.75	11605	759	3.48
SEd	1.56	4.63	297	-	-
CD at 5%	3.41	10.08	647	-	-

Table 2: Effect of different irrigation treatments on yield and expense efficiency (average of three years)

Irrigation schedule	Seed cotton yield (q/ha)	No. of balls /Plant	Total water use (mm)	WEE(kg/ha mm)
0.6ETc	23.60	57.05	602	3.92
0.8ETc	26.26	60.20	660	3.98
1.0ETc	30.93	63.98	736	4.21
1.2ETc	30.96	63.51	802	3.86
Flood	23.61	55.17	978*	2.41
CD	1.57	7.93	-	-

* Including 25% conveyance losses

Table 3: Effect of different irrigation treatments yield and water expense efficiency (average of three years)

Treatments	Seed Cotton Yield (q/ha)	No of bolls/plant	Total water use (mm)	WEE(kg/ha mm)
120 % RD	29.96	65.87	759	3.95
100 % RD+2%KNO_3	29.40	64.08	759	3.87
80 % RD+2%KNO_3	28.72	64.92	759	3.78
60 % RD+2%KNO_3	24.44	58.25	759	3.22
Recommended Practice	24.85	55.24	1003*	2.48
SEd	0.67	4.32	-	-
CD	1.46	9.41	-	-

* Including 25% conveyance losses

ETc treatments. Thus, drip irrigation to Bt cotton at 1.0 ETc was found optimum. This treatment gave 31.0 % higher seed cotton yield and saved 32.9 % of irrigation water over conventional flood irrigation. The water expense efficiency was higher in the drip-irrigated treatments as compared to flood irrigation. The maximum water expense efficiency of 4.21 kg/ha mm was recorded at 1.0 ETc followed by 3.98 kg/ha mm at 0.8 ETc irrigation treatment with drip system.

Effect of fertigation

The maximum seed cotton yield was recorded at 120% RD of fertilizers, however, it was at par with 100% and 80% RD of fertilizer with 2% KNO3 spray (Table 3). Thus, 80% RD of NPK+ foliar spray of 2% KNO3 at 90 and 105 DAS was found optimum for Bt cotton. This treatment gave 15.6 % higher seed cotton yield over conventional method of fertilizer application and irrigation.

The maximum water expense efficiency of 3.95 kg/ha mm was recorded with 120% of RD treatment, followed by 3.87 kg/ha mm with 100% of RD +2% KNO_3 as foliar spray and 3.78 kg/ha mm with 80% of RD +2% KNO_3 as foliar spray. Reddy and Aruna (2010) reported that fertigation with 125 percent recommended dose of N and K applied 10 percent as basal and remaining 90 percent from 30-120 days in nine splits recorded higher *kapas* yield as compared to recommended manual fertilizer application under drip irrigation on Bt cotton (BG-I) in vertisols at Nandyal, Andhra Pradesh.

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