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Effect of Drip Irrigation in Bt-Cotton Yield

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Field experiments were conducted during winter 2006-07 and 2007-08 at Tamil Nadu Agricultural University, Coimbatore to find out the effect of drip irrigation on the productivity and water use efficiency in Bt-cotton (*Gossypium hirsutum* L.). The experiments were laid out in a randomized block design replicated four times. The treatments consisted of drip irrigation at 0.40, 0.60, 0.80 and 1.0 ET_C (Crop evapotranspiration) compared with farmers' method (flood irrigation method). The results revealed that application of water to Bt-cotton through drip resulted in better growth, higher seed cotton yield and better quality of lint than the surface method. The yield advantage due to different irrigation schedules through drip based on ETc was 26.2 and 12.8% over surface method during 2006-07 and 2007-08, respectively. Among the irrigation through drip, irrigation at 0.80 ET_C recorded better growth and gave higher seed cotton yield than irrigation at 0.60 ET_C. The water use efficiency with drip irrigated Bt-cotton was 44.4% higher than the flood method of irrigation.

Key words: Bt-cotton, drip irrigation, irrigation scheduling, ET_C, yield

India is the second largest producer of cotton (*Gossypium hirsutum* L.) in the world with the largest acreage (9.59 m ha) but productivity is only a little above 20% of the world's average productivity of 794 kg ha^{-1} (AICCIP 2008). In Tamil Nadu, cotton is being grown mainly under rainfed condition and the productivity is very low (708 kg lint ha^{-1}) as compared to India because 65% of cotton is cultivated under rainfed conditions.

Cotton under rainfed conditions normally suffers either due to lack of proper distribution of rains or heavy rains and terminal moisture stress. Exposure of cotton to repeated cycles of low and excess moisture stress during the growth period has adverse effect on growth and development. Ever increasing demand for irrigation water coupled with depleting ground water sources call for efficient use of water. Introduction of micro irrigation systems like drip irrigation can help to bring more area under irrigation and improve the crop yield substantially. Drip irrigation is an option wherever water availability limits conventional irrigation and further it also reduces the risk of yield reduction due to terminal dry spells. Experimental results have widely indicated that drip irrigation would save water and increase yield in different regions (Sivanappan, 2004). With these ideas in view, a study was conducted to find out the effect of drip irrigation on yield of Bt-cotton and water use efficiency.

Materials and Method

Field experiments were conducted at Tamil Nadu Agricultural University, Coimbatore from 2006 to 2008 during the winter season to find out the effect of drip irrigation on yield of Bt-cotton and water use efficiency. The soil of the experimental fields was alkaline with a pH 8.7 and organic carbon 0.42 per cent. The soils were low in available N (145 kg ha^{-1}), medium in available P (13.1 kg ha^{-1}) and high in available K (470 kg ha^{-1}). The experiments were laid out in a randomized block design replicated four times. The treatments consisted of drip irrigation at 0.40, 0.60, 0.80 and 1.00 ET_C (Crop evapo transpiration) compared with farmers' method (flood irrigation method). The first crop was sown on 5.9.2006 and the second on 14.8.2008. A total rainfall of 625 and 685 mm was received during 2006-07 and 2007-08, respectively.

Irrigation was given at every alternative day in drip treatments as per the treatments requirement by adjusting the duration of water release at constant flow rate of 4 l/hr, whereas in farmer's method, 7 irrigations were given. NCS 45 Bt-cotton hybrid was sown at 60 cm x 90 x 120 cm (paired row). Recommended dose of N (120 kg ha^{-1}) in three splits and P and K (50 kg each ha^{-1}) were applied as urea, single super phosphate and muriate of potash. The observations on yield components and yield were recorded and analyzed statistically. Water use efficiency was calculated from yield and quantity of irrigation water applied in each treatment.

Results and Discussion

Growth characters

There was a significant difference in the plant height and DMP among different treatments during both the years. Drip irrigation at 0.80 ET_C recorded taller plants and higher DMP than the other treatments. Water was released strictly in the root zone maintaining soil: air ratio at an optimum level

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for plant growth and development. This situation increased the availability of nutrients in the soil throughout the growing season which ultimately resulted in higher growth and development of cotton.

Yield

Mean of two years data indicated that drip irrigation at 0.80 ET_C was superior to 0.60 and 0.40 ET_C. The least seed cotton yield was recorded under farmer's practice (flood irrigation method) (Table 1). Drip irrigation at 0.80 ETc recorded significantly higher seed cotton yield in both the years (455 and 485 kg ha^{-1}) respectively as compared to flood irrigation. Increase in seed cotton yield under 0.80 ET_C was due to significantly higher number of good opened bolls $plant^{-1}$ (Table 1). Nalayini *et al*. (2009) also reported that drip irrigation is more beneficial in improving RCHB 708 Bt in Coimbatore and Bunny Bt in Nagpur.

Water use efficiency

Among the drip treatments, irrigation at 0.80 ET_C recorded 11.9% higher kapas yield over 1.00 ET_C and 23.3% over 0.60 ET_C and 26.2% over 0.40 ET_C. These results corroborate with the results obtained by Veeraputhiran and Chinnusamy (2009). Drip irrigation method had favourably increased the WUE of Bt-cotton in both the years. Increasing the level of water application by drip irrigation decreased the WUE which was mainly due to limited quantity of water applied under lower drip irrigation regimes.

Table 1. Effect of drip irrigation on growth and yield of Bt-cotton

Treatment	Plant ht. (cm)			No. bolls $plant^{-1}$			DMP (g $plant^{-1}$)			Yield (kg ha^{-1})		
	06-07	07-08	Mean	06-07	07-08	Mean	06-07	07-08	Mean	06-07	07-08	Mean
Drip irrigation at 0.40 ET_C	98.3	96.8	97.5	23.3	30.2	26.7	279	340	309.5	1208	1629	1418
Drip Irrigation at 0.60 ET_C	101.3	101.7	101.5	27.5	37.0	82.3	299	368	333.5	1804	1601	1452
Drip irrigation at 0.80 ET_C	114.4	117.6	116	35.4	44.6	40.0	332	411	371.5	1594	1987	1790
Drip Irrigation at 1.00 ET_C	110.2	110.3	110.2	32.5	42.2	37.2	311	396	353.5	1498	1852	1600
Flood irrigation	102.6	100.7	101.7	29.6	36.0	33.2	293	365	329	1139	1402	1270
SED	5.10	5.8	-	1.7	2.4	-	16.4	16.7	-	123.1	113.0	-
CD (P = 0.05)	10.8	12.3	-	3.6	6.4	-	34.7	36.2	-	261.1	239	-

Table 2. Effect of drip irrigation on WUE and fibre quality in Bt- cotton

Treatments	WUE (kg ha^{-1} mm^{-1})			Fibre length (mm)			Micronaire (10 $^{-6}$gm $inch^{-1}$)			Strength (g tex^{-1})		
	06-07	07-08	Mean	06-07	07-08	Mean	06-07	07-08	Mean	06-07	07-08	Mean
Drip irrigation at 0.40 ET_C	4.4	5.0	1.17	25.3	26.0	25.7	3.7	3.6	3.65	18.5	19.5	19.0
Drip Irrigation at 0.60 ET_C	3.6	4.1	3.9	25.6	26.1	25.9	3.6	3.8	3.70	19.0	20.4	19.7
Drip irrigation at 0.80 ET_C	2.8	3.2	3.0	26.3	26.8	26.6	3.8	4.1	3.40	18.9	18.5	18.7
Drip Irrigation at 1.00 ET_C	3.2	3.7	3.5	25.1	25.8	24.5	3.9	4.3	4.10	19.5	21.0	20.3
Flood irrigation	2.6	2.9	2.7	25.1	24.8	24.9	4.2	4.5	4.35	20.1	21.8	20.9
SED	0.3	0.2	-	-	-	-	-	-	-	-	-	-
CD (P = 0.05)	0.7	0.4	-	-	-	-	-	-	-	-	-	-

Similar results were also reported by Rajak *et al.* (2006). Compared to flood irrigation (2.6 and 2.9 kg ha^{-1} mm^{-1}), drip irrigation substantially improved the WUE (3.2 and 3.7 $kgha^{-1}$ mm^{-1} in 2006-07 and 2007-08, respectively). This was in harmony with the findings of Srinivasa Reddy and Thimme Gowda (1997) in hybrid cotton.

Fibre quality

Fibre quality parameters like staple length, fineness of fibre, bundle strength and uniformity ratio did not show consistent values due to treatments over two years (Table 2). However, fibre length was more in 0.80 ET_C, fineness was more when crop irrigated through drip at 1.00 ET_C in alternate days. Uniformity ratio and bundle strength were more in flood irrigation. Johnson *et al*. (2002) also reported that micronaire, fibre length, uniformity ratio and strength and more strongly correlated with favourable soil moisture.

Conclusion

Based on the results of the two year's study, it can be concluded that drip irrigation at 0.80 ET_C at alternate days significantly improved the seed cotton yield and saved water compared to 0.40, 0.60 and 1.00 ET_C and farmers irrigation method.

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