RESEARCH ARTICLE

SCHEDULING OF IRRIGATION IN DIFFERENT CULTIVARS OF COTTON UNDER SEMI-ARID CONDITIONS

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Abstract: Field experiments were conducted during *kharif* 2016 and 2017 at the Research Farm of the Department of Soil Science, CCS Haryana Agricultural University, Hisar, to study the seed cotton yield and water productivity (WP) of *Bt* (Bio-6588, RCH-650) and non-*Bt* (H-1098 (I) cotton cultivars under different irrigation schedules. The irrigation schedules were: first irrigation at 40 days after sowing (DAS) and subsequent irrigation based on IW/CPE of 0.60, 0.75 and 0.90. In addition, first irrigation at 50 DAS followed by subsequent irrigation at IW/CPE of 0.60, 0.75 and 0.90. Thus, a total of six irrigation schedules were kept. Irrespective of irrigation schedules, there was no significant difference in seed cotton yield of *Bt* cotton cultivars but their yields were significantly higher than the seed cotton yield of non-*Bt* cotton (H-1098 (I) during both the years. Due to frequent rains during the crop growing season, the proposed irrigation schedules could not be followed precisely, hence, no influence on the seed cotton yield of the both *Bt* and non-*Bt* cotton cultivars during both the years. Hence, irrigation scheduling based on IW/CPE considering both the time and amount of rainfall for cotton or may be for other *kharif* crops during rainy season did not found suitable/applicable for managing irrigation water efficiently.

Keywords: Cotton cultivars, Seed cotton yield, Irrigation, Water productivity

INTRODUCTION

Cotton is a potentially important commercial crop having vital role in textile industry. It is extensively grown in areas where conventional irrigation methods are usual practices. However, the seed cotton yields and water use efficiency achieved under these methods are low. In north-western India, cotton is sown immediately after wheat harvest and the summer season demands frequent irrigations. In this region, the water requirement of cotton ranges from 700 to 1200 mm (Kairon *et al*. 2002). The entire area of cotton in northern zone is grown as irrigated [Punjab (96.5%), Haryana (99.4%), Uttar Pradesh (92.3%) and Rajasthan (95.0%) FAI, 2005)]. Cotton is very sensitive to excess irrigation in initial phase of its growth and water stress at later stages may adversely affect its yield (Kashefipour *et al*. 2006). Further, *Bt* cotton performing better under irrigation than non-*Bt* cotton (Jana 2005) , therefore, there is a need for standardization of irrigation schedules based on scientific approaches. The optimum range of soil-moisture for cotton is about 20% of the available water with the root zone extending up to 0.75-0.80 m, having a total water requirement of 0.4 to 0.5 m (IIT 2008). The information available on irrigation response of *Bt* cottons is quite scarce. Hence, the present study was carried out to evolve the optimum schedule of irrigation for *Bt* cotton.

MATERIALS AND METHODS

The experiments were conducted in *kharif* 2016 and 2017. Cotton cultivars H-1098 (I), Bio-6588 and RCH-650 were taken for scheduling of irrigation.The sowing was done by hand dibbling on May 9 and May 3, during 2016 and 2017 respectively. The plant to plant distance was 40 cm and 45 cm, and row to row distance was 90 and 100 cm, respectively, during 2016 and 2017. Six irrigation schedules were maintained and those were 1st irrigation at 40DAS and thereafter at IW/CPE of 0.60, 0.75 and 0.90. Similarly, 1st irrigation at 50 DAS and thereafter at IW/CPE of 0.60, 0.75 and 0.90. The irrigation treatments were taken in sub-plots and cotton cultivars in main plots. The design used was split plot with each treatment replicated thrice. The daily and cumulative PAN evaporation and rainfall, and their difference during the crop growth period of 2016 and 2017 are depicted in Fig. 1 and Fig. 2, respectively.

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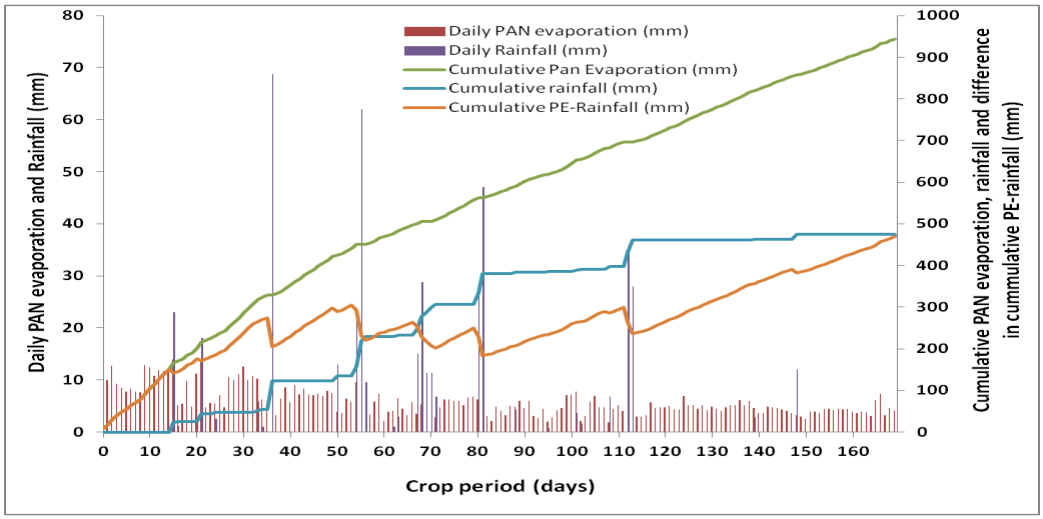

Fig.1: Daily and cumulative PAN evaporation and rainfall, and their difference during the crop growth period of 2016

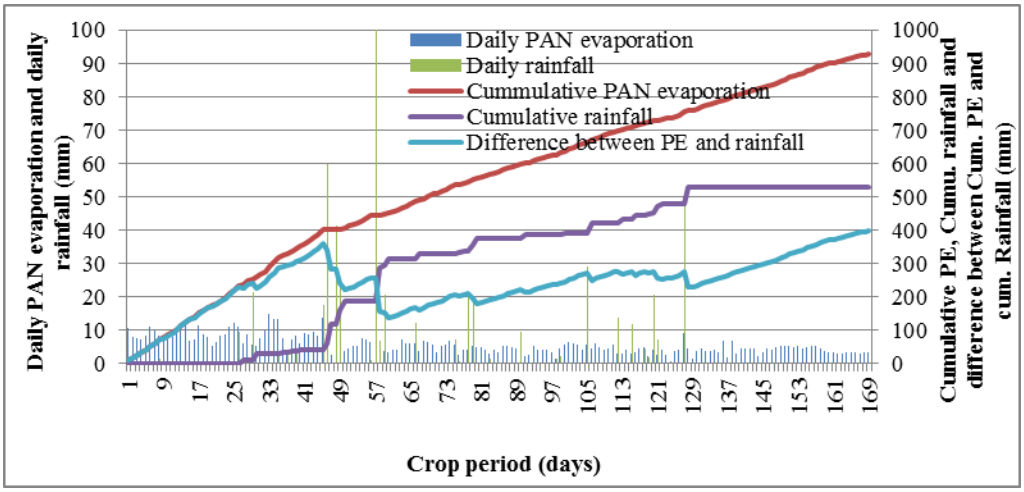

Fig. 2: Daily and cumulative PAN evaporation and rainfall, and their difference during the crop growth period of 2017

RESULTS AND DISCUSSION

Irrigation

During 2016, one irrigation (60 mm) was applied in the irrigation schedules of both 40 DAS and 50 DAS at IW/CPE of 0.60 due to frequent rains during cropping season while corresponding number of irrigations applied was 2 and 4 at IW/CPE of 0.75 and 0.90, respectively (Table 2). The number of irrigations applied was similar under irrigation schedule of 40 and 50 DAS because of the rainfall on 37th (68.7 mm). While during 2017, one irrigation (60 mm) was applied in the irrigation schedules of both 40 DAS and 50 DAS at IW/CPE of 0.75 due to frequent rains during cropping season while corresponding number of irrigations applied were 0 and 2 at IW/CPE of 0.60 and 0.90, respectively (Table 3). The number of irrigations applied were similar under irrigation schedule of 40 and 50 DAS because of the rainfall on 29th (21.3 mm) and 48th (41.5 mm) day of sowing which in fact did not coincide with critical stages (square and boll formation) of crop.

Table 1. Irrigations (with dates) applied under varying irrigation schedules

Irrigation schedules	Dates	Total depth (mm)
40 DAS+IW/CPE=0.60	One- 21st September, 2016	60
40 DAS+IW/CPE=0.75	Two- 22nd August and 17th September, 2016	120
40 DAS+IW/CPE=0.90	Four- 24th June, 16th August, 14th September and 29th September 2016	240
50 DAS+IW/CPE=0.60	One- 21st September, 2016	60
50 DAS+IW/CPE=0.75	Two- 22nd August and 17th September, 2016	120
50 DAS+IW/CPE=0.90	Four- 24th June, 16th August, 14th September and 29th September 2016	240

Table 2. Irrigations (with dates) applied under varying irrigation schedules

Irrigation schedules	Dates	Total depth (mm)
40 DAS+IW/CPE=0.60	No irrigation	-
40 DAS+IW/CPE=0.75	One- 12th August, 2017	60
40 DAS+IW/CPE=0.90	Two- 14th July and 7th August 2017	120
50 DAS+IW/CPE=0.60	No irrigation	-
50 DAS+IW/CPE=0.75	One- 12th August, 2017	60
50 DAS+IW/CPE=0.90	Two- 14th July and 7th August 2017	120

Seed cotton yield

During 2016 and 2017, the seed cotton yields of Bio-6588 and RCH-650 were statistically at par but significantly higher than H-1098 (I) (Table 1). The Bio-6588 and RCH-650 resulted in 39.0 and 30.0 per cent higher seed cotton yield than H-1098 (I) (2759 kg ha^{-1}) during 2016 while in the year 2017, the Bio-6588 and RCH-650 resulted in 35.3 and 32.9 per cent higher seed cotton yield than H-1098 (I) (2970 kg ha^{-1}). The difference in seed cotton yield of the cultivars at different moisture regimes was, however, found non-significant due to sufficient moisture as a result of frequent rain during both the seasons. Increasing frequency of irrigation from 0.6 to 0.9 IW/CPE increased seed cotton yield (Table 1). These finding are in contrast to those of Rajendran *et al*. (2005) and Bandopadhyay *et al*. (2009) and found better performance of cotton IW/CPE of 0.40 which could be ascribed to greater partitioning of photosynthates to reproductive parts as compared to IW/CPE of 0.60 which favoured production of more stalks with insignificant contribution to increase in seed cotton yield.

Water productivity (WP)

During 2016, the water productivity (WP) of total and irrigation was highest in Bio-6588 (0.65 and 3.73 kg m^{-3}) followed by RCH-650 (0.61 and 3.48 kg m^{-3}) and least in H-1098 (I) (0.47 and 2.66 kg m^{-3}) (Fig. 3). Among the irrigation schedules, the WP of total and irrigation water was highest when irrigation was applied either at 40 days after sowing (DAS) or at 50 DAS and thereafter at IW/CPE of 0.60 as compared to other irrigation schedules. The water productivity decreased with increase in moisture regimes from IW/CPE of 0.60 to 0.90. These values of irrigation water productivity (IWP) are not true representation of the productivity due to intermittent rainfall and scheduling of irrigation based on IW/CPE. Therefore, some other criteria may be developed for scheduling of irrigation, particularly in *kharif* crops. However, the water productivity of total and irrigation water came out out to be unrealistic due to frequent rainfall, therefore, irrigation could not be applied as per IW/CPE. The decline in irrigation and total water productivity (0.75 and 0.90 IW/CPE ratio) may be ascribed to the fact that increase in yield was not commensurate with the increase in consumptive use and applied water. Similar trends are reported by Vories *et al*. (1991).

Table 3. Seed cotton yield and water productivity of different cultivars under different irrigation treatments

Treatment		Seed cotton yield, kg/ha		Water productivity (kg m^{-3}) during 2016	
		2016	2017	IWP	TWP
Cultivar	H-1098 (I)	2759	2970	2.66	0.47
	Bio-6588	3839	4017	3.73	0.65
	RCH-650	3589	3947	3.48	0.61
CD at 5%		222	178.7	-	-
Irrigation	40 DAS+IW/CPE=0.60	3355	3555	5.59	0.63

schedule (irrigation at)	40 DAS+IW/CPE=0.75	3362	3649	2.78	0.56
	40 DAS+IW/CPE=0.90	3575	3663	1.49	0.55
	50 DAS+IW/CPE=0.60	3446	3587	5.74	0.64
	50 DAS+IW/CPE=0.75	3290	3708	2.74	0.55
	50 DAS+IW/CPE=0.90	3363	3705	1.40	0.51
CD at 5%		NS	NS	-	-
CD at 5 % (cultivar x moisture regime)		NS	NS	-	-

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