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Research Paper :

Yield response of Bt cotton under different irrigation schedules and fertilizer levels

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ABSTRACT

The field experiment was conducted at the experimental farm of AICRP on Water Management, Marathwada Agricultural University Parbhani during *Kharif* season of 2009-10 on cotton. Field experiment was planned comprising of irrigation as the main factor and fertilizer as sub factor in split plot design with three replications. Irrigation treatments consisted of I_1 (Drip irrigation of 0.3 PE), I_2 (Drip irrigation of 0.5 PE), I_3 (Drip irrigation of 0.7 PE), I_4 (Drip irrigation of 0.5 PE through drip only during critical growth stages), I_5(Drip irrigation of 0.5 PE through drip + green gram as intercrop), I_6 (Irrigation through furrow at 150 CPE during dry spell).The fertilizer treatments included F_1 (75%RDF), F_2 (100%RDF), F_3 (125% RDF). The drip irrigation scheduled at 0.5 PE was better in regards with the growth attributes of Bt Cotton *viz*., plant height, number of functional leaves, leaf area, number of squares per plant, number of green balls per plant. On the other hand, application of 125% RDF improved growth characteristics of Bt cotton. Drip irrigation scheduled at 0. 5 PE with green gram as inter crop gave highest water use efficiency whereas drip of 0.5 PE depth with green gram as intercrop and 75% of RDF gave highest fertilizer use efficiency. RVI and NDVI at 60DAS show that, RVI and NDVI were higher in 0.5PE (I_2). Drip irrigation of 0.5 PE with green gram as intercrop produced significantly higher seed cotton equivalent yield. However, the highest GMR, NMR and comparatively higher B: C ratio was obtained if drip irrigation was scheduled at 0.5 PE with75% RDF.

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Key words : Irrigation schedule, Fertilizer doses, Yield response, Bt cotton

Cotton (*Gossypium* spp.) is one of the most important commercial crops playing a key role in economics and social affairs of the World. Many times it is also called "White Gold". Bt Cotton (*Bacillus thuringiensis*) is becoming popular now days throughout the country. Almost 95% of total area under cotton is converted to Bt Cotton. Although the problem of balls has been eliminated by induction of cry toxin gene, there are other problems with the cultivation practices of Bt Cotton. The most important is irrigation and fertilizer management of Bt Cotton. Water and fertilizer stress during critical growth stages of crop affects the cotton yield tremendously. Looking to the optimization of irrigation water and fertilizer doses through drip, the research project entitled "Yield response of Bt cotton under different irrigation schedules and fertilizer levels" was undertaken, to study the effect of drip irrigation schedules and fertilizer levels on growth and yield of Bt cotton,to study soil moisture distribution in Bt cotton under different irrigation schedules, to assess the effect of drip irrigation schedules and fertilizer levels on spectral reflectance of Bt cotton,to assess the water use efficiency and economic feasibility of drip irrigation system for Bt cotton.

METHODOLOGY

Treatment details:

- Irrigation schedules (3 days based PE for drip)

  I_1= Irrigation of 0.3 PE through drip.

  I_2= Irrigation of 0.5 PE through drip.

  I_3= Irrigation of 0.7 PE through drip.

  I_4= Irrigation of 0.5PE through drip only during critical stages.

  I_5=Irrigation of 0.5 PE through drip + green gram as intercrop.

  I_6= Irrigation through furrow at 150 CPE during dry spell (one pre sowing and one post sowing irrigation).

- Fertilizer levels

  F_1 = 75% RDF

  F_2 = 100% RDF

F_3 = 125% RDF

In drip fertigation:

N = 7 splits (30, 10, 10, 10, 10, 10 and 20% 7, 30, 45, 60, 75, 90 and 115DAS)

P = 3 splits (50, 25, 25% at 7, 30 and 45 DAS).

K = 4 splits (30, 20, 20 and 30% at 7, 30, 90 and 115 DAS).

In surface soil application:

N = 3 splits (at sowing 30, 40 and 30% at 7, 30 and 45 DAS).

P = 2 splits (50 % each at 7 and 30 DAS).

K = 3 splits (30, 30, and 40% at 7, 30 and 45 DAS).

Design specification :

Gross plot size	:	7.2 x 7.2 m
Net plot size	:	6.0 x 6.0 m
Crop	:	Cotton
Botanical name	:	*Gossypium* spp.
Variety	:	Bt cotton(Bt Bunny)
Replications	:	Three
Plant spacing	:	120:60 x 60 cm paired row planting for all treatments except I_5 for I_5 spacing is 180 x 30 cm with green gram as intercrop.
Design	:	Split plot.

The crop growth parameters were recorded approximately at 30 days interval after sowing with 5 randomly selected plants from each plot.

The water-use efficiency (WUE) for each treatment was estimated by the following equation: WUE=Y/CU where, WUE = Water-use efficiency (t /ha mm), Y = Cotton yield (t ha^{-1}), CU = Total seasonal consumptive-use of water (mm)

The calculation for spectral indices relative vegetative index (RVI) was computed from the spectral indices data. NIR =NIR_C/ NIR_b

where, NIR_C = Canopy radiance in NIR band, NIR_b= Irradiance on barium plate in NIR band

$$R = \frac{R_c}{R_b}$$

where, R_c = Canopy radiance in R band

R_b = Irradiance on barium plate in R band

$$RVI = \frac{NIR}{NIR + R} \qquad NDVI = \frac{NIR - R}{NIR + R}$$

For economic evaluation, treatment wise cost of cultivation, fixed and operational costs were used to determine the gross monetary returns (GMR), net monetary returns (NMR), and benefit-cost ratio (B:C Ratio).

RESULTS AND DISCUSSION

The results of the present study as well as relevant discussion have been summarized under following heads:

Growth parameters:

Data regarding to mean height per plant as influenced periodically by various irrigation schedules and fertilizer levels show that the mean height per plant increased with the advancement in the age of the crop.The effect of irrigation schedule on number of sympodia per plant was significant,the irrigation 0.5PE (I_2) recorded significantly higher branches per plant, the different fertilizers could not significantly affect the mean number of sympodial branches per plant, the effect of irrigation schedule and fertilizer could not significantly influence the number of monopodial branches per plant, the mean number of functional leaves per plant increased up to 150 DAS and thereafter decreased, the mean leaf area was influenced significantly due to different irrigation schedules at all the stages of growth. At 120 DAS the mean leaf area was significantly higher in 0.5PE (I_2), the mean number of squares per plant increased up to 120 DAS and thereafter decreased. At 120 DAS the mean number of squares was significantly higher in 0.5PE (I_2) , the mean number green bolls per plant increased up to 120 DAS and thereafter decreased. At 120 DAS the mean number of green bolls was significantly higher in 0.5PE (I_2) and at par with 0.7PE (I_3). The treatment I_5 (drip Irrigation at 0.5 PE with green gram as intercrop) recorded significantly higher yields (3853 kg/ha) as compared to all other treatments The fertilizer level F_3 (125% RDF) recorded significantly higher yield (3280 kg/ha).

Water use efficiency:

The highest water use was in I_3 schedule whereas highest water use efficiency was observed under treatment I_5 followed by I_2 and I_1.

Fertilizer use efficiency:

The maximum fertilizer use efficiency was observed under I_5F_1 (drip irrigation at 0.5 PE + green gram intercrop with 75% RDF)

Moisture content:

The moisture content in treatment I_3 0.7PE schedule

Table 1 : Water use efficiency

Irrigation schedule	Yield (kg/ha)	Irrigation water use (mm)	Effective rainfall (mm)	Total water use (mm)	WUE (kg/ha-mm)
I_1- Irrigation of 0.3 PE (drip)	3138	192.5	519	711.5	4.41
I_2- Irrigation of 0.5 PE (drip)	3730	306.9	519	825.9	4.52
I_3- Irrigation of 0.7 PE (drip)	3544	421.2	519	940.2	3.77
I_4 - Irrigation during critical growth stages (drip)	2749	144.4	519	663.4	4.14
I_5 - Irrigation at 0.5 PE + intercrop (drip)	3853	306.9	519	825.9	4.66
I_6 - Irrigation at 150 CPE during dry spell (furrow)	1730	255.0	519	774.0	2.23

Table 2 : Fertilizer use efficiency

Treatments	F_1	F_2	F_3	Mean
I_1	19.65	15.14	13.76	16.18
I_2	24.22	18.87	15.13	19.41
I_3	24.20	17.08	14.35	18.54
I_4	15.39	14.33	12.28	14.00
I_5	24.43	19.56	15.92	19.97
I_6	11.06	8.57	7.27	8.96
Mean	19.82	15.59	13.12	16.18

recorded higher moisture content than other irrigation schedule treatments. It was also found that there was an increase in moisture content with increasing schedule of irrigation. The trend in moisture distribution indicated that the moisture content was found to be maximum at surface layer below the emitter. The moisture content declined with the schedule and the moisture gained at 30 to 45 cm schedule was significantly low.

Relative vegetative index and normalized difference vegetation index (NDVI):

RVI and NDVI at 60DAS shows that, RVI and NDVI were higher in 0.5PE (I_2) followed by 0.3PE(I_1), 0.7PE(I_3) and also RVI and NDVI were higher in fertilizer level (125%RDF).This means that there was better growth of crop in 0.5PE(I_2) and fertilizer level (125%RDF).

Cost economics:

The B: C ratio of 3.08 was found to be highest in treatment I_2F_1 followed by I_3F_1(drip irrigation with 75% recommended dose of fertilizer kg/ha). Similar type of investigation was also carried out by Bhardwaj *et al.* (1988).

Conclusion:

– The drip irrigation scheduled at 0.5PE was better in regards with the growth attributes of cotton. On the other hand positive effect of higher dose of fertilizer was not evident for all growth attributes.

– The drip irrigation of 0.5 PE with green gram as intercrop produced significantly higher seed cotton equivalent yield.

– The fertilizers with 125% of recommended dose (125:62.5:62.5 kg/ha, N: P: K) gave higher seed cotton yield equivalent as compared to 75% and 100% recommended dose of fertilizers. No significant effect of interaction between irrigation schedule and fertilizer level was observed on seed cotton equivalent yield.

– The spectral indices *viz.*, RVI, NDVI found suitable for assessment of growth and vegetation vigour. Data Regarding to RVI and NDVI at 60DAS shows that, RVI and NDVI were higher in 0.5PE (I_2).This means that there was better growth of crop in 0.5PE (I_2) and fertilizer level (125%RDF).

– As regards to the effect of irrigation depths, it was observed that at surface layer the moisture content in 0.7PE (I_2) and 0.5PE (I_3) were higher than surface irrigation. The surface irrigation showed lower moisture content. Vertical moisture distribution shows that the moisture content was higher at surface layer and it decreaseed as the depth of soil increased in all treatments.

– Drip irrigation scheduled at 0. 5 PE with green gram as inter crop gave highest water use efficiency whereas drip of 0.5 PE depth with green gram as intercrop and 75% of RDF gave highest fertilizer use efficiency.

– On the basis of yield and cost economics the treatment I_2F_1 proved to be superior among all combinations.

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