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Growth and yield response of Bt cotton (*Gossypium hirsutum* L.) to surface and subsurface drip irrigation

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Abstract
A field experiment was carried out in vertisols at Irrigation Water Management Research Centre (IWMRC) Belvatagi, Dharwad during kharif 2015-16 to compare surface and sub surface drip irrigation methods in Bt cotton (*Gossypium hirsutum* L.) with different Etc. levels.Three levels of drip irrigation *viz*., irrigation at 1.0 Etc., 0.8 Etc. and 0.6 Etc. and two methods of drip irrigation *viz*., surface drip and subsurface drip irrigation were compared with alternatively alternate furrow method of irrigation. Sub surface drip irrigation recorded numerically higher seed cotton yield (3,109 kg ha^{-1}) compared to surface drip irrigation (2,758 kg ha^{-1}). Etc. levels did not influence seed cotton yield significantly. Interaction effect of method of irrigation and Etc. levels was significant. Sub surface drip irrigation with1.0 Etc. significantly increased plant height (98.08 cm), number of monopodia (3.58), number of sympodia (17.68), total number of bolls per plant (39.03) and seed cotton yield (3,471kgha^{-1}). Similarly higher water use efficiency was recorded at 0.6 Etc. 6.87 kg ha^{-1}-mm over 0.8 and 1.0 Etc. (29.3 and 43.4 per cent increase respectively).

Keywords: Bt cotton, Drip irrigation, Etc. levels

Introduction
Cotton, the ‘white gold' or the 'king of the fibre’, as it is often referred to, still holds its position high. Its use world over has been on the upswing. World over, cotton is gradually assuming the status of a preferred fibre even for fashion fabrics. Cotton cultivation needs to be sustainable, offering livelihood security to millions of people in the country. In India an estimated 4 million farmers and about 60 million people depend on cotton production and textile industry to make a living. Cotton is the most important commercial crop contributing nearly 75 per cent of total raw material needs of textile industry in India (Anon, 2007). Textile industry is the number one export enterprise in the country earning revenue of over $ 8.5 billion. Hence, it is called as the 'White gold', and plays a vital role in the economic development of the country. India is one of the major producers of cotton in the world with largest acreage of 11.7 m ha. During last ten years Bt Cotton (Bacillus thuringiensis) is becoming popular 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. Hence micro irrigation i.e. drip irrigation permits more efficient use of irrigation water as compared to other irrigation methods. Average water saving by drip irrigation in cotton is up to 57.8, 52.8 and 47.5 per cent at 0.6, 0.8 and 1.0 Etc. respectively as compared to conventional furrow irrigation method in cotton at Coimbatore (Nalayini *et al*., 2006) [7]. In addition, in recent years sub surface drip irrigation is also gaining importance due to reduced evaporation losses with higher water use efficiency. Sub surface drip irrigation(SDI) is the irrigation of crops through buried plastic tubes containing embedded emitters located at regular spacing which provides the ultimate in water use efficiency for open-field agriculture, often resulting in water savings. The extent of water saved in sub surface drip is by 20 per cent over surface drip irrigation (Martinez and Reca, 2014). Looking to the optimization of irrigation water through drip, the research project entitled “Response of Bt cotton (*Gossypium Hirsutum* L.) to surface and subsurface drip irrigation with different etc. levels” was undertaken, to study the effect of drip irrigation schedules on growth and yield of Bt cotton, soil moisture distribution under different irrigation schedules, water use efficiency.

Material and Methods

A field experiment was conducted during kharif 2015-16 at Irrigation Water Management Research Centre, Belvatagi, Dharwad to compare the effect of surface and subsurface drip irrigation with different Etc. levels on seed cotton yield and water use efficiency as against surface irrigation (Alternatively alternate furrow irrigation). The soil of the experimental site was clay in texture with pH of 8.20, organic carbon 0.45per cent and. EC 0.27 dS/m. The initial available N, P2O5 andK2O of the soil were 220, 34.5 and 710 kg ha-1, respectively. The values of field capacity and bulk density were 40.5 per cent and1.35 g/cc, respectively. The experiment was laid out in split plot design and was replicated four times. First class BG-II hybrid was sown during 2nd July 2015 with spacing of 60 cm x 120 cm. The experiment consists of six treatments *viz*., M1 I1: surface drip irrigation at 1.0 Etc., M1 I2: surface drip irrigation at 0.8 Etc., M1 I3: surface drip irrigation at 0.6 Etc., M2 I1: sub surface drip irrigation at 1.0 Etc., M2 I2: sub surface drip irrigation at 0.8 Etc., M2 I3: sub surface drip irrigation at 0.6 Etc. and one control C1:surface irrigation at 0.6 IW/CPE ratio. Scheduling of irrigation was undertaken on the basis of crop coefficient factors during cotton growth period and pan coefficient at every three days interval by considering rainfall using the formulaV = Ep × Kp (0.7) Kc × S1× S2 where, V, volume of water to be given/dripper (litres); Ep, pan evaporation (mm); Kp, pan co-efficient (0.7); Kc, crop co-efficient; S1, lateral spacing (0.9 m) and S2, dripper spacing (0.6 m). In cotton Kc values considered were 0.45, 0.75, 1.15 and 0.70 for initial (0–25 DAS), development stage (26–70 DAS), boll development (71–120 DAS) and maturity stage (121-harvest) respectively as per FAO Irrigation Water Management Training Manual No. 3 (1986). Scheduling of irrigation was done at three days frequency based on Etc. levels. The volume of water was calculated as: Time of irrigation was as per the discharge of water per dripper. In control six cm depth of irrigation was given on the basis of cumulative pan evaporation (100 mm CPE). The annual rainfall received during the year 2015 was 582.9 mm with of 392.2 mm during the cropping period from 2ndJuly to 28th February Growth and yield parameters and seed cotton yield were recorded as per standard procedures. Soil analysis were carried out using standard procedures. The data collected from the experimental field were analyzed statistically following the procedure as described by Gomez and Gomez (1984) [4]. The level of significance used in 'F' and 't' test was P=0.05. The mean values were separately subjected to Duncan's Multiple Range Test (DMRT) using the corresponding error mean sum of square sand degrees of freedom values. The control treatment was compared with the treatment combinations of main and subplots by using Randomized Block Design.

Results and Discussion

Effect of drip irrigation on yield parameters

The results (table 1) revealed Surface drip and sub surface drip method of irrigation did not make any significant difference with respect to number of sympodia, total bolls per plant, boll weight, seed cotton yield per plant and total seed cotton yield. Number of sympodia was found non significant with respect to method of irrigation at all growth stages. Higher number of sympodia i. e., 8.14 and 17.23 were obtained in subsurface drip irrigation at 60 and 120 DAS respectively. Number of sympodia was significantly influenced by Etc. levels at 60 and 90 DAS. At 60 DAS higher number of sympodia was obtained in irrigation scheduled at 1.0 Etc. (8.16) and this was found on par with 0.6 Etc. (8.06). No significant difference was observed with respect to number of sympodia in Etc. levels at 120 DAS.

The number of sympodia was significantly influenced by interaction effect of irrigation method and Etc. levels. At 60 DAS subsurface drip irrigation with 1.0 Etc. recorded significantly higher number of sympodia (8.45), which was followed by surface drip irrigation with 0.6 Etc. (8.25). Significantly lower number of sympodia was recorded in surface drip irrigation with 1.0 Etc. (13.15) compared to all other treatments. At 120 DAS significantly higher number of sympodia was obtained in subsurface drip irrigation with irrigation scheduled at 1.0 Etc. (17.68) and was on par with surface drip irrigation at 0.6 Etc. (17.33). Significantly lower number of sympodia was obtained in surface drip irrigation with 1.0 Etc. (16.55). Significantly higher number of sympodia (8.43) was recorded in surface irrigation at 0.6 IW/CPE ratio at 60 DAS compared to other treatments and this was on par with subsurface drip irrigation at 1.0 Etc. (8.45).

Mean boll weight did not differed significantly due to method of irrigation and Etc. levels. However numerically higher mean boll weight was observed in subsurface drip irrigation (6.04 g) and irrigation scheduled at 1.0 Etc. (6.08 g). Interaction effect of method of irrigation and Etc. levels indicated that biggest boll size was produced by irrigation scheduled at 1.0 Etc. with subsurface drip irrigation (6.44 g) compared to other treatments and significantly lower boll weight was obtained in surface drip irrigation with 1.0 Etc. (5.72 g).Surface irrigation at 0.6 IW/CPE ratio produced significantly higher boll weight (6.25 g) compared to all other treatments and was on par with subsurface drip irrigation at 1.0 Etc. (6.44 g).

Total number of bolls per plant was unaffected significantly due to method of irrigation. Higher number of bolls per plant was observed in subsurface drip irrigation (37.34). Total number of bolls per plant was significantly differed due to Etc. levels. Higher number of bolls per plant were produced in irrigation scheduled at 1.0 Etc. (37.24) and it was on par with 0.6 Etc. (36.78).Interaction of method of irrigation and Etc. levels indicated that irrigation scheduled at 1.0 Etc. with subsurface drip irrigation produced significantly higher number of bolls per plant (39.03) as compared to other treatment combinations. Surface irrigation at 0.6 IW/CPE ratio produced significantly higher number of bolls per plant (38.13) compared to all other treatments and was on par with subsurface drip irrigation at 1.0 Etc. (39.03) and surface drip irrigation with 0.6 Etc.

The seed cotton yield per plant was not significantly influenced by method of irrigation and Etc. levels. Higher seed cotton yield per plant was obtained in subsurface drip irrigation (164.08 g) and irrigation scheduled at 1.0 Etc. (164.0 g). Interaction effects of irrigation methods and Etc. levels differed significantly with respect to seed cotton yield per plant. Among the different treatment combinations subsurface drip irrigation with 1.0 Etc. recorded significantly higher seed cotton yield per plant (167.25 g) as compared to all other treatment combinations. Surface irrigation at 0.6 IW/CPE ratio recorded significantly higher seed cotton yield per plant (166 g) over other treatments and this was on par with subsurface drip irrigation at 1.0 Etc. (167.25 g).

The seed cotton yield per hectare was not significantly influenced by method of irrigation and Etc. levels. Higher seed cotton yield per hectare was obtained in subsurface drip irrigation (3109 kg ha^{-1}) and irrigation scheduled at 1.0 Etc.

(2996 kg ha^{-1}). Interaction between method of irrigation and Etc. level was found significant with respect to seed cotton yield per hectare. Among different interaction effects subsurface drip irrigation with 1.0 Etc. recorded significantly higher seed cotton yield (3471kg ha^{-1}) as compared to other treatments and it was found on par with surface drip irrigation with 0.6 Etc. (3072kg ha^{-1}). Significantly lowest seed cotton yield was recorded in 1.0 Etc. and 0.8 Etc. with surface drip irrigation (2521and 2681kg ha^{-1}, respectively). Surface irrigation at 0.6 IW/CPE ratio recorded significantly higher seed cotton yield per hectare (3206 kg ha^{-1}) over surface drip irrigation with 1.0 and 0.8 Etc. and was on par with subsurface drip irrigation at 1.0 Etc. (3471 kg ha^{-1}) and surface drip irrigation with 0.6 Etc. (3072 kg ha^{-1}) and also with subsurface drip irrigation with 0.8 Etc. and subsurface drip irrigation with 0.6 Etc.

Effect of drip irrigation on total water used and water use efficiency

Total water use

The total water use by the crop was higher in furrow irrigation (677 mm) as against drip irrigation regimes under 1.0 Etc., (625 mm) under 0.8 Etc. and (530 mm) under 0.6 Etc. (435 mm). The amount of water required for cotton ranges from 660 to 1,145 mm for different places or different varieties, depending on duration, soil and climatic conditions. As the seed cotton yield was comparable with furrow irrigation considerable saving in water used was possible by adopting drip irrigation. The water saving in 1.0, 0.8 and 0.6 Etc. levels were 7.6, 21.7 and 35.7 per cent respectively compared to furrow irrigation. Higher saving in water use in drip irrigation might be due to decreased evaporation losses.

Water use efficiency

Water use efficiency did not differed significantly due to method of irrigation. However water use efficiency was found numerically higher in subsurface drip irrigation 5.93 kg ha^{-1}-mm compared to surface drip irrigation (an 10.02 per cent increase). These results are in conformity with Abdrabbo (2013) [2] at Egypt. Water use efficiency by Etc. levels differed significantly. Among Etc. levels 0.6 Etc. recorded significantly higher water use efficiency 6.87 kg ha^{-1}-mm over 0.8 and 1.0 Etc. (29.3 and 43.4 per cent increase respectively). This might be due to higher seed cotton yield and limited quantity of water applied under 0.6 Etc. Similar results were found with Lomte and Kagde (2009) [5]. Amount of water applied varies based on Etc. levels. Amount of water applied in surface drip irrigation with 1.0 Etc. was 625 mm, in surface drip irrigation with 0.8 Etc. 530 mm and in surface drip irrigation with 0.6 Etc. 435 mm of water was applied. Same amount of water is used in subsurface drip irrigation. Among different treatment combinations significantly higher water use efficiency of 7.06 kg ha^{-1}mm was registered with surface drip irrigation with 0.6 Etc. Increase in the level of water application by drip irrigation decreased the water use efficiency, while limited quantity of water applied under lower drip irrigation regimes with higher seed cotton yield and also due to higher moisture content at all stages increased water use efficiency at lower Etc. These results were in harmony with Veeraputhiran and Chinnuswamy (2009) [9]. It is showed that moisture content during different stages at both 15 and 30 cm depth were positively correlated with seed cotton yield. Lower water use efficiency was recorded in surface drip irrigation with 1.0 Etc. (4.03 kg ha^{-1}-mm) due to lower seed cotton yield and lower soil moisture per cent at different soil depths.

Comparison of treatments with control (surface irrigation @ 0.6 IW/CPE ratio)

The alternatively alternate furrow irrigation consists of irrigating every odd furrow (1, 3, 5, etc.) during an irrigation event, then, during the following irrigation, irrigating even furrows (2, 4, 6, etc.).

Significantly higher seed cotton yield was recorded in surface irrigation at 0.6 IW/CPE ratio (3206 kg ha^{-1}) over surface drip irrigation with 1.0 and 0.8 Etc. (an increase of 27.1 and 19.5 per cent). However this was found on par with subsurface drip irrigation with 1.0, 0.8 and 0.6 Etc. along with surface drip irrigation at 0.6 Etc. This could be attributed to large amount of application of water (677 mm) and also due to higher effective rainfall of 137 mm during boll formation and maturity stage. The amount of water used in surface drip irrigation with 1.0 Etc. and subsurface drip irrigation with 1.0 Etc. is 625 mm compared to control method 677 mm. The extent of reduction in seed cotton yield in surface drip irrigation with 1.0 Etc. is 21.4% while in subsurface drip irrigation with 1.0 Etc. is increased by 8.3%. The increase in seed cotton yield in subsurface drip irrigation with 1.0 Etc. might have resulted in lesser evaporation losses of water in comparison to surface irrigation as they are placed inside the soil. These results were found in conformity with Patil *et al.*, 2008 [8]. The results of three years indicated that alternatively alternate furrow irrigation and drip irrigation were equally good methods. But under water scarcity areas and low rainfall years, drip irrigation would be better than alternatively alternate furrow irrigation for obtaining higher water use efficiency. The differences in yield of Bt cotton, with surface irrigation at 0.6 IW/CPE ratio, could be traced back to differences in yield components such as good opened bolls, total number of bolls, mean boll weight and seed cotton yield per plant. Although the seed cotton yield was similar, the water use efficiency was lower in surface irrigation 4.68 kg ha^{-1}-mm than in drip irrigation (Bengal *et al*., 1987) [3] and water requirement for surface irrigation was more than in drip irrigation in cotton (Magar and Sonawane, 1987) [6].

Correlation studies

The result obtained on correlation coefficient between seed cotton yield and its yield components are presented in Table 3.

The results revealed that seed cotton yield have significant positive correlation with good opened bolls (0.987 **), total number of bolls (0.990 **), boll weight (0.972 **), boll girth at 90 (0.955 *) and 120DAS (0.984 **), stem girth at 60 (0.958 *), 90 (0.957 *) and 120 DAS (0.942 *), number of seeds per boll (0.979 **) and seed cotton yield per plant (0.919 *). Whereas number of bad opened bolls have negative correlation with seed cotton yield (-0.794).

Table 1: Number of sympodia per plant, total bolls per plant, Boll weight, seed cotton yield per plant, seed cotton yield per hectare of Bt cotton as influenced by method of irrigation and Etc. levels

Treatment	Number of sympodia per plant		Total bolls per plant	Boll weight (g)	Seed cotton yield Per plant (g)	Seed cotton yield (kg ha^{-1})
	60 DAS	120 DAS				
Method of irrigation (M)						
M_1: Surface drip	8.03	16.84	36.17	5.83	162.50	2,758
M_2: Subsurface drip	8.14	17.23	37.34	6.04	164.08	3,109
S.Em±	0.03	0.12	0.27	0.16	0.35	149.80
CD (P= 0.05)	NS	NS	NS	NS	NS	NS
Etc. levels (I)						
I_1: 1.0 Etc.	8.16^{a}	17.11	37.24^{a}	6.08	164.00	2,996
I_2: 0.8 Etc.	8.03^{b}	16.85	36.25^{b}	5.82	162.88	2,815
I_3: 0.6 Etc.	8.06^{ab}	17.14	36.78^{ab}	5.91	163.00	2,990
S.Em±	0.04	0.10	0.29	0.09	0.61	99.81
CD (P= 0.05)	0.10	NS	0.89	NS	NS	NS
Interactions (MXI)						
M_1I_1	7.88^{d}	16.55^{d}	35.45^{c}	5.72^{b}	160.75^{b}	2,521^{b}
M_1I_2	7.96^{cd}	16.65^{cd}	35.85^{c}	5.75^{b}	162.50^{b}	2,681^{b}
M_1I_3	8.25^{b}	17.33^{ab}	37.21^{b}	6.01^{b}	164.25^{b}	3,072^{ab}
M_2I_1	8.45^{a}	17.68^{a}	39.03^{a}	6.44^{a}	167.25^{a}	3,471^{a}
M_2I_2	8.10^{bc}	17.05^{bc}	36.65^{bc}	5.88^{b}	163.25^{b}	2,949^{b}
M_2I_3	7.88^{d}	16.95^{bcd}	36.35^{bc}	5.80^{b}	161.75^{b}	2,908^{b}
S.Em±	0.05	0.14	0.41	0.13	0.86	141.15
CD (P= 0.05)	0.15	0.43	1.26	0.41	2.65	434.92
Control						
C_1	8.43	17.53	38.13	6.25	166.00	3,206
S.Em±	0.05	0.15	0.48	0.16	0.85	161.52
CD (P= 0.05)	0.16	0.45	1.43	0.49	2.53	479.89

Control (C_1): Surface irrigation (AAFI) at 0.6 IW/CPE ratio **DAS:** Days after sowing
Values followed by different letters in a column significantly differ as per DMRT.

Table 2: Total amount of water used and water use efficiency as influenced by method of irrigation and Etc. levels

Treatment	Total water applied (mm)	WUE (kg ha^{-1} mm)
Method of irrigation (M)		
M_1: Surface drip	530	5.39
M_2: Subsurface drip	530	5.93
S.Em±	-	0.29
CD (P= 0.05)	-	NS
Etc. levels (I)		
I_1: 1.0 Etc.	625	4.79^{c}
I_2: 0.8 Etc.	530	5.31^{b}
I_3: 0.6 Etc.	435	6.87^{a}
S.Em±	-	0.19
CD (P= 0.05)	-	0.58
Interactions (MXI)		
M_1I_1	625	4.03^{c}
M_1I_2	530	5.06^{b}
M_1I_3	435	7.06^{a}
M_2I_1	625	5.55^{b}
M_2I_2	530	5.56^{b}
M_2I_3	435	6.69^{a}
S.Em±	-	0.26
CD (P= 0.05)	-	0.82
Control (Alternatively alternate furrow irrigation)		
C1	677	4.68
S.Em±	-	0.30
CD (P= 0.05)	-	0.90

Control (C_1): Surface irrigation (AAFI) at 0.6 IW/CPE ratio **DAS**: Days after sowing
Values followed by different letters in a column significantly differ as per DMRT.

Table 3: Correlation between seed cotton yield and yield components

	1	2	3	4	5	6	7	8	9	10	11	12
1. Good opened bolls	1											
2. Bad opened bolls	-0.701	1										
3. Total bolls per plant	.998**	-0.729	1									
4. Mean boll weight	.994**	-0.673	.995**	1								
5. Boll diameter at 90 DAS	.948*	-0.731	.964**	.958*	1							
6. Boll diameter at 120 DAS	1.000**	-0.689	.997**	.994**	.944*	1						

7. Stem diameter at 60 DAS	.989**	-0.638	.989**	.998**	.949*	.989**	1					
8. Stem diameter at 90 DAS	.958*	-0.753	.974**	.972**	.991**	.954*	.966**	1				
9. Stem diameter at 120 DAS	.934*	-0.808	.955*	.950*	.967**	.928*	.942*	.990**	1			
10. No of seeds per boll	.994**	-0.722	.993**	.991**	.931*	.994**	.987**	.955*	.944*	1		
11. Seed cotton yield per plant	.956*	-0.638	.963**	.980**	.938*	.954*	.986**	.970**	.960**	.966**	1	
12. Seed cotton yd per ha	.987**	-0.794	.990**	.972**	.955*	.984**	.958*	.957*	.942*	.979**	.919*	1

Conclusion

From the results it was concluded that adoption of subsurface drip irrigation with 1.0 Etc. was found optimum for obtaining higher seed cotton yield with increased water use efficiency.

References

1. Anonymous, All India Coordinated Cotton Improvement Project, Annual report Project coordinator, CICR, Coimbatore, Tamil Nadu, 2007, 7(1).
2. Abdrabbo AA. Comparison among different irrigation systems for deficit irrigated cornin the nile valley. CIGR Ejournal, 2013, (11).
3. Bengal GB, Jadhav SB, Umrani NK. Comparitive studies of drip and furrow irrigated systems in cotton- Proceedings of National Seminar on Drip and Sprinkler Irrigation Methods, Rahuri, Maharastra, India, 1987.
4. Gomez KA, Gomez AA. Statistical Procedure for Agricultural Research, A Wiley Inter-Science Publication, New York (USA), 1984, 196-211.
5. Lomte DM, Kagde NV. Response of hybrid cotton (*Gossipiumhirsutum* L.) to different levels of drip irrigation in vertisol. J Cotton Res. Dev. 2009; 23(1):100-103.
6. Magar S, Sonawane BV. Moisture distribution pattern and nitrogen saving in drip irrigation for cotton in Vertisols. Paper Presented in NationalSeminar on Drip and Sprinkler Irrigation Methods Adoption. April 10-11, 1987, Rahuri, India, 1987.
7. Nalayini P, Raja R, Anderson AK. Evapotranspiration based scheduling of irrigation through drip for cotton (*Gossipiumhirsutum* L.) Indian J Agron. 2006; 51(3):232-235.
8. Patil VC, Halemani HL, Girijesh GK, Chandrashekar CP, Kalibavi CM, Hallikeri SS. Effect of drip and furrow irrigation on yield and quality of cotton genotypes in northern dry zones of Karnataka. J Indian Soc. Cotton. Improv. 2008; 33(2):85-93.
9. Veeraputhiran R, Chinnusamy C. Soil moisture and water use studies under drip and furrow irrigation methods in hybrid cotton. J Cotton Res. Dev. 2009; 23(1):74-79.