E-ISSN: 2618-0618
P-ISSN: 2618-060X

www.agronomyjournals.com
2024; SP-7(7): 96-101
Received: 23-04-2024
Accepted: 27-05-2024

Bhusari Sandip Ashok
Ph.D. Research Scholar,
Department of Agronomy,
Post Graduate Institute, MPKV,
Rahuri, Maharashtra, India

Dr. Bodake Prashant Shankar
Head, Department of Agronomy,
Dr. BSKKV, Dapoli, Maharashtra,
India

Salgar SB
Ph.D. Research Scholar,
Department of Agronomy,
Post Graduate Institute, MPKV,
Rahuri, Maharashtra, India

Gaikwad SG
Ph.D. Research Scholar,
Department of Agronomy,
Post Graduate Institute, MPKV,
Rahuri, Maharashtra, India

Corresponding Author:
Bhusari Sandip Ashok
Ph.D. Research Scholar,
Department of Agronomy,
Post Graduate Institute, MPKV,
Rahuri, Maharashtra, India

Effect of water saving techniques of irrigation and fertigation on growth of Bt. cotton

Bhusari Sandip Ashok, Dr. Bodake Prashant Shankar, Salgar SB and Gaikwad SG

DOI: https://doi.org/10.33545/2618060X.2024.v7.i7Sb.1002

Abstract
A field experiment on "Effect of resource conservation techniques of irrigation and fertigation through feed pipe on growth, yield and uptake of Bt. Cotton" was conducted during 2019-20 at AICRP on WM Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar Maharashtra (India). The experiment was conducted in split plot design. The treatments consist of four main plot treatments of irrigation *viz*., M1: control, M2: 19" feed pipe, M3: pit feed with organic matter and M4: 19" perforated pipe and three sub plot treatments of fertigation *viz*., S1: 100% RDF, S2: 80% RDF and S3: 60% RDF. Among the above main plot and sub plot treatments, application of irrigation through the 19" feed pipe (M2) with 100% RDF (F1) found highest plant height, maximum number of leaves, maximum leaf area and higher sympodial branches which was significantly superior over the rest of treatments at all the crop growth stages during both years. Whereas, significantly lowest plant height, number of leaves, leaf area and sympodial branches was recorded under the application of irrigation through the treatment control (M1) with the application of 60% RDF (F3) at all the crop growth stages during both years.

Keywords: Feed pipe, perforated pipe, RDF, irrigation, fertigation

Introduction
Cotton (*Gossypium hirsutum* L.) is the most important fibre cum cash crop of our country, sustaining one of the country's largest organized industry the textile industry, which constitutes nearly 20 percent of industrial production and 38 percent of exports. Cotton supplies the 85 percent of raw materials to the total fibre consumption in the textile sector. Cotton plays an important role in transforming subsistence agriculture into a profit-oriented business. India is the pioneer country in hybrid cotton cultivation on commercial scale and hybrid cotton covers about 40 percent of the total cotton area and contributes 50 percent of the national cotton production.
Global 2021-22 cotton area and production are projected as 32.90 million hectares (81.29 million acres) and 119.60 million bales of 217.72 Kg each. Cotton productions in most of the major producing countries are expected to increase except China in 2021-22. India is projected to produce 28.50 million bales followed by China (26.80 million bales), United States (18.50 million bales), Brazil (12.50 million bales) and Pakistan (5 million bales).
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 percent of total raw material needs of textile industry in India. Textile industry is the number one export enterprise in the country earning revenue of over $ 8.5 billion (Anonymous, 2012b) [1]. Hence, it is called as the 'White gold', and plays a vital role in the economic development of the country.
Feed pipe is a very important tool now a day for cotton, other commercial crops and orchards in water scarcity area and efficient wonderful tool for cotton for their quality index. The feed pipe is an instrument, which is attached to drip irrigation system to improve, optimise and also for efficient irrigation to plant root canopy.

This device plays a very vital role to increasing the efficiency of irrigation and fertigation and to save water as well as fertilizers near to 100 percent because feed pipe provide irrigation and fertilizers directly to the root zone (rhizosphere).

Materials and Methods

The experiment was conducted during *kharif* 2019, at AICRP on Irrigation Water Management Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri (M. S.). The soil of the experimental field was clayey in texture. It was low in available nitrogen (221.10 kg ha^{-1}), medium in phosphorus (12.42 kg ha^{-1}) and high in potassium (442.10 kg ha^{-1}) with slightly alkaline in reaction (pH 7.86). The electrical conductivity of soil was 0.41 dSm^{-1}. The moisture content at field capacity and permanent wilting point was 38.10 percent and 18.50 percent, respectively. The bulk density of soil was 1.24 Mg m^{-3}. The available WHC of experimental filed was quite high and it indicates that the soil was moisture retentive.

The experiment was conducted in split plot design. The gross plot size is 10.50 m x 8.10 m and net plots sizes was 8.40 m x 5.40 m. The treatments consist of four main plot treatments of irrigation *viz*., M1: control, M2: 19" feed pipe, M3: pit feed with organic matter and M4: 19" perforated pipe and three sub plot treatments of fertigation *viz*., S1: 100% RDF, S2: 80% RDF and S3: 60% RDF. The crop was sown by dibbling method with sufficient soil moisture.

The weather data was recorded at Indian Meteorological Observatory Located at Research Farm of Water Management Project, Mahatma Phule Krishi Vidyapeeth, Rahuri during the period of experimentation. the total precipitation received during the crop growth period was 730 mm in 42 rainy days during first season (it was recorded higher than the average due to very high rainfall for this year). The mean weekly maximum temperature was ranged between 39.1-27.1 °C, while minimum temperature was ranged between 26.2-15.2 °C. The mean relative humidity was ranged between 87-59 percent at morning hours, while at evening hours it was ranged between 79-30 percent. The pan evaporation was high in the month of June and thereafter it was decreased. The maximum (11.9 mm) and minimum (1.6 mm) pan evaporation was observed on 23rd and 43th meteorological week, respectively. The mean maximum (8.2 km hr^{-1}) and minimum (0.2 km hr^{-1}) wind velocity was obtained on 32 MW and 48 MW. The mean maximum and minimum bright sunshine hours were 9.3 and 1.3 hours, respectively during experimental period.

Results and Discussion

The mean plant height (cm), number of functional leaves $plant^{-1}$, leaf $area^{-1}$ and sympodial branches $plant^{-1}$ of Bt. cotton was influenced significantly due to different treatments are presented in table 1, 2, 3 and 4 respectively.

Effect of main plot treatment: Irrigation

The growth attributing characters *viz*. plant height, number of functional leaves $plant^{-1}$, leaf $area^{-1}$ and sympodial branches $plant^{-1}$ of Bt. cotton was influenced significantly due to the different treatments of irrigation. Whereas the significantly minimum plant height was registered at control (M1) at all the crop growth stages for all growth attributing characters. Data presented in table 1 indicated that the crop was irrigated through 19" feed pipe recorded significantly maximum plant height at 30, 60, 90, 120, 150 and at harvest was 22.08, 50.04, 92.23, 122.44, 140.76 and 154.96 cm respectively, than rest of the treatments of irrigation at all the crop growth stages. However, it was at par with 19" perforated pipe at 30, 60, 90, 150 DAS and at harvest. And it was also at par with 19" hole feed with organic matter at 90 DAS. Maximum plant height was recorded by 19" feed pipe (M2) might be due to adequate moisture and adequate aeration because of this 19" feed pipe provide moisture directly to the root zone. These results are in agreement with those reported by Singh *et al.* (2007a) [10] and Mane *et al*. (2017) [6].

Table 1: Plant height of Bt. Cotton as influenced periodically by different treatments during 2019.

Treatment	Plant height (cm)					
	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	At harvest
I) Main Plot treatment: Irrigation						
M1: Control (Drip without feed pipe)	19.71	43.95	80.25	110.20	123.51	129.74
M2: 19" feed pipe	22.08	50.04	92.23	122.44	140.76	154.96
M3: 19" hole feed with organic matter	20.24	44.00	85.42	112.38	129.26	137.51
M4: 19" perforated pipe	21.40	47.26	89.10	115.63	135.47	142.74
SE (m) ±	0.61	1.18	2.04	1.84	2.01	3.74
CD at 5%	1.83	4.08	7.06	6.38	6.95	12.93
II) Sub Plot treatment: fertigation						
S1: 100% RDF	21.92	49.84	95.16	124.40	146.78	155.58
S2: 80% RDF	20.67	46.70	84.99	113.28	127.31	138.64
S3: 60% RDF	19.98	43.00	80.11	107.81	122.66	129.50
SE (m) ±	0.45	0.66	1.34	2.73	1.86	4.15
CD at 5%	1.36	1.98	4.03	8.17	5.58	12.43
Interaction (MxS)						
Between two subplot means at same level of main plot mean						
SE (m) ±	0.90	1.32	2.69	5.45	3.72	8.29
CD at 5%	NS	3.96	NS	NS	11.17	NS
Between two mains plot means at same level of sub plot mean						
SE (m) ±	0.96	1.60	3.00	4.82	3.64	7.73
CD at 5%	NS	5.20	NS	NS	11.44	NS
GM	20.86	46.51	86.75	115.16	132.25	141.24

Table 2: Interaction effect between irrigation and fertigation levels on plant height of Bt. cotton at 60 days after harvesting during 2019.

Plant height (cm)				
Sub Plot treatment: Fertigation	**Main Plot treatment (Irrigation)**			
	M 1	**M 2**	**M 3**	**M 4**
S1: 100% RDF	45.00	57.24	47.31	49.81
S2: 80% RDF	43.52	50.07	46.18	47.02
S2: 60% RDF	40.46	42.82	43.77	44.95
Source			SE (m)±	CD at 5%
Between two subplot means at same level of main plot mean			1.32	3.96
Between two mains plot means at same level of sub plot mean			1.59	5.19

Table 3: Interaction effect between irrigation and fertigation levels on plant height of Bt. cotton at 150 days after harvesting during 2019.

Plant height (cm)				
Sub Plot treatment: Fertigation	**Main Plot treatment (Irrigation)**			
	M 1	**M 2**	**M 3**	**M 4**
S1: 100% RDF	129.37	170.30	138.67	148.77
S2: 80% RDF	123.43	125.70	128.37	131.73
S2: 60% RDF	117.73	126.27	120.73	125.90
Source			SE (m)±	CD at 5%
Between two subplot means at same level of main plot mean			3.72	11.16
Between two mains plot means at same level of sub plot mean			3.64	11.43

Table 4: Number of leaves plant^{-1} of Bt. Cotton as influenced periodically by different treatments during 2019.

Treatment	**Number of leaves plant^{-1}**					
	30 DAS	**60 DAS**	**90 DAS**	**120 DAS**	**150 DAS**	**At harvest**
I) Main Plot treatment: Irrigation						
M1: Control (Drip without feed pipe)	12.47	75.93	127.77	187.40	178.83	154.40
M2: 19" feed pipe	17.26	116.96	162.67	223.89	202.01	172.68
M3: 19" hole feed with organic matter	15.07	97.97	136.48	206.79	194.24	163.63
M4: 19" perforated pipe	16.71	106.64	146.33	214.92	197.17	169.49
SE (m) ±	0.62	1.57	4.25	2.30	1.96	1.97
CD at 5%	2.16	5.44	14.72	7.97	6.77	6.82
II) Sub Plot treatment: fertigation						
S1: 100% RDF	18.63	105.58	156.30	225.96	203.19	172.13
S2: 80% RDF	15.83	99.61	144.36	206.92	192.23	164.18
S3: 60% RDF	11.67	92.93	129.28	191.88	183.78	158.84
SE (m) ±	0.40	1.46	3.71	1.45	1.54	1.08
CD at 5%	1.20	4.36	11.11	4.35	4.61	3.24
Interaction (MxS)						
Between two subplot means at same level of main plot mean						
SE (m) ±	0.80	2.91	7.41	2.90	3.07	2.16
CD at 5%	NS	NS	NS	8.69	NS	6.48
Between two mains plot means at same level of sub plot mean						
SE (m) ±	0.90	2.85	7.40	3.30	3.18	2.65
CD at 5%	NS	NS	NS	10.65	NS	8.61
GM	15.38	99.38	143.31	208.25	193.06	165.05

Table 5: Interaction effect between irrigation and fertigation levels on Number of leaves plant^{-1} of Bt. cotton at 120 days after sowing during 2019.

Number of leaves plant^{-1}				
Sub Plot treatment: Fertigation	**Main Plot treatment (Irrigation)**			
	M 1	**M 2**	**M 3**	**M 4**
S1: 100% RDF	211.07	234.67	225.67	232.43
S2: 80% RDF	188.33	222.67	203.67	213.00
S2: 60% RDF	162.80	214.33	191.03	199.33
Source			SE (m)±	CD at 5%
Between two subplot means at same level of main plot mean			2.89	8.69
Between two mains plot means at same level of sub plot mean			3.30	10.64

Table 6: Interaction effect between irrigation and fertigation levels on Number of leaves plant^{-1} of Bt. cotton at harvest during 2019.

Number of leaves plant^{-1}				
Sub Plot treatment: Fertigation	**Main Plot treatment (Irrigation)**			
	M 1	**M 2**	**M 3**	**M 4**
S1: 100% RDF	155.53	181.87	173.13	178.23
S2: 80% RDF	154.25	174.37	162.97	167.00
S2: 60% RDF	152.40	161.80	154.80	163.23
Source			SE (m)±	CD at 5%
Between two subplot means at same level of main plot mean			2.16	6.47
Between two mains plot means at same level of sub plot mean			2.64	8.60

Data presented in table 2 revealed that the application of irrigation through 19" feed pipe was recorded significantly maximum number of leaves plant^{-1} at 30, 60, 90, 120, 150 and at harvest was 17.26, 116.96, 162.67, 223.89, 202.01 and 172.68 respectively, than rest of the treatments of irrigation at all the crop growth stages. however, it was at par with 19" perforated pipe at 30 DAS, 150 DAS and at harvest. The maximum numbers of leaves plant^{-1} with 19" feed pipe (M2) might be due to favourable soil moisture that supports the establishment and development of Bt. cotton crops. These results were confirmed by Mane *et al*. (2017) [6].

Data presented in Table 3 revealed that the significantly maximum leaf area plant^{-1} was observed where crop was irrigated through 19" feed pipe at 30, 60, 90, 120, 150 DAS and at harvest was 95.72, 386.36, 798.74, 736.30, 466.88 and 435.31 at all the stages of crop growth however, it was at par with 19" perforated pipe at 60 DAS, 150 DAS and at harvest. The 19" feed pipe showed significantly higher leaf area plant^{-1} due to enough moisture available at root zone and additionally, more-nutrients may have been absorbed from the root zone for longer period. These results are supported by Sagarka *et al*. (2002) [9] and Rao and Janawade (2006) [8].

Data presented in Table 4 revealed that the Significantly maximum number of sympodial branches plant^{-1} was observed where crop was irrigated through 19" feed pipe at 60, 90, 120, 150 and at harvest was 14.44, 18.62, 22.18, 26.01 and 26.45, respectively. However, it was at par with 19" perforated pipe at 60 DAS, 90 DAS, 120 DAS and 150 DAS. The maximum numbers of sympodial branches plant^{-1} with 19" feed pipe (M2) might be due to favourable soil moisture, proper spacing between pair of rows and weed free environment that supports the establishment and development of Bt. cotton crops. These results were confirmed by Mane *et al*. (2017) [6].

Effect of sub plot treatment: fertigation

The growth attributing characters *viz*. plant height, number of functional leaves plant^{-1}, leaf area^{-1} and sympodial branches plant^{-1} of Bt. cotton was influenced significantly due to the different treatments of fertigation. Whereas, significantly minimum plant height was recorded under 60% RDF at all the crop growth stages for all the growth attributing charachters.

Data presented in Table 1 revealed that the application of 100% RDF (S1) recorded significantly higher plant height at 30, 60, 90, 120, 150 DAS and at harvest was 21.92, 49.84, 95.16, 124.40, 146.78 and 155.58 cm, respectively than other treatments at all the crop growth stages during both the years. However, it was at par with 80% RDF at 30 DAS. The higher plant height was recorded under 100% RDF (S1) might be due to supply of chemical fertilizer in adequate amount directly to the root zone of crop and is crucial for the establishment and initial growth of plants in terms of plant height. These findings are confirmed by Hargilias and Saini (2018) and Ghule *et al.* (2013) [3].

Data presented in Table 2 implicated that the fertigation with 100% RDF registered significantly maximum number of leaves plant^{-1} at 30, 60, 90, 120, 150 and at harvest it was 18.63, 105.58, 156.30, 225.96, 203.19 and 172.13 respectively, than remaining treatment at all the crop growth stages however, it was at par with 80% RDF at 30 DAS. The number of leaves plant^{-1} recorded higher under 100% RDF (M2) practice might be due to N, P and K are major plant nutrients causing increased meristematic activity of the plant as a result of proportionate increase in growth attributes in terms of number of leaves plant^{-1}. These results are in conformity with those reported by Ghule *et al.* (2013) [3].

Data presented in Table 3 expressed that the fertigation with 100% RDF observed significantly maximum leaf area plant^{-1} at 30, 60, 90, 120, 150 DAS and at harvest was 92.83, 360.86, 749.01, 705.22, 426.98 and 405.65 respectively, than remaining treatment at all the crop growth stages however, it was at par with 80% RDF at 30 DAS, 60 DAS, 90 DAS, 120 DAS and 150 DAS. The maximum leaf area plant^{-1} recorded higher under 100% RDF (S2) might be due to increased nutrient availability to crops due to increased fertilizer doses favour crop growth and development. These results are in conformity with those reported by Ghule *et al.* (2013) [3].

Data presented in Table 4 implicated that the fertigation with 100% RDF registered significantly maximum number of sympodial branches plant^{-1} at 30, 60, 90, 120, 150 and at harvest it was 13.61, 16.51, 20.39, 25.17 and 24.59 respectively, than remaining treatment at all the crop growth stages however, it was at par with 80% RDF at 60 DAS, 90 DAS, 120 DAS and at harvest and also it was at par with 60% RDF with 90 DAS and at harvest. The maximum number of sympodial branches plant^{-1} recorded under 100% RDF (S1) might be due to increased nutrient availability to crops due to increased fertilizer doses favour crop growth and development. These results are in conformity with those reported by Srinivasan (2006) [11], Rajendran and Arunvenkatesh (2014) [7] and Jayakumar *et al.* (2015) [5].

Table 7: Leaf area plant^{-1} of Bt. Cotton as influenced periodically by different treatments during 2019.

Treatment	Leaf area plant^{-1}					
	30 DAS	60 DAS	90 DAS	120 DAS	150 DAS	At harvest
I) Main Plot treatment: Irrigation						
M1: Control (Drip without feed pipe)	77.94	298.16	663.24	596.77	365.07	337.49
M2: 19" feed pipe	95.72	386.36	798.74	736.30	466.88	435.31
M3: 19" hole feed with organic matter	84.97	327.56	709.97	684.10	387.34	375.66
M4: 19" perforated pipe	91.49	378.36	759.67	710.38	439.87	410.04
SE (m) ±	0.70	3.79	1.85	4.78	8.94	10.49
CD at 5%	2.41	13.10	6.39	16.54	30.93	36.29
II) Sub Plot treatment: fertigation						
S1: 100% RDF	92.83	360.86	749.01	705.22	426.98	405.65
S2: 80% RDF	87.58	345.83	732.23	675.96	410.05	382.58
S3: 60% RDF	82.18	336.28	717.48	664.48	407.34	380.64
SE (m) ±	1.58	6.86	10.50	11.00	5.77	6.58
CD at 5%	4.75	20.58	31.50	32.98	17.31	19.74
Interaction (MxS)						
Between two subplot means at same level of main plot mean						
SE (m) ±	3.17	13.71	21.49	22.00	15.54	17.15
CD at 5%	NS	NS	NS	NS	NS	NS
Between two mains plot means at same level of sub plot mean						
SE (m) ±	2.68	11.82	17.64	18.59	15.52	17.50
CD at 5%	NS	NS	NS	NS	NS	NS
GM	87.53	347.66	732.91	681.8	414.79	389.63

Table 8: Number of sympodial branches plant^{-1} of Bt. Cotton as influenced periodically by different treatments during 2019.

Treatment	Number of sympodial branches plant^{-1}				
	60 DAS	90 DAS	120 DAS	150 DAS	At Harvest
I) Main Plot treatment: Irrigation					
M1: Control (Drip without feed pipe)	11.76	12.92	15.19	18.98	18.95
M2: 19" feed pipe	14.44	18.62	22.18	26.01	26.45
M3: 19" hole feed with organic matter	12.08	12.22	18.98	22.62	21.70
M4: 19" perforated pipe	13.07	17.47	21.12	24.02	24.24
SE (m) ±	0.57	0.36	0.48	0.65	0.47
CD at 5%	1.71	1.24	1.67	2.23	1.62
II) Sub Plot treatment: fertigation					
S1: 100% RDF	13.61	16.51	20.39	25.17	24.59
S2: 80% RDF	12.99	15.92	19.45	22.56	23.14
S3: 60% RDF	12.17	15.63	18.27	20.99	22.77
SE (m) ±	0.32	0.38	0.46	0.45	0.61
CD at 5%	0.96	1.14	1.37	1.36	1.83
Interaction (MxS)					
Between two subplot means at same level of main plot mean					
SE (m) ±	0.64	0.76	0.92	0.91	1.22
CD at 5%	NS	NS	NS	NS	3.65
Between two mains plot means at same level of sub plot mean					
SE (m) ±	0.78	0.71	0.89	0.98	1.10
CD at 5%	NS	NS	NS	NS	3.39
GM	12.92	16.02	19.37	22.91	22.84

Table 9: Interaction effect between irrigation and fertigation levels on number of sympodial branches per plant^{-1} of Bt. cotton at harvest during 2019.

Number of sympodial branches per plant^{-1}				
Sub Plot treatment: Fertigation	**Main Plot treatment (Irrigation)**			
	M 1	M 2	M 3	M 4
S1: 100% RDF	23.76	27.01	24.42	26.18
S2: 80% RDF	19.37	26.31	21.97	23.93
S2: 60% RDF	13.73	25.04	20.72	22.60
Source			SE (m)±	CD at 5%
Between two subplot means at same level of main plot mean			1.21	3.65
Between two mains plot means at same level of sub plot mean			1.10	3.39

Interaction

The interaction between treatments of irrigation and fertigation were found significant in respect of plant height at 60 DAS and 150 DAS. For number of leaves plant^{-1} were found to be significant at 120 and at harvest. The interaction effect found to be non-significant in case of leaf area plant^{-1}. The interaction effect for sympodial branches was found significant at harvest. The combination of treatments 19" feed pipe and 100% RDF significantly recorded higher plant height at 60 and 150 DAS, maximum number of leaves plant^{-1} at 120 DAS and at harvest and maximum number of sympodial branches plant^{-1} at harvest.

Conclusion

1. It was concluded that the effect of water saving techniques of irrigation i.e. 19" feed pipe significantly recorded higher growth parameters than rest of the treatments and it was found at par with the treatment 19 perforated pipe.
2. The effect of fertigation level with 100% RDF obtained higher growth parameters than rest of the levels of fertigation.

References

1. Anonymous. Measuring the contribution of Bt. cotton adoption to India's cotton yields. International Food Policy Research Institute, Discussion Paper. 2012;1170.
2. Rajak D, Manunatha MV, Rajkumar GR, Ravishankar G. Response of cotton to drip and surface irrigation in saline vertisols. Journal of Agricultural Engineering. 2010;47(2):15-17.
3. Ghule PL, Palve DK, Jadhav JD, Dahiphale VV. Plant geometry and nutrient levels effect on productivity of Bt cotton. International Journal of Agricultural Sciences. 2013;9(2):486-494.
4. Hargilas V, Saini DP. Performance of Bt cotton hybrids under varying plant spacings and nutrient levels. Journal of Cotton Research and Development. 2018;32(1):106-111.
5. Jayakumar M, Surendran U, Manickasundaram P. Drip fertigation program on growth, crop productivity, water and fertilizer use efficiency of Bt cotton in semi-arid tropics of India. Communications in Soil Science and Plant Analysis. 2015;46:293-304.
6. Mane RB, Tumbare AD, Nimbalkar CA. Effect of irrigation regimes and nutrient management through drip on growth, yield and leaf reddening in Bt cotton (*Gossypium hirsutum* L.). Journal of Cotton Research and Development. 2017;31(2):213-223.
7. Rajendran K, Arunvenkatesh S. Nutrient dynamics under drip fertigation in cotton. Academic Research Journal. 2014;2(1-2):37-41.
8. Rao S, Janawade AD. Studies on integrated nutrient management in irrigated hybrid cotton. Journal of Cotton Research and Development. 2006;20(2):212-215.
9. Sagarka BS, Malavia DD, Solan RM, Kachot NA, Dabhi BM. Effect of irrigation method and nitrogen on yield and quality of winter cotton (*Gossypium hirsutum* L.). Indian Journal of Agronomy. 2002;47(4):544-549.
10. Singh K, Rathore P. Effect of different spacing and nitrogen levels on growth and yield attributes of American cotton (*Gossypium hirsutum* L.) genotypes. Journal of Cotton Research and Development. 2007;21(2):178-179.
11. Srinivasan G. Agronomic evolution of Bt cotton hybrids in summer irrigated tract of Southern Tamil Nadu. Journal of Cotton Research and Development. 2006;20(2):224-225.