Research Article

Response of Cotton to Various Irrigation and Nitrogen Levels with Different Quality of Irrigation Water under Drip Irrigation System

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Abstract

An experiment entitled 'Response of cotton to various water regimes and nitrogen level with saline water under drip irrigation system" was carried out at the Precision Farming Development Centre, ARS, Swami Keshwanand Rajasthan Agricultural University, Bikaner during *kharif* 2016, 2017 and 2018 on loamy sand soil. Study was carried out to determine the response of different irrigation and nitrogen levels using saline & best available water using drip irrigation. The experiment comprising total 18 treatment combinations; two water quality (best available water and saline water), three irrigation levels (0.6 ETc, 0.8 ETc and 1.0 ETc) and three nitrogen levels (75 percent recommended dose of nitrogen, 100 percent recommended dose of nitrogen & 125 percent recommended dose of nitrogen) in factorial randomized block design with three replications. Results revealed that plant height, number of sympodial branches, number of bolls; boll weight and seed cotton yield was influenced significantly by irrigation and nitrogen levels. Irrigation with best available and saline water at 0.8 ETc irrigation level and 100 percent recommended dose of nitrogen improved the plant height, number of sympodial branches, number of bolls, boll weight seed cotton yield, net return and B:C ratio than rest of treatments.

Keywords: Cotton, drip irrigation, Etc, saline water, RDN

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Introduction

Cotton is known as the "white gold" due to the multifaceted value of lint and other byproducts. Even though man-made synthetic fibers are produced in quantum, natural vegetable fiber is hassle-free in the life of human beings and in the ecofriendly environment. Globally cotton production is 118.5 million bales in 2018-19 [1]. On a global basis, China is first in cotton production followed by India. In India covers 12.43 million hectares acreage with an annual production of 34.89 million bales and productivity 477 kg/ha [2]. Punjab, Haryana, Rajasthan, Gujarat, Maharashtra, Madhya Pradesh, Andhra Pradesh, Karnataka, and Tamil Nadu are most cotton-growing states of India. Sriganganagar, Hanumangarh, Banswara, Bhilwara, Jodhpur, Nagaur, Alwar, Ajmer and Bikaner are major cotton growing districts of Rajasthan. The crop occupied 6.29 lakh hectares area and produced 20.93 lakh bales with the productivity of 551 kg/ha [3], out of this 80% area and production covered by Sriganganagar, Hanumangarh (Bikaner Region). The most of irrigation water is saline water in this region so there is a need to develop techniques of cotton cultivation under saline water. Using brackish and saline water is one of the most effective ways to solve the problem of water resource shortage. It is known that the growth inhibition and the adverse effects induced by salinity can be alleviated by proper use of fertilizer and water management, depending on plant species, salinity level, and environmental conditions [4-6]. None the less, over-fertilization with N may contribute to soil salinization and increase the negative effects of soil salinity on plant performance. Also, the potential for NO_3 leaching may increase were moderate to high amounts of salts are present in the soils because plants under salt stress cannot absorb and or utilize the applied N as efficiently as the plants not subjected to salt stress. When, the salinity of irrigation water rises, the leaching fraction can be control increase to control root zone salinity through drip irrigation by continuous water dropping at the particular palace [7].

Materials and Methods

The field experiment was conducted at Agricultural Research Station, Swami Keshwanand Rajasthan Agricultural University, Bikaner, Rajasthan, India (28o 01'N latitude and 73o 22'E longitude at an altitude of 234.70 meters above mean sea level) during *kharif* season of 2016, 2017 and 2018. The soil of experimental field was loamy-sand, alkaline in reaction (pH 8.2) having 120 kg/ha available N (Alkaline permanganate method, low level of available phosphorus (15.1 kg/ha, Olsen's method and medium in available potassium (173.7 kg/ha, Flame photometric method in 0-15 cm

soil depth at the start of the experiment. A seed rate of 1.8 kg/ha of Bt. the cotton seed was used for experimentation. The experiment was laid out in a factorial randomized complete block design with three replications. The experiment comprising total 18 treatment combinations; two water quality (best available water and saline water), three irrigation levels (0.6 ETc, 0.8 ETc and 1.0 ETc) & three fertigation levels (75 percent recommended dose of nitrogen, 100 percent recommended dose of nitrogen & 125 percent recommended dose of nitrogen. The sowing of cotton seed by dibbling with maintained crop geometry 100 × 60 cm. The manure and fertilizers are applied as FYM 15 t/ha and 150:40:00 NPK each kg/ha whereas potash given as a foliar application of potassium nitrate @ 2% at full blooming and boll formation stage. The experimental crop was raised as per the recommended package of practices.

Results and Discussion

Plant height

The plant height significantly influenced due to irrigation levels. It is observed that the plant height of cotton was higher at irrigation at 0.8 ETc (15.06 cm) as compared to 0.6 ETc but remain statistically at par with 1.0 Etc. [8] also reported that plant height higher under drip irrigation at 0.8 ETc Irrigation level at 0.8 ETc increased plant heights to the tune of 10.49 percent over 0.6 ETc as pooled mean basis. Further, result showed that plant height was significantly influenced by different levels of nitrogen. Application of 100 percent recommended dose of nitrogen recorded significantly highest plant height (153.06, 158.06, &156.39 cm) as compared to 75 percent recommended dose of nitrogen but remain at par with 125 percent recommended dose of nitrogen during 2016, 2017 and 2018, respectively. However, the plant height of cotton was not influenced by the quality of irrigation water.

Number of sympodial branches

A data (**Table 1**) showed that the number of sympodial branches of cotton influenced significantly by irrigation levels. The mean of three years of data indicated that drip irrigation at 0.8 evapotranspiration (ETc) was superior to 0.6 and 1.0 ETc. Drip irrigation at 0.8 ETc recorded a significantly higher number of sympodial branches/plant during all the three years as well as pooled mean basis (30.56, 30.28, 29.72 and 30.19, respectively) as compared to 0.6 ETc but remain at par with 1.0 ETc. Among irrigation levels, irrigation at 0.8 ETc recorded 23.98 percent higher number of sympodial branches plant^{-1} over 0.6 ETc.

Table 1 Effect of water quality, water regime and nitrogen levels on plant height and number of sympodial branches/plant of cotton

Treatments	Plant height (cm)				Number of sympodial branches/plant			
	2016-17	2017-18	2018-19	Pooled	2016-17	2017-18	2018-19	Pooled
BAW	146.30	150.19	148.59	148.36	28.48	28.19	27.93	28.20
Saline water	144.63	147.96	147.22	146.60	27.96	27.63	27.30	27.63
S.Em.±	0.86	1.00	0.75	0.87	0.28	0.28	0.23	0.26
C.D. at 5%	2.48	2.86	2.15	2.45	0.80	0.80	0.67	0.74
0.6 V water (Water applied 352.2 mm)	137.83	139.22	138.50	138.52	24.72	24.11	24.22	24.35
0.8 V water (Water applied 469.6 mm)	150.28	155.83	153.06	153.06	30.56	30.28	29.72	30.19
1.0 V water (Water applied 587 mm)	148.28	152.17	152.17	150.87	29.39	29.33	28.89	29.20
S.Em.±	1.29	1.49	1.12	1.31	0.42	0.42	0.35	0.39
C.D. at 5%	3.72	4.29	3.22	3.68	1.19	1.20	1.00	1.11
Fertigation with 75% RDN	132.00	134.50	133.22	133.24	24.78	24.33	22.83	23.98
Fertigation with 100% RDN	153.06	158.06	156.39	155.83	30.39	30.17	30.39	30.31
Fertigation with 125% RDN	151.33	154.67	154.11	153.37	29.50	29.22	29.61	29.44
S.Em.±	1.29	1.49	1.12	1.31	0.42	0.42	0.35	0.39
C.D. at 5%	3.72	4.29	3.22	3.68	1.19	1.20	1.00	1.11

Number of sympodial branches of cotton was influenced significantly by different levels of nitrogen (Table 1). Mean of three years data indicated that the application of 100 percent recommended dose of nitrogen was superior over 75 percent recommended dose of nitrogen but at par with 125 percent recommended dose of nitrogen. Application of 100 percent recommended dose of nitrogen obtained higher number of sympodial branches/plant during all the three years, as well as pooled mean basis (30.39, 30.17, 30.39 and 30.31, respectively) as compared to 75, percent recommended dose of nitrogen. [9] also found that a significantly higher number of sympodial branches/plant was obtained with fertigation of 100 percent RDN. Among nitrogen levels, the application of 100

percent recommended dose of nitrogen recorded 26.40 percent higher number of sympodial branches/plant over 75 percent recommended dose of nitrogen on pooled mean basis.

Number of bolls

A perusal of data in (Table 1) showed that the number of bolls of cotton influenced significantly by irrigation levels. Mean of three years data indicated that drip irrigation at 0.8 evapotranspiration (ETc) was superior than 0.6 and 1.0 ETc. Drip irrigation at 0.8 ETc recorded a significantly higher number of bolls/plant during all the three years as well as pooled mean basis (82.09, 82.23, 81.37 and 81.89, respectively) as compared to 0.6 ETc but remain at par with 1.0 ETc. [10] also found that Bt cotton responded up to 0.8 Etc drip irrigation which recoded 54.3 bolls/plant. Among irrigation levels, irrigation at 0.8 ETc recorded 23.98 percent higher number of bolls/plant over 0.6 ETc.

It is evident from the data obtained (Table 1) indicated that the number of bolls of cotton was influenced significantly by different levels of nitrogen. Mean of three years data indicated that application of 100 percent RDN was superior than 75 percent recommended dose of nitrogen but at par with 125 percent RDN. Application of 100 percent recommended dose of nitrogen recorded a significantly higher number of bolls/plant during all the three years as well as pooled mean basis (81.24, 81.27, 81.15 and 81.22, respectively) as compared to 75 percent recommended dose of nitrogen. Among nitrogen levels, the application of 100 percent recommended dose of nitrogen recorded 26.40 percent higher number of bolls/plant 9.97per cent over 75 percent recommended dose of nitrogen on pooled mean basis. [9] also found that a significantly higher number of bolls/plant was obtained with fertigation of 100 percent RDN. However, number of sympodial branches of cotton was not influenced by the quality of irrigation water.

Boll weight

The boll weight of cotton did not influenced by irrigation water quality. The further, result showed that the boll weight of cotton was influenced significantly by irrigation levels. Mean of three years data indicated that drip irrigation at 0.8 evapotranspiration (ETc) was superior than 0.6 and 1.0 ETc. Drip irrigation at 0.8 ETc recorded significantly higher boll weight during all three years as well as pooled mean basis (3.94, 4.23, 4.16 and 4.11 g, respectively) as compared to other treatments it was at par with 1.0 ETc. Among drip treatments, irrigation at 0.8 ETc recorded 19.83 percent higher boll weight over 0.6 ETc on pooled mean basis.

A perusal of data in (**Table 2**) indicated that the boll weight of cotton influenced significantly by different nitrogen levels. Mean of three years data indicated that the application of 100 percent recommended dose of nitrogen was superior than 75 and 125 percent recommended dose of nitrogen. Application of 100 per cent recommended dose of nitrogen recorded significantly higher boll weight in all three years as well as pooled mean basis (3.90, 4.06, 4.05 and 4.0 g, respectively) as compared to other treatments it was at par with 125 recommended dose of nitrogen. Among nitrogen levels, the application of 100 percent recommended dose of nitrogen recorded 10.19 percent higher boll weight over 75 percent recommended dose of nitrogen on pooled mean basis. [9] found that significantly higher boll weight was obtained with fertigation of 100 percent RDN.

Table 2 Effect of water quality, water regime and nitrogen levels on number of bolls/plant and boll weight of cotton

Treatments	**Number of bolls/plant**				**Boll weight (g)**			
	2016-17	**2017-18**	**2018-19**	**Pooled**	**2016-17**	**2017-18**	**2018-19**	**Pooled**
BAW	78.47	79.34	78.75	78.85	3.80	3.91	3.92	3.88
Saline water	77.80	78.53	77.68	78.00	3.72	3.86	3.82	3.80
S.Em.±	0.35	0.42	0.41	0.39	0.03	0.04	0.04	0.04
C.D. at 5%	0.99	1.20	1.18	1.10	0.09	0.13	0.12	0.11
0.6 V water (Water applied 352.2 mm)	71.47	73.45	73.32	72.74	3.50	3.33	3.46	3.43
0.8 V water (Water applied 469.6 mm)	82.09	82.23	81.37	81.89	3.94	4.23	4.16	4.11
1.0 V water (Water applied 587 mm)	80.85	81.12	79.96	80.65	3.85	4.09	4.00	3.98
S.Em.±	0.52	0.63	0.61	0.59	0.05	0.07	0.06	0.06
C.D. at 5%	1.49	1.80	1.76	1.65	0.14	0.19	0.18	0.17
Fertigation with 75% RDN	72.86	74.86	73.87	73.86	3.58	3.66	3.65	3.63
Fertigation with 100% RDN	81.24	81.27	81.15	81.22	3.90	4.06	4.05	4.00
Fertigation with 125% RDN	80.32	80.67	79.62	80.20	3.80	3.94	3.93	3.89
S.Em.±	0.52	0.63	0.61	0.59	0.05	0.07	0.06	0.06
C.D. at 5%	1.49	1.80	1.76	1.65	0.14	0.19	0.18	0.17

Seed cotton yield

Data presented in **Table 3** showed that seed cotton yield did not influence by irrigation water quality. It might be due to growth inhibition and the adverse effects induced by salinity can be alleviated by proper use of fertilizer and water management, depending on plant species, salinity level, and environmental conditions [4-6].

Data (Table 3) indicated that seed cotton yield influenced significantly by irrigation levels. Mean of three years data indicated that drip irrigation at 0.8 evapotranspiration (ETc) was superior than 0.6 and 1.0 ETc. Drip irrigation at 0.8 ETc recorded significantly higher seed cotton yield during all the three years as well as pooled mean basis (35.66, 36.69, 35.39 and 35.92 q/ha, respectively) as compared to other treatments it was at par with 1.0 ETc. An increase in seed cotton yield at 0.8 ETc was due to a significantly higher number of bolls/plant and boll weight (Table 2). [8] also indicated that drip irrigation is more beneficial in improving cotton productivity. Among drip treatments, irrigation at 0.8 ETc recorded 31.58 percent higher seed cotton yield over 0.6 ETc. [11] also reported that drip irrigation at 80% PE once in 3 days interval increased the seed cotton yield when compared to other drip irrigation treatments. This was mainly due to the limited quantity of water applied, increased seed cotton yield and favorable micro-climate.

A data in (Table 3) indicated that seed cotton yield influenced significantly due to different nitrogen levels. Mean of three years data indicated that application of 100 percent recommended dose of nitrogen recorded significantly higher seed cotton yield in all the three years as well as pooled mean basis (33.96, 35.34, 35.27 and 34.86 q/ha, respectively) as compared to other treatments but it was statistically at par with 125 percent recommended dose of nitrogen. Increase in seed cotton yield with an application of 100 percent RDN was due to a significantly higher number of bolls/plant and boll weight (Table 2). Among nitrogen levels, application of 100 percent RDN recorded 18.49 percent higher seed cotton yield over 75 percent recommended dose of nitrogen on pooled mean basis. [9] found that significantly higher seed cotton yield was obtained with fertigation of 100 percent RDN.

Table 3 Effect of water quality, water regime and nitrogen levels on yieldof cotton

Treatments	Seed cotton yield (q/ha)			
	2016-17	2017-18	2018-19	Pooled
BAW	32.48	33.43	33.40	33.10
Saline water	31.68	32.43	32.32	32.14
S.Em.±	0.35	0.37	0.40	0.37
C.D. at 5%	1.01	1.07	1.14	1.05
0.6 V water (Water applied 352.2 mm)	26.11	26.83	28.95	27.30
0.8 V water (Water applied 469.6 mm)	35.66	36.69	35.39	35.92
1.0 V water (Water applied 587 mm)	34.46	35.27	34.23	34.65
S.Em.±	0.52	0.56	0.59	0.56
C.D. at 5%	1.51	1.61	1.70	1.57
Fertigation with 75% RDN	29.53	29.20	29.52	29.42
Fertigation with 100% RDN	33.96	35.34	35.27	34.86
Fertigation with 125% RDN	32.74	34.25	33.79	33.59
S.Em.±	0.52	0.56	0.59	0.56
C.D. at 5%	1.51	1.61	1.70	1.57

Economics

Data presented in **Table 4** indicate that best available water significantly increased the net return and B:C ratio as compared to saline water on pooled mean basis. The highest significant pooled mean gross returns (119345₹ ha^{-1}) and B:C ratio (3.42) were obtained in the best available water. The difference between BAW and saline water net return was only 4909 ₹ha^{-1}only.

Data in Table 4 reveals that 0.8 Etc water gave significantly higher net return and B:C ratio as compared to 0.6 and 1.0 Etc of water on pooled mean basis. The highest significant pooled mean net returns (133687₹ ha^{-1}) and B:C ratio (3.70) was obtained with 0.8 Etc.

Results (Table 4) revealed that the application of 100 % RDN recorded significantly higher net return and B:C ratio as compared to 75 % RDN and 125 % RDN on pooled mean basis. The highest significant pooled mean net returns (128286₹ ha^{-1}) and B:C ratio (3.60) was obtained. The pooled mean net return was higher by 27485₹ ha^{-1} and 6703₹ ha^{-1} under the application of 100 % RDN over control 75 % and 100 % RDN.

Table 4 Effect of water quality, water regime and nitrogen levels on economics of cotton

Treatments	Net return(₹ ha^{-1})	B:C ratio
BAW	119345	3.42
Saline water	114436	3.32
S.Em.±	-	-
C.D. at 5%	-	-
0.6 V water (Water applied 352.2 mm)	89064	2.78
0.8 V water (Water applied 469.6 mm)	133687	3.70
1.0 V water (Water applied 587 mm)	127921	3.62
S.Em.±	-	-
C.D. at 5%	-	-
Fertigation with 75% RDN	100801	3.05
Fertigation with 100% RDN	128286	3.60
Fertigation with 125% RDN	121583	3.45
S.Em.±	-	-
C.D. at 5%	-	-

A view of crop in the PFDC experimental field of Cotton in *Kharif* cropping season 2018

Conclusion

As a result of this 3 year field study, it can be concluded that plant height, number of sympodial branches, number of bolls, boll weight, seed cotton yield, net return, and B:C ratio were significantly affected by drip irrigation levels and different nitrogen levels. Irrigation water quality did not influence these parameters. Plant height, number of sympodial branches, number of bolls, boll weight seed cotton yield, net return, and B:C ratio is recorded higher under irrigation levels at 0.8 ETc and 100 percent cent recommended dose of nitrogen. In the tube well-irrigated area where water is moderately saline, cotton could be cultivated successfully using a drip system with about a 15 % reduction in yield as compared to good quality water.

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References

[1] USDA. 2019. Cotton Outlook. Agricultural outlook forum.United States Department of Agriculture.www.usda.gov/oce/forum.
[2] GOI. Pocket Book of Agricultural Statistics, Ministry of Agriculture & Farmers Welfare Department of Agriculture, Cooperation & Farmers Welfare Directorate of Economics & Statistics New Delhi- 110001, 2018.
[3] GOR. Directorate of Agriculture, Pant KrishiBhawan, Jaipur, Rajasthan – 302005, 2018.
[4] Albassam BA. 2001. Effect of nitrate nutrition on growth and nitrogen assimilation of pearl millet exposed to sodium chloride stress. J Plant Nutr. 24:1325–1335
[5] Flores P, Carvajal M, Cerda A, Martinez V. 2001. Salinity and ammonium/nitrate interactions on tomato plant development, nutrition, and metabolites. J Plant Nutrition. 24:1561–1573.
[6] Tuna AL, Kayab C, Ashraf M, Altunlu H, Yokas I, Yagmur B. 2007. Effects of calcium sulphate on growth, membrane stability and nutrient uptake of tomato plants grown under salt stress. Environ Exp Bot. 59:173–178.
[7] Bowman DC, Devitt DA, Miller WW. 2006. Effect of moderate salinity on nitrate leaching from Bermuda grass turf: a lysimeter study. Water Air and Soil Poll. 175:49–60.
[8] Nalayini, P., Sankaranarayanan,K., Velmourougane, K. and Suveetha, M. 2014. Biodegradable polyethylene mulching –a new approach for moisture conservation, weed control and enhanced productivity of winter irrigated cotton- maize. 1:386 – 391.
[9] Shruti, M. Y. and Aladakatti, Y. R. 2017. Effect of drip irrigation and fertigation on yield, economics and water use efficiency of intra-hirsutumBt cotton. Journal of Farm Science. 30 (2): 185-189.
[10] Patil, V. C., Halemani, H. L., Hallikeri, S. S., Noli, S. S. and Bandiwaddar, T. T. 2004. Response of hybrid cotton to drip and fertigation. Proceedings of International Symposium on Strategies for Sustainable Cotton Production- A Global Vision. 45–147. UAS, Dharwad.
[11] Aladakatti, Y. R., Hallikeri, S. S., Nandagavi, R. A., Shivamurthy, D.and Malik Rehan. 2012. Precision irrigation and fertigation toenhance the productivity and economic returns of Bt Cotton in vertisols. Agro-Informatics and Precision Agriculture. 341-343.

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