International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2021; 9(1): 782-785

Received: 30-10-2020
Accepted: 09-12-2020

Pavan DG
Department of Agronomy, Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli, Tamil Nadu, India

Somasundaram S
Cotton Research Station, Veppanthattai, Perambalur, Tamil Nadu Agricultural University, Tamil Nadu, India

Avudaithai S
Department of Agronomy, Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli, Tamil Nadu, India

S Nithila
Department of Agronomy, Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli, Tamil Nadu, India

Corresponding Author:
Pavan DG
Department of Agronomy, Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirappalli, Tamil Nadu, India

Effect of subsurface drip irrigation-fertigation regimes on high density cotton cultivation in sodic soil

Pavan DG, Somasundaram S, Avudaithai S and S Nithila

DOI: https://doi.org/10.22271/chemi.2021.v9.i1k.11320

Abstract
A field experiment was conducted to study the effect of subsurface drip irrigation- fertigation regimes on high density cotton cultivation under sodic soil at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirapalli during *kharif* 2019-20. The experiment was laid out in factorial randomized block design with three replications. The treatments consisted of combination of two factors *viz*., four subsurface drip irrigation levels (I_1 – 0.4 Epan, I_2 – 0.6 Epan, I_3 – 0.8 Epan and I_4– 1.0 Epan) and three fertigation levels (N_1 – 100% RDF, N_2 – 125%, RDF and N_3– 150% RDF). Readings taken at the harvest stage revealed that the plant height, leaf area index, dry matter production and seed cotton yield were recorded significantly higher with subsurface drip irrigation level of 1.0 Epan. Among fertigation levels 150% RDF significantly recorded higher plant height, leaf area index and dry matter production but the total number of bolls plant^{-1}, bolls m^{-2} and seed cotton yield were significantly higher with the fertigation of 125% RDF. The study shows that for better productivity of cotton in this region, subsurface drip irrigation of 1.0 Epan combined with fertigation of 125% RDF may be recommended for compact cotton varieties.

Keywords: Compact cotton, subsurface drip irrigation, fertigation, Epan, sodic soil

Introduction
Cotton (*Gossypium* spp.) popularly known as "White Gold", it is a major cash crop and one of the most important textile fiber across the world and grown commercially in more than 52 countries. In India cotton is cultivated in an area of 126 lakh hectare with the production and productivity of 337 lakh bales and 451 kg ha^{-1} respectively. Perhaps India is the only nation in the world where all the four developed species are cultivated on business scale. Even though maximum area is under Bt cotton the average productivity of India is lower than world average (792 kg ha^{-1}). Cotton production in India cannot be reckoned neglecting salt affected soils but improving productivity in these soils is an exigent task. India contributes around 52 m ha of salt affected land (Mandal *et al*., 2018) [11]. Though cotton is a moderately salt tolerant crop, its threshold level is limited to 7.7 ds m^{-1} (Maas and Hoffman, 1977) [10]. So its germination and young seedling stages are highly affected under salt stress condition but it resumes its growth in later stages with decreased seed cotton yield (Akhter *et al*., 2004) [1].
Productivity of cotton should be increased by using water judiciously. An improved irrigation method by which water is used judiciously and productivity is enhanced is subsurface drip irrigation. In SSDI the plant canopy is not irrigated and the foliage remains dry so the incidence of disease was reduced. The crop yield under SSDI is higher with lower water requirements than those with other irrigation methods. Research shows that cotton under subsurface drip irrigation accounts for water-saving of 30-40% and with a yield improvement of 26-38%. In drip fertigation the continuous water supply leads to higher availability of nutrients in the soil and the biomass production can be increased. The increase in yield attributes of cotton under drip fertigation leads to enhanced photosynthesis, expansion of leaves and translocation of nutrients to reproductive parts compared to conventional methods of soil application of nutrients (Jayakumar *et al*., 2014) [8]. So the combination of subsurface drip irrigation and fertigation regimes may sustain cotton productivity with water and fertilizer saving in sodic soil. Hence this study was initiated.

Materials and Methods

The study was carried out at Anbil Dharmalingam Agricultural College and Research Institute, Tiruchirapalli during *kharif* season 2019. The soil texture was sandy clay loam with low available nitrogen (216 kg ha^{-1}), medium in available phosphorus (14.8 kg ha^{-1}) and high in available potassium (245.6 kg ha^{-1}). The field trail was performed using factorial randomized block design with three replication. The treatments consisted of combination of two factors *viz.*, four irrigation levels (I_1 – 0.4 Epan, I_2 – 0.6 Epan, I_3 – 0.8 Epan and I_4– 1.0 Epan) and three fertigation levels (N_1 – 100% RDF, N_2 – 125%, RDF and N_3– 150% RDF). The cotton variety Co 17 was sown during 2019 by hand dibbling of seeds at 60 x 10 cm spacing. All the agronomic practices were adopted as per the TNAU crop production guide. Observation on cotton were recorded at harvest stage. The experimental data recorded on various parameters were statistically analysed by the method of analysis of variance given by Gomez (1984) [4].

Results and Discussion

Growth parameters

Plant height

Subsurface drip irrigation and fertigation regimes caused significant variations on plant height at harvest stage as depicted in Table 1. Higher plant height of 100.1 cm was obtained under subsurface drip irrigation level of 1.0 Epan and was found comparable with 0.8 Epan (93.3 cm). This was followed by 0.6 Epan (88.1 cm). Lower plant height was obtained under 0.4 Epan (84.9 cm). This may be due to availability of higher moisture content near the root zone throughout the crop growth period as indicated by Roopashree *et al*. (2016) [13]. Among fertigation levels 150% RDF recorded higher plant height of 96.2 cm and was found comparable with 125% RDF (91.7 cm). Lower plant height was obtained under 100% RDF (86.9). This may be due to increase in nutrient levels which enhance nutrient absorption, greater photosynthesis and proper distribution of the generated assimilates. Similar results were reported by Awasya *et al*. (2006) [2]. Interaction was found non-significant at harvest.

Leaf area index

The leaf area index was significantly influenced by different subsurface drip irrigation and fertigation regimes as depicted in Table 1. Significantly higher LAI of 1.29 was obtained under subsurface drip irrigation of 1.0 Epan and was comparable with 0.8 Epan (1.21) at harvest. Lower leaf area index was recorded under 0.4 Epan (1.07). This might be due to increased irrigation level which maintains the soil moisture content nearer to the field capacity. Similarly Wang *et al*. (2011) [16] reported that limited drip irrigation levels cause water deficiency in cotton field and reduces net photosynthetic rate and apparent photosynthesis leads to lower leaf area index. Fertigation of 150% RDF recorded significantly higher leaf area index 1.31 at harvest. This was followed by 125% RDF (1.17). Lower leaf area index was recorded under 100% RDF (1.05). This might be attributed due to continuous and better availability of nutrients under application of water soluble fertilizers resulted in more number of leaves per plant as suggested by Muthukrishnan and Fanish (2011) [12]. Interaction was absent.

Dry matter production

Subsurface drip irrigation and fertigation regimes caused significant variations in the dry matter production as depicted in Table 1. Subsurface drip irrigation of 1.0 Epan significantly recorded higher dry matter production of 7885 kg ha^{-1}. This was followed by 0.8 Epan (7191 kg ha^{-1}). Lower dry matter production was attained under 0.4 Epan (6514 kg ha^{-1}). This was perhaps due to increased moisture content along with better nutrient uptake resulted in cell elongation and turgidity (Dadgale *et al*., 2014) [3]. Significantly higher dry matter production of 7972 kg ha^{-1} was obtained under the fertigation of 150% RDF. This was followed by 125% RDF (7068 kg ha^{-1}) at harvest. Higher plant height and leaf area index associated with the fertigation of 150% RDF may be the reason for the higher dry matter production. This is in line with the findings of Yeates *et al*. (2010) [17], they reported that increase in plant height and leaf area index tends to increase the photosynthetic accumulation leads to higher dry matter production. Interaction was found non-significant at harvest stage.

Yield parameters

Subsurface drip irrigation and fertigation regimes caused significant variation on yield parameters as depicted in Table 2.

Higher number of bolls $plant^{-1}$ (9.3) and bolls m^{-2} (118.7) were registered under the subsurface drip irrigation level 1.0 Epan and was comparable with 0.8 Epan. Lower number of bolls $plant^{-1}$ (7.3) and m^{-2} (92.2) was observed under 0.4 Epan. This factor may be due to the retention of optimum moisture in the root rhizosphere region, which meets the crop water demands needed for growth and production as suggested by Hussein *et al*. (2011) [7]. Fertigation of 125% RDF significantly recorded higher number of bolls $plant^{-1}$ (9.5) and bolls m^{-2} (121.3). This was followed by 150% RDF. Lower number of bolls $plant^{-1}$ and m^{-2} were recorded under 100% RDF. This might be due to increase in the amount of nutrient levels leads to excessive vegetative growth, which is generally detrimental to yield parameters and yield. This is in confirmation with the early findings of Kanchana *et al*. (2019) [9]. Interaction was significant (Table 3). Combination of 1.0 Epan + 125% RDF registered higher number of bolls $plant^{-1}$ (10.7) and bolls m^{-2} (139.5) and was comparable with 0.8 Epan + 125% RDF. Lower number of bolls $plant^{-1}$ (6.9) and bolls m^{-2} (86.5) was recorded under 0.4 Epan + 100% RDF. This might be due to drip fertigation of optimum level of nutrients (NPK) with sufficient moisture level obviously increase nutrient uptake with better translocation of assimilates from source to sink resulted in higher yield parameters (Gutal, 1989) [6].

Seed cotton yield

Subsurface drip irrigation and fertigation regimes caused significant variation on seed cotton yield as depicted in Table 2. Subsurface drip irrigation level of 1.0 Epan recorded higher seed cotton yield of 2446 kg ha^{-1} and was comparable with 0.8 Epan (2361 kg ha^{-1}). This was followed by 0.6 Epan (2172 kg ha^{-1}). Lower seed cotton yield was obtained under 0.4 Epan (1790 kg ha^{-1}). This may be due to better growth as a result of optimum moisture throughout the life cycle without any stress period, which increased the movement of assimilates from source to sink. This is line with the findings of Veeraputhran and chinnuswamy, (2009) [15]. Significantly higher seed cotton yield was obtained under the fertigation of 125% RDF (2478 kg ha^{-1}) and was followed by 150% RDF (2156 kg ha^{-1}). Lower seed cotton yield was obtained under fertigation of 100% RDF (1942 kg ha^{-1}). This is in confirmation with Gormus *et al*. (2016) [5], according to them usage of 150 percent RDF documented lower yield since overuse of fertiliser causes excessive vegetative growth, delayed maturity, increased boll rot, produces more number of immature bolls and invited sucking pests leads to reduction in yield. The interaction between different subsurface drip irrigation and fertigation regimes showed a significant variation on seed cotton yield (Table 4). Combination of 1.0 Epan + 125% RDF recorded higher seed cotton yield of 2805 kg ha^{-1} and was comparable with 0.8 Epan + 125% RDF (2698 kg ha^{-1}). This was followed by 0.6 Epan + 125% RDF (2508 kg ha^{-1}). This may be due to superior performance of all yield attributing parameters at better availability of soil moisture with optimum fertilizer which was reflected in seed cotton yield. These findings are in close conformity with Shivakumar (2010) [14].

Table 1: Effect of subsurface drip irrigation and fertigation regimes on growth parameters and dry matter production at harvest

Treatments	Plant height (cm)	LAI	Dry matter (kg ha^{-1})
Irrigation regimes			
I_1 - 0.4 Epan	84.9	1.07	6514
I_2 - 0.6 Epan	88.1	1.13	6836
I_3 - 0.8 Epan	93.3	1.21	7191
I_4 - 1.0 Epan	100.1	1.29	7885
SEd	3.6	0.06	220
CD (p=0.05)	7.5	0.13	456
Fertigation regimes			
N_1 -100% RDF	86.9	1.05	6280
N_2 -125% RDF	91.7	1.17	7068
N_3 -150% RDF	96.2	1.31	7972
SEd	3.1	0.05	190
CD (p=0.05)	6.5	0.11	395
Interaction	NS	NS	NS

Epan – Pan Evaporation, RDF – Recommended Dose of Feritilizer, S – Significant and NS – Non-significant

Table 2: Effect of subsurface drip irrigation and fertigation regimes on yield parameters and yield

Treatments	Bolls plant^{-1}	Boll m^{-2}	Seed cotton yield (kg ha^{-1})
Irrigation regimes			
I_1 - 0.4 Epan	7.3	92.2	1790
I_2 - 0.6 Epan	8.2	104.8	2172
I_3 - 0.8 Epan	8.9	113.9	2361
I_4 - 1.0 Epan	9.3	118.7	2446
SEd	0.2	2.4	53
CD (p=0.05)	0.4	4.8	110
Fertigation regimes			
N_1 -100% RDF	7.4	94.0	1942
N_2 -125% RDF	9.5	121.3	2478
N_3 -150% RDF	8.3	106.9	2156
SEd	0.2	2.1	45
CD (p=0.05)	0.4	4.2	95
Interaction	S	S	S

Epan – Pan Evaporation, RDF – Recommended Dose of Feritilizer, S – Significant and NS – Non-significant

Table 3: Interaction of subsurface drip irrigation and fertigation regimes on yield parameters

Treatments	bolls plant^{-1}				bolls m^{-2}			
	Fertigation regime				Fertigation regime			
	N_1- 100% RDF	N_2- 125% RDF	N_3- 150% RDF	Mean	N_1- 100% RDF	N_2- 125% RDF	N_3- 150% RDF	Mean
I_1- 0.4 Epan	6.9	7.6	7.5	7.3	86.5	92.7	97.5	92.2
I_2- 0.6 Epan	7.3	9.6	7.7	8.2	93.8	120.9	99.9	104.8
I_3- 0.8 Epan	7.6	10.2	8.8	8.9	98.1	132.2	111.5	113.9
I_4- 1.0 Epan	7.8	10.7	9.2	9.3	97.8	139.5	118.5	118.7
Mean	7.4	9.5	8.3		94.0	121.3	106.9	
	SEd		CD (p=0.05)		SEd		CD (p=0.05)	
I x N	0.3		0.6		4.1		8.3	

Table 4: Interaction of subsurface drip irrigation and fertigation regimes on seed cotton yield

Treatments	Seed cotton yield (kg ha^{-1})			
	Fertigation regime			
	N_1- 100% RDF	N_2- 125% RDF	N_3- 150% RDF	Mean
I_1- 0.4 Epan	1627	1901	1843	1790
I_2- 0.6 Epan	1864	2508	2145	2172
I_3- 0.8 Epan	2109	2698	2275	2361
I_4- 1.0 Epan	2170	2805	2362	2446
Mean	1942	2478	2156	
	SEd		CD (p=0.05)	
I x N	0.3		0.6	

Conclusion
From this investigation, it was concluded that for high density cotton planting system with compact varieties combination of 1.0 Epan + 125% RDF may be recommended through subsurface drip irrigation for higher productivity in sodic soil. It was also recommended that under water scarcity condition irrigation and fertigation of 0.8 Epan + 125% RDF may be recommended.

Reference
1. Akhter J, Murray R, Mahmood K, Malik KA, Ahmed S. Improvement of degraded physical properties of a saline-sodic soil by reclamation with kallar grass (Leptochloa fusca). Plant and Soil 2004;258(1):207-216.
2. Awasya H, Johnson P, Sarawgi S, Nanda H, Kulkarni A. Integrated nutrient management in upland cotton (*Gossypium hirsutum* L.) under *Vertisols* of Chattisgarh. Journal of Agriculture Issues 2006;11(2):67-70.
3. Dadgale PR, Chavan DA, Gudade BA, Jadhav SG, Deshmukh VA, Suresh Pal. Productivity and quality of Bt cotton (*Gossypium hirsutum*) as influenced by planting geometry and nitrogen levels under irrigated and rainfed conditions. Indian Journal of Agricultural Sciences 2014;84(9):1069-1072.
4. Gomez KA, Gomez. Statistical procedures for agricultural research (2nd ed). Intl. Rice. Res. Int., P.O. Box. Manila Philippines and John Wiley and Sons, New York, USA 1984.
5. Gormus O, A El-Sabagh, Islam M. Optimizing yield and fiber quality of cotton under Mediterranean environment: managing nitrogen and potassium nutrition. Journal of Experimental Biology and Agricultural Sciences 2016;4(5):572-580.
6. Gutal GB. In: Cost economics of drip irrigation system for tomato crop. Oxford & IBH publishing Co. Pvt. Ltd, New Delhi 1989, 171-176.
7. Hussein Fuad, Mussaddak Janat, Abdallah Yakoub. Assessment of yield and water use efficiency of drip-irrigated cotton (*Gossypium hirsutum* L.) as affected by deficit irrigation. Turkish Journal of Agriculture and Forestry 2011;35(6):611-621.
8. Jayakumar M, Surendran U, Manickasundaram P. Drip fertigation program on growth, crop productivity, water, and fertilizer-use efficiency of BT cotton in semi-arid tropical region of India. Communications in Soil Science and Plant Analysis 2014;46(3):293-304.
9. Kanchana T, Sakthivel N, Thavaprakaash N, Balamurugan J. Performance of compact cotton (*Gossypium hirsutum* L.) genotypes to varied nutrient levels under high density planting system in winter irrigated condition. Journal of Pharmacognosy and Phytochemistry 2019;8(3):3084-3088.
10. Maas Eugene V, Glenn Hoffman J. Crop salt tolerance–current assessment. Journal of the irrigation and drainage division 1977;103(2):115-134.
11. Mandal Subhasis, Raju R, Anil Kumar, Parveen Kumar, Sharma PC. Current Status of Research, Technology Response and Policy Needs of Salt-affected Soils in India: A Review. J Indian Soc. Coastal Agric. Res 2018;36(2):40-53.
12. Muthukrishnan P, Fanish SA. Influence of drip fertigation on yield, water saving and water use efficiency in maize (*Zea mays* L.) based intercropping system. Madras Agri. J 2011;98(7-9):243-247.
13. Roopashree M, Rajkumara S, Neelakanth JK. Effect of surface and sub-surface drip irrigation at different etc. Levels on growth and yield of Bt cotton (*Gossypium hirsutum* L.). Journal of Farm Sciences 2016;29(4):456-460.
14. Shivakumar B. Effect of irrigation and fertigation levels on yield, quality and water productivity of rabi maize in alfisols. M.Sc. (Ag) Thesis, Acharya NG Ranga Agricultural University, Rjendranagar, Hyderabad 2010.
15. 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.
16. Wang, Ji-chuan, Gao Shan, Xu Ya-li, Han Xiu-feng. Effect of irrigation schedule on photosynthetic characteristic and yield components in hybrid cotton Zhaofeng-1. Agric. Res. in Arid Areas 2011;(3):49-54.
17. Yeates SJ, Constable GA, Mc Cumsite T. Irrigated cotton in the tropical dry season biomass accumulation portioning and RUE. Field Crop Res 2010;116:290-299.