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Influence of nutrient and irrigation levels on yield and economics cotton in Southern dry zone of Karnataka

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Abstract
A field experiment entitled ‘‘influence of nutrient and irrigation levels on yield and economics cotton in Southern Dry Zone of Karnataka’’ was conducted during *kharif* season of 2016 at Zonal Agricultural Research Station, V. C. Farm, Mandya. The experiment was carried out under split plot design with 3 irrigation levels as main plots (0.6, 0.8 and 1.0 IW/CPE ratios) and 3 nutrient levels as sub plots (75, 100 and 125% RDF-150:75:75 kg NPK/ha), and these treatments were replicated thrice. Irrigation at 0.8 IW/CPE ratio and nutrient level of 100 percent RDF have significantly recorded higher growth and yield parameters *viz.,* plant height, sympodial branches, number of bolls plant^{-1} and kapas yield (22.94 q ha^{-1}) and also higher net monetary returns and B:C ratio (1.51) as compared to irrigation at 0.6 IW/CPE ratio and nutrient level of 75 percent RDF, respectively. But, with respect to growth and yield 0.8 IW/CPE ratio and nutrient level of 100 percent RDF were at par with irrigation at 1.0 IW/CPE ratio and nutrient level of 125 percent RDF, respectively. Whereas, with respect to net monetary returns and B:C ratio, these were found similar to irrigation at 1.0 IW/CPE ratio and nutrient level of 125 percent RDF, respectively and found optimum in enhancing the cotton growth, kapas yield and net monetary returns.

Keywords: Cotton**,** Economics**,** Irrigation, Nutrient, IW/CPE ratio and Yield

1. Introduction
White Gold is the popularly name for Cotton and also considered as “King of fiber crops”. It is one of the globally important cash crops and plays an important role in the world agriculture and industrial economy. Cotton, being a major fiber crop, it’s a very important raw material and contributes at least 65 percent of its requirements for the Indian textile industry which significantly contributes towards Indian economy with over 1500 mills, 4 million handlooms, 1.7 million power looms and thousands of garments, processing units, hosiery and nearly 60 million people in the country have got direct or indirect employment.

In the world, cotton is being cultivated in an area of 33.40 m ha with a production of 121.40 million bales with an average productivity of 792 kg ha^{-1}. About 45 percent of world fiber requirement fulfilled by the cotton. India is the largest producer of cotton contributing 31.05 percent to world cotton production followed by China. India has the largest area (12.20 m ha) with 37.70 million bales production with an average productivity of 524 kg ha^{-1} (Anon., 2017) [1]. Gujarat is the leading producer with 125 lakh bales production, followed by Maharashtra (85 lakh bales). While, Tamil Nadu stands first in productivity with 1214 kg/ha cotton production (Anon., 2016) [2].

Cotton productivity of in our country is low, since major portion of the crop is grown under rainfed condition (70 percent). With the external supply of irrigation, cotton yield has increased as reported by Sankaranarayanan *et al.* (2004) [3]. They noticed 20 to 25 percent increased seed cotton yield under irrigated condition over unirrigated crop.

Not only the irrigation supply plays a major role for the better crop production, nutrients application is also required increased yield production. Although most of the response to nutrients was attributed to N (all cultivars) and to some extent P, all the three major nutrients application has an effect on lint yield. Potassium (K) fertilization is a key to better quality (Kefyalew *et al.,* 2007)[4] as the results for all quality factors suggests. So, it clearly indicates that, for better growth and yield, optimum irrigation as well as nutrient levels plays an important role. Meanwhile, in red sandy loamy soils of Southern Dry Zone of Karnataka, the

influence of optimum irrigation regime under different nutrients level was revealed to be meager. Hence, the present study was conducted to optimize the irrigation regime, nutrient levels and their interaction for higher kapas yield of cotton.

Materials and methods

A field experiment was conducted at Zonal Agricultural Research Station, V. C. Farm, Mandya, during 2016 of *kharif* season, on red sandy loam soil from June to December. The soil texture of the experimental plot was sandy loam. The soil pH was 7.27 with neutral reaction and was normal in electrical conductivity (0.38 dS m^{-1}). The organic carbon content was 0.46 percent and was low in available nitrogen (210.54 kg ha^{-1}), medium in available phosphorus (27.48 kg ha^{-1}) and available potassium (152.20 kg ha^{-1}). The experiment was laid out in a split plot design with 3 irrigation levels as main plots (0.6, 0.8 and 1.0 IW/CPE ratios) and 3 nutrient levels as sub plots (75, 100 and 125% RDF-150:75:75 kg NPK/ha) and these treatments were replicated thrice. Cotton hybrid *i.e.,* Varalakshmi (DCH-32) was used in the experimental study and was sown at a spacing of 90 cm × 60 cm and the fertilizers were applied through soil application as per the treatments, in which 50 percent of N and full dose of P and K were applied at the time of sowing as basal dose. Remaining 50 percent of nitrogen was applied as dressing in two equal splits at 50 DAS (25% N) and at 75 DAS (25% N). Irrigation was given using water meter by calculating the IW/CPE relation by fixing the irrigation water (IW) depth as 60 mm. All the required plant protection measures were taken for the control of sucking pests and diseases at each stage of the crop.

Results and discussion

Growth and yield parameters

The data (Table 1) of experimental study reveals that, 1.0 IW/CPE ratio irrigation had recorded significantly higher plant height at 150 DAS (154.47 cm), sympodial branches $plant^{-1}$ (20.11) and number of bolls $plant^{-1}$ (55.55) at harvest compared to irrigation at 0.6 IW/CPE ratio (136.28 cm, 14.01 and 40.04, respectively). However, it was at par with irrigation at 0.8 IW/CPE ratio (150.33 cm, 17.54 and 52.47, respectively). This good response was due to supply of optimum quantity of irrigation more frequently, which lead to increased nutrients availability which resulted in better uptake by the plant as well as better partition of these nutrients actively growing plant parts. The similar results were also observed by Srinivasan and Aananthi (2017) [5], Yang *et al.* (2015) [6], Alse and Jadhav (2011) [7].

The nutrient levels also influenced the cotton growth and yield significantly. Among different nutrient levels, 125 percent RDF was recorded significantly higher plant height at 150 DAS (150.00 cm), sympodial branches $plant^{-1}$ (19.23) and number of bolls $plant^{-1}$ (52.235) at harvest compared to 75 percent of RDF (135.35 cm, 14.81 and 45.49, respectively). However, it was at par with 100 percent of RDF (145.73 cm, 17.63 and 49.33, respectively). The growth attributes were increased significantly was the result of higher quantity of nutrients coupled with frequent irrigation, which caused better nutrient uptake and their partition. Increased plant height was a result of higher nitrogen application which plays an important role in cell division and elongation. Phosphorus is known to influence better root growth leading to increased uptake of water and nutrient. Better phosphorus management helped in diversion of plant metabolites towards the developing buds, flowers and bolls, and also more photosynthates translocation of towards the sink and consequent development of yield attributes as reported by Seema *et al.* (2012) [8]. Higher quantity of nutrient supply at the initial stages of the crop growth is also one of the reasons for increased growth and yield parameters. These results are in line with the findings of Gundlur *et al.* (2013) [9], Mandeep Kumar *et al.* (2011) [10], Ghongane *et al.* (2009) [11], Kalaichelvi, (2009) [12] and Pettigrew, (2004) [13].

The combined effect of nutrient and irrigation levels resulted in non-significant difference in plant height, sympodial branches and number of bolls $plant^{-1}$ and yield. These results are in line with the findings of Gundlur *et al.* (2013) [9].

Kapas and lint yield

The nutrient and irrigation levels affected kapas and lint yield of cotton significantly (Table 1). 1.0 IW/CPE irrigation ratio had recorded significantly higher kapas yield of cotton (24.37 q/ha,) compared to irrigation at 0.6 IW/CPE ratio (15.91 q/ha). However, it was at par with irrigation at 0.8 IW/CPE ratio (22.94 q/ha).

Among the various nutrient levels, 125 percent RDF was recorded significantly higher kapas and lint yield of cotton (23.55 and 8.35 q/ha, respectively) compared to 75 percent RDF (17.18 and 5.83, respectively). However, it was at par with 100 percent of RDF (22.49 and 7.88 q/ha, respectively). This positive increase in kapas and lint yield was due to increased growth parameters, yield attributes and dry matter production, as well as its partition to different parts and also to combined effect of N, P and K with frequent irrigations. The important yield parameter i.e., sympodial branches were also increased significantly, leading to higher boll number and boll weight which enhanced seed cotton yield (kapas).

Even at boll development stage, the leaf growth continued and higher dry matter production was there, resulting translocation of the photosynthates to developing squares and bolls which were also the reason for higher yield. These results are in conformity with the findings of Deepa and Aladakatti (2016) [13], Amandeep *et al.* (2015) [14], Jat *et al.* (2014) [15], Shukla *et al.* (2014) [16], Gundlur *et al.* (2013) [9], Amandeep *et al.* (2013) [17].

Table 1: Effect of nutrient and irrigation levels on growth and yield parameters and yield of cotton

	Parameters			
	Plant height (cm) at 150 DAS	**Sympodial branches $plant^{-1}$ at harvest**	**Number of bolls per plant**	**Kapas yield (q/ha)**
Irrigation levels				
I_1: IW/CPE = 0.6	136.28	14.01	40.04	15.91
I_2: IW/CPE = 0.8	150.33	17.54	52.47	22.94
I_3: IW/CPE = 1.0	154.47	20.11	55.55	24.37
SEm. ±	1.97	0.68	1.96	0.43
C. D. @ 5%	7.73	2.65	7.65	1.69
Nutrient levels				

F_1: 75 % RDF	135.35	14.81	45.49	17.18
F_2: 100 % RDF	145.73	17.63	49.33	22.49
F_3: 125 % RDF	150.00	19.23	52.23	23.55
SEm. ±	1.85	0.66	0.94	0.83
C. D. @ 5%	7.26	2.58	3.67	3.25
Irrigation levels × Nutrient levels				
S. Em. ± (Between sub plots at same main plot)	3.56	1.07	1.99	2.70
C. D. (p=0.05) (Between sub plots at same main plot)	NS	NS	NS	NS
S. Em. ± (Between main plots at same or different sub plots)	1.01	0.94	1.37	1.50
C. D. (p=0.05) (Between main plots at same or different sub plots)	NS	NS	NS	NS

Economics (Rs. ha^{-1})

The data pertaining to economics as influenced by different nutrient and irrigation levels are presented in the Table 2.

Cost of cultivation

Irrigation at IW/CPE ratio of 1.0 recorded higher cost of cultivation (Rs. 69,982.8/ha) followed by irrigation at IW/CPE ratio of 0.8 (Rs. 67,053.8/ha). While, irrigation at IW/CPE ratio of 0.6 recorded lower cost of cultivation (Rs. 64,530.8/ha).

Nutrient level of 125 percent RDF recorded higher cost of cultivation (Rs. 69,484/ha) followed by 100 percent RDF (Rs. 67,188.4/ha). While, 75 percent RDF recorded lower cost of cultivation (Rs. 64,892.7/ha) Among the interactions of nutrient and irrigation levels, IW/CPE ratio of 1.0 combined with 125 percent RDF recorded higher cost of cultivation (Rs. 69,958.40 ha^{-1}) followed by irrigation at IW/CPE ratio of 0.8 combined with 125 percent RDF (Rs. 69,349.4 ha). While, irrigation at IW/CPE ratio of 0.6 combined with 75 percent RDF recorded lower cost of cultivation (Rs. 64,555.20 ha^{-1}).

Gross returns (Rs. ha^{-1})

Irrigation at IW/CPE ratio of 1.0 recorded higher gross returns (Rs. 1,09,685 ha^{-1}) followed by irrigation at IW/CPE ratio of 0.8 (Rs. 1,03,225 ha^{-1}). While, irrigation at IW/CPE ratio of 0.6 recorded lower gross returns (Rs. 71,580 ha^{-1}).

Among different nutrient levels, 125 percent RDF given higher gross returns (Rs. 1,05,990 ha^{-1}) followed by 100 percent RDF (Rs. 1,01,205 ha^{-1}). While, lower gross returns was recorded with 75 percent RDF (Rs. 77,925 ha^{-1}).

Gross returns were higher with the irrigation at IW/CPE ratio of 1.0 combined with 125 percent RDF (Rs. 1,23,435 ha^{-1}) followed by irrigation at IW/CPE ratio of 1.0 combined with 100 percent RDF (Rs. 1,17,420 ha^{-1}). While, irrigation at IW/CPE ratio of 0.6 combined with 75 percent RDF recorded lower gross returns (Rs. 59235 ha^{-1}).

Net returns (Rs. ha^{-1})

Irrigation at IW/CPE ratio of 1.0 recorded higher net returns (Rs. 39702.20 ha^{-1}) followed by irrigation at IW/CPE ratio of 0.8 (Rs. 36171.2 ha^{-1}). While, irrigation at IW/CPE ratio of 0.6 recorded lower net returns (Rs. 7049.20 ha^{-1}).

Among the nutrient levels, higher net returns were recorded with 125 percent RDF (Rs. 36506 ha^{-1}) followed by 100 percent RDF (Rs. 34016.6 ha^{-1}). While, 75 percent RDF recorded lower net returns (Rs. 12402.3 ha^{-1}).

Among the interactions, irrigation at IW/CPE ratio of 1.0 combined with 125 percent RDF recorded higher net returns (Rs. 53476.60 ha^{-1}) followed by irrigation at IW/CPE ratio of 1.0 combined with 100 percent RDF (Rs. 49757.20 ha^{-1}). While, lower net returns was recorded with irrigation at IW/CPE ratio of 0.6 combined with 75 percent RDF (Rs. -5320.20 ha^{-1}).

B: C ratio (Benefit: Cost ratio)

Irrigation at IW/CPE ratio of 1.0 recorded higher B:C ratio (1.57) followed by irrigation at 0.8 IW/CPE ratio (1.54). While, lower B:C ratio was recorded with the irrigation at IW/CPE ratio of 0.6 (1.11).

Nutrient level of 125 percent RDF recorded higher B:C ratio (1.53) followed by 100 percent RDF (1.51). While, lower B:C ratio was recorded with 75 percent RDF (1.19).

Among the interaction effects, irrigation at IW/CPE ratio of 1.0 combined with 125 percent RDF recorded higher B:C ratio (1.76) followed by irrigation at IW/CPE ratio of 1.0 combined with 100 percent RDF and irrigation at IW/CPE ratio of 0.8 combined with 100 percent RDF (1.74 and 1.66, respectively). While, lower B:C ratio was recorded with the irrigation at IW/CPE ratio of 0.6 combined with 75 percent RDF(0.92).

The increased economical returns were due to higher seed cotton yield which was a result of better utilization optimum supply of nutrients and water in adequate quantities. These results are in conformity with the findings of Bharathi *et al*. (2016) [19], Gadade *et al*. (2015) [20], Jadhav *et al*. (2015) [21], Dateshwa *et al*. (2010) [22] and Daleshwar *et al.* (2006) [23].

Table 2: Economics of cotton crop as influenced by nutrient and irrigation levels

Treatments	Total Cost of cultivation (Rs./ha)	Gross monetary returns (Rs./ha)	Net monetary returns (Rs./ha)	B:C Ratio
Irrigation levels				
I_1: IW/CPE = 0.6	64530.8	71580.0	7049.2	1.11
I_2: IW/CPE = 0.8	67053.8	103225.0	36171.2	1.54
I_3: IW/CPE = 1.0	69982.8	109685.0	39702.2	1.57
Nutrient levels				
F_1: 75% RDF	64892.7	77295.0	12402.3	1.19
F_2: 100% RDF	67188.4	101205.0	34016.6	1.51
F_3: 125% RDF	69484.0	105990.0	36506.0	1.53
Irrigation levels × Nutrient levels				
I_1F_1: 0.6 IW/CPE+75% RDF	64555.2	59235.0	-5320.2	0.92
I_1F_2: 0.6 IW/CPE+100% RDF	66850.8	75015.0	8164.2	1.12
I_1F_3: 0.6 IW/CPE+125% RDF	69146.4	80490.0	11343.6	1.16

I_2F_1: 0.8 IW/CPE+75% RDF	64758.2	84450.0	19691.8	1.30
I_2F_2: 0.8 IW/CPE+100% RDF	67053.8	111180.0	44126.2	1.66
I_2F_3: 0.8 IW/CPE+125% RDF	69349.4	114045.0	44695.6	1.64
I_3F_1: 1.0 IW/CPE+75% RDF	65367.2	88200.0	22832.8	1.35
I_3F_2: 1.0 IW/CPE+100% RDF	67662.8	117420.0	49757.2	1.74
I_3F_3: 1.0 IW/CPE+125% RDF	69958.4	123435.0	53476.6	1.76

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