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RESPONSE OF BT COTTON TO SITE SPECIFIC NUTRIENT MANAGEMENT IN IRRIGATED ECOSYSTEM

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ABSTRACT
A field investigation was carried at Agricultural Research Station, Siruguppa, to study the response of Bt cotton to site specific nutrient management in irrigated ecosystem during two consecutive *kharif* seasons (2008-09 and 2009-2010) on deep black soil with available nitrogen, P_2O_5 and K_2O of 195.7, 15.5 and 430.1 kg/ha, respectively. The experiment was laid out in a Complete Randomized Block Design with three replications. The experiment consists of eleven treatments viz.,T_1: Absolute control (No fertilizers), T_2: Nutrients for 30 q/ha yield target (135: 75: 150 N-P_2O_5 and K_2O kg/ha plus macro and minor nutrients), T_3: T_2 –N omission, T_4: T_2 -P omission, T_5: T_2 -K omission, T_6: T_2–Ca omission, T_7: T_2 -Mg omission, T_8:T_2 -S omission, T_9: T_2- Zn omission, T_{10}: T_2 -Fe omission and T_{11}: T_2-B omission. The N and K was applied in three splits, 25% at basal, 50% at 30 DAS and remaining 25% at 60 DAS, whereas P was applied at basal. The seeds of Rasi Bt (cv. RCH 2 Bt BG-II) cotton were dibbled at a spacing of 90 X 60 cm. The experimental results reveals that, application of nutrients for 30 q/ha targeted yield (135:75:150 N, P_2O_5 and K_2O kg/ha plus macro and minor nutrients) registered significantly superior seed cotton yield (2663 kg/ha) with higher gross, net returns and B:C ratio of Rs. 74623/ha, Rs. 50694/ha and 3.17, respectively, compared to without nutrient application (T_1), N omission (T_3), P omission(T_4) and K omission (T_5) treatments. Significantly lower seed cotton yield (1291 kg/ha), gross return (Rs.36206/ha), net returns (Rs. 19619/ha) and B: C ratio (2.36) was observed in without nutrient application. From the experimental results, it was concluded that application of nutrient based on SSNM produced maximum seed cotton yield and monetary benefits under irrigated ecosystem in Tungabhadra command area.

KEYWORDS: Bt cotton**,** seed cotton yield, site specific nutrient management, irrigated ecosystem, gross return, net return and B:C ratio.

INTRODUCTION

Cotton (*Gossypium* spp.) is an important commercial fiber crop grown under diverse agro-climatic conditions and is known as king of fiber of crops and called as a white gold. It is major source of raw material for textile industry. It offers gainful employment to several million people involved in cultivation, trade, processing, manufacturing and marketing. India has unique place among the cotton growing countries of the world. In India, cotton is grown over an area of 12.65 m.ha with a total production of 40.0 m. bales. The productivity of cotton is 537 kg of lint ha^{-1} which is much lower than the world average of 621 kg ha^{-1} (Anon., 2014). Among the cotton growing states, Karnataka ranks forth, with an area of 7.60 lakh ha and forth in production with 26.90 lakh bales of lint with an average productivity of 626 kg of lint ha^{-1} (Anon., 2014).

Area under transgenic cotton is increasing year by year and new cotton hybrids are available for cultivation. Bt cotton is an exhaustive crop and needs heavy fertilization to attain the higher yield. Compared to desi, American cotton varieties and hybrids, nutrient removal is higher in Bt cotton hybrids. In general, a rainfed crop removes about 6–7 kg N, 2–2.5 kg P, 7–8 kg K per 100 kg seed cotton (Blaise et al., 2014). Further, nutrient recommendation differs with crop response, genotypes, soil and climatic conditions. Site specific nutrient management (SSNM) which suggests need based supply of nutrients ensures application of nutrients at right time in desired quantities for the crop to obtain set target yields. Besides, omission of any nutrient in crop growth also shows its role in limiting the crop yield. Hence, a field investigation was carried out to study the site specific nutrient management in Bt cotton under irrigated ecosystem.

MATERIALS & METHODS

A field investigation was carried out to study the response of Bt cotton to site specific nutrient management in Tungabhdra Command area of Karnataka at Agricultural Research Station, Siruguppa. The experiment conducted for two consecutive *kharif* seasons of 2008-09 and 2009-2010 on deep black soil with available nitrogen, P_2O_5 and K_2O of 195.7, 15.5 and 430.1 kg/ha, respectively. The experiment was laid out in a Complete Randomized Block Design with three replications. The experiment consists of eleven treatments viz.,T_1: Absolute control (No fertilizers), T_2: Nutrients for 30 q/ha yield target (135: 75: 150 N-P_2O_5 and K_2O kg/ha plus macro and minor nutrients), T_3: T_2 –N omission, T_4: T_2 -P omission, T_5: T_2 -K omission, T_6: T_2–Ca omission, T_7: T_2 -Mg omission, T_8:T_2 -S omission, T_9: T_2- Zn omission, T_{10}: T_2 -Fe omission and T_{11}: T_2-B omission. The N and K was applied in three splits, 25% at basal, 50% at 30 DAS and remaining 25% at 60 DAS,

whereas P was applied at basal. The seeds *Bt* cotton hybrid Rasi BT (cv. RCH 2 Bt BG-II) were dibbled at a spacing of 90 X 60 cm. Data on growth and yield parameters were recorded from 5 randomly selected plants in each treatment plot measuring 34.56 m^2. Seed cotton yield (kg/ha) was calculated from whole plot. The all other recommended practices were uniformly followed as per the university's manual of Package of Practices. The cost of cultivation and relative economics of each crop was calculated on the basis of prevailing market price of the inputs and the produce. Fisher method of analysis of variance was applied for analysis and interpretation of this data as given by Panse and Sukhatme (1967).

RESULTS & DISCUSSION

Seed cotton yield differed significantly varied due to application of different nutrients as per target yield. Application of nutrients for the target yield of 30 q ha^{-1} (135:75:150 N, P_2O_5 and K_2O kg/ha plus macro and minor nutrients) recorded significantly higher seed cotton yield of 2663 kg ha^{-1} in pooled data of two years, as compared to other nutrient levels applied for different target yields (Table 1) and the extent of increase in yield varied from 3 to 106 over rest of the treatments. Significantly lower seed cotton yield was recorded with absolute control (without fertilizers, 1291 kg ha^{-1}). Significantly higher seed cotton yield per plant was registered with application of nutrients for the target yield of 30 q ha^{-1} (135:75:150 N, P_2O_5 and K_2O kg/ha plus macro and minor nutrients) when compared to other treatments. Similar trend was also observed in number bolls per plant (49.37) and mean boll weight (4.89 g) in the treatment receiving nutrients for the target yield of 30 q ha^{-1} over other treatments. Similar results were reported by Police Patil *et al.* (2009) and Biradar *et al*. (2012). Further, the results are also in conformity with the findings of Bhale Rao *et al*. (2012) who reported that application of 150 per cent RDF (200:100:100 kg NPK ha-1) resulted in significantly higher seed cotton yield and yield attributing characters in cotton due to combined effect of N, P_2O_5 and K_2O. Brar *et al.* (2000) reported that response of cotton to higher doses of nitrogen be attributed to the vital role of N in cell division and cell elongation. Potassium had significant effect on improving the resistance capacity of the crop to drought and alleviates the negative effects of water functioning as the main osmotic solute in plants. Further phosphorus facilitates plant respond to nitrogen and potassium fertilization (Kalaichelvi *et al*. 2006). The increased nutrient levels significantly increased growth parameters of Bt cotton. Application of nutrients for the target yield of 30 q ha^{-1} (135:75:150 N, P_2O_5 and K_2O kg/ha plus macro and minor nutrients) recorded higher number of sympodial bracnches per plant(24.02) and plant height (125.4 cm), as compared to other nutrient levels applied to the cotton. The increase in yield with increasing nutrient levels is attributed to the higher number of bolls harvested per plant, number of sypmpodial branches and mean boll weight (Table 2). These results are in compliance with the findings of Anil Kumar (2004), Dev Raj *et al.* (2011) and Hosamani *et al*. (2013) who reported significantly higher Bt-cotton yield due to application of higher level of nutrients.

The viability of the any technology will be assessed by the monetary benefits of the experiment. In the present study, experimental results(Table 3) revealed that significantly higher gross returns (Rs.74623 ha^{-1}), net returns (Rs.50694 ha^{-1}) and B:C ratio (3.17) were registered with application of nutrients for the target yield of 30 q ha^{-1} (135:75:150 N, P_2O_5 and K_2O kg/ha plus macro and minor nutrients) and it was closely followed by application of nutrients for the target yield of 30 q ha^{-1} (135:75:150 N, P_2O_5 and K_2O kg/ha plus macro and minor nutrients minus boron) with gross return (Rs. 71907 ha^{-1}), net return (Rs.48624 ha^{-1}) and B:C ratio (3.17). Significantly lower gross return (Rs.36206 ha^{-1}), net return (Rs. 19619 ha^{-1}) and B:C ratio (2.36) was observed in absolute control (with fertilizer). Similar results are also reported by Manjunatha *et al*. (2014) and Ashaq Hussain *et al*. (2013). From the experiment it is concluded that N is the most limiting nutrient and its omission resulted in drastic reductions in yield and profitability of cotton.

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TABLE 1.Seed cotton yield and yield parameters as influenced by response of Bt cotton site specific nutrient management in irrigated condition

Treatments	Seed cotton yield (kg/ha)			Seed cotton yield (g/pl)			Boll wt(g)			Number of bolls/pl		
	2008-09	2009-10	Mean	2008-09	2009-10	Mean	2008-09	2009-10	Mean	2008-09	2009-10	Mean
T1 - Absolute control (No fertilizers)	1552	1030	1291	78.47	72.93	75.7	4.46	4.35	4.41	34.53	29.98	25.77
T2 - Nutrients for 30 q/ha yield target (All major and minor nutrients)	2942	2383	2663	161.07	175.93	168.5	4.94	4.84	4.89	44.80	46.97	49.37
T3 - T2 – N (N- Omission plot) – apply P,K	2412	1891	2186	122.73	146.87	134.8	4.47	4.45	4.46	35.07	35.67	36.27
T4 - T2 – P (P- Omission plot) –apply N, K	2580	2090	2335	131.87	149.93	140.9	4.66	4.80	4.73	39.07	40.53	42.0
T5 - T2 – K (K- Omission plot) - apply N,P	2656	2085	2366	135.30	148.73	142.02	4.78	4.57	4.67	37.67	41.72	45.77
T6 - T2 – Ca (Ca- Omission plot) –apply N,P,K	2855	2016	2436	148.73	139.07	143.9	4.78	4.58	4.68	40.00	42.90	45.80
T7 - T2 – Mg (Mg- Omission plot) - --do--	2705	2016	2361	144.83	158.60	151.7	4.73	4.40	4.56	37.23	41.13	45.07
T8 - T2 – S (S- Omission plot) -- --do--	2816	2026	2421	149.47	165.07	157.3	4.78	4.66	4.72	42.07	45.77	49.47
T9 - T2 – Zn (Zn- Omission plot) -- --do--	2741	2170	2456	144.10	154.80	149.5	4.74	4.79	4.77	38.43	42.72	47.0
T10 -T2 – Fe (Fe- Omission plot) -- --do--	2818	2036	2427	150.30	148.20	149.3	4.83	4.75	4.79	39.67	42.77	45.87
T11 -T2 – B (B - Omission plot) -- --do--	2787	2368	2578	148.03	160.60	154.3	4.77	4.73	4.75	37.42	42.12	46.80
SEM +/-	85	90	62	1.796	4.08	3.15	0.035	0.05	0.03	0.952	0.82	1.32
C.D @ 5 %	252	267	177	14.15	12.02	9.0	0.103	0.16	0.09	2.81	2.33	3.90

TABLE 2. Growth parameters of Bt cotton as influenced by response of Bt cotton site specific nutrient management in irrigated condition

Treatments	Number of sympodia /plant			Number of Monopodia /plant			Plant height (cm)		
	2008-09	2009-10	Mean	2008-09	2009-10	Mean	2008-09	2009-10	Mean
T1 - Absolute control (No fertilizers)	18.53	22.60	20.63	2.47	1.27	1.87	101.87	111.53	106.7
T2 - Nutrients for 30 q/ha yield target (All major and minor nutrients)	22.17	25.93	24.02	2.53	1.30	1.92	119.23	131.46	125.4
T3 - T2 – N (N- Omission plot) – apply P,K	19.60	23.60	21.60	2.40	1.60	2.0	105.13	121.87	113.5
T4 - T2 – P (P- Omission plot) –apply N, K	20.33	24.27	22.30	2.67	1.60	2.13	111.93	122.80	117.4
T5 - T2 – K (K- Omission plot) - apply N,P	20.20	23.53	21.87	2.30	1.73	2.02	107.74	124.33	116.0
T6 - T2 – Ca (Ca- Omission plot) –apply N,P,K	21.93	24.80	23.37	2.43	1.67	2.05	104.13	129.80	114.2
T7 - T2 – Mg (Mg- Omission plot) - --do--	20.80	22.33	21.57	2.58	1.60	2.08	103.07	129.97	116.4
T8 - T2 – S (S- Omission plot) -- --do--	22.00	24.80	23.40	2.60	1.53	2.07	107.07	132.33	118.5
T9 - T2 – Zn (Zn- Omission plot) -- --do--	20.68	24.20	22.43	2.68	1.73	2.22	105.93	133.03	119.1
T10 -T2 – Fe (Fe- Omission plot) -- --do--	20.93	25.2	23.07	2.64	1.73	2.20	108.40	132.67	120.2
T11 -T2 – B (B - Omission plot) -- --do--	21.07	26.13	23.60	2.56	1.67	2.12	107.53	132.67	120.1
SEM +/-	0.743	1.20	0.71	0.157	0.09	0.09	2.365	1.82	1.49
C.D @ 5 %	NS	NS	2.03	NS	0.28	NS	6.98	5.38	4.27

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TABLE 3: Gross returns, net returns and B: C ratio as influenced by response of Bt cotton site specific nutrient management in Irrigated condition

Treatments	Gross returns (Rs/ha)			Net returns (Rs/ha)			B:C ratio		
	2008-09	2009-10	Mean	2008-09	2009-10	Mean	2008-09	2009-10	Mean
T1 - Absolute control (No fertilizers)	40361	30887	36206	25267	15793	19619	2.67	2.04	2.36
T2 - Nutrients for 30 q/ha yield target (All major and minor nutrients)	76501	71502	74623	54014	47185	50694	3.40	2.94	3.17
T3 - T2 – N (N- Omission plot) – apply P,K	62703	59421	60441	41328	36306	39532	2.93	2.57	2.75
T4 - T2 – P (P- Omission plot) –apply N, K	67071	62696	64653	45731	39526	42407	3.14	2.71	2.93
T5 - T2 – K (K- Omission plot) - apply N,P	69056	62553	66407	47824	39495	42337	3.25	2.71	2.98
T6 - T2 – Ca (Ca- mission plot) –apply N,P,K	74239	60474	66868	52452	36917	46119	3.41	2.57	2.99
T7 - T2 – Mg (Mg- Omission plot) - --do--	70330	60482	65233	48343	36675	43202	3.20	2.54	2.87
T8 - T2 – S (S- Omission plot) -- --do--	73216	61793	67877	51079	37856	44901	3.31	2.58	2.95
T9 - T2 – Zn (Zn- Omission plot) -- --do--	71266	65112	68185	49429	41645	46308	3.26	2.75	3.01
T10 -T2 – Fe (Fe- Omission plot) -- --do--	73268	61065	66902	51381	37358	45456	3.35	2.57	2.96
T11 -T2 – B (B - Omission plot) -- --do--	72453	71060	71907	50684	47491	48624	3.33	3.02	3.17
SEM +/-	2221	1724	1256	1251	1724	1020	0.11	0.08	0.07
C.D @ 5 %	6552	5085	3587	3689	5085	2914	0.32	0.23	0.19