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Effect of Soil and Foliar Application of Inorganic Fertilizers with Farm Yard Manure on Yield and Quality of Bt Cotton under Irrigated Ecosystem

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Abstract A field experiment was conducted during *kharif* seasons of 2009–10 to 2011-12 to assess the effect of incorporation FYM in soil with foliar application of different primary, secondary and micronutrients on yield and quality of Bt hybrid cotton under irrigated condition. The experiment was laid out in randomized block design with 10 treatments replicated thrice. The soils of the experimental field was clayey in texture having pH 7.2, medium in organic carbon (0.43%) and available phosphorus and high in available potash (575 kg/ha). The experimental results indicated that higher seed cotton yield (2361 kg/ha) and highest net return of Rs 73,887/ha with BCR 2.67 was recorded with incorporation of 10 t FYM /ha coupled with soil test based recommended fertilizers and one spray of 2% urea at flowering and one spray of 1% urea + 1% $MgSO_4$ during boll development stage.

Keywords Inorganic fertilizer, Foliar application, Bt cotton, Irrigated conditions, Seed cotton yield.

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Introduction

Cotton is an important commercial crop and plays an important role in state economy. Gujarat is leading cotton growing state which grows cotton about 2.69 million ha producing 11.60 million bales of lint with the productivity of 733 kg lint per hectare [1]. However, the productivity is still below to the world average. There is possible risk of deficiency of nutrient due to mono cropping of cotton which may result in reduction of productivity. This may be due to imbalance use of fertilizers. Imbalances use of major and micronutrients is the major problems. These nutrients are more important because in Bt cotton synchronized boll development altered the source sink relationship due to rapid translocation of saccharides and nutrients from leaves to developing boll [2]. To overcome these problems, additional nutrition besides normal recommendations through foliar feeding is required. Higher boll retention may be due to insect resistance in Bt hybrid cotton. More than 25 to 50% recommended dose of fertilizers (RDF) along with micro and secondary nutrients with early application in their absence or delay caused leaf reddening and decline in seed cotton yield [3, 4]. Plants respond quickly to foliar nutrition of both major and micro nutrients to supplement soil uptake and correct in-season nutrient deficiency in plant parts. Foliar nutrition is one of the most efficient ways of supplying essential nutrients to a growing crop considering the above facts the present experiment was conducted to study the influence of foliar nutrition of both major

and micronutrients on productivity and profitability of Bt cotton in irrigated ecosystem.

Materials and Methods

A field experiment was conducted during *kharif* seasons of 2009–10 to 2011–12 at Main Cotton Research Station, Navasari Agricultural University, Surat (20° 12´N and 72°12´E with an elevation of 11.34 m above the mean sea level) with ten treatments i.e.T_1 : RDF (240 : 40 : 0 kg NPK / ha) alone, T_2 : RDF based on soil test value, T_3 : T_2 + FYM 10 t/ha, T_4 : T_3 + 2 foliar spray of 2% urea at peak flowering stage to boll development stage, T_5 : T_3 + 2 foliar spray of 2% DAP at flowering stage, T_6 : T_3 + 2 foliar spray of 19 : 19 : 19 at peak flowering stage to boll development stage, T_7 : T_4 + 2 foliar spray of 2% DAP (alternatively) starting from flowering to boll development stage, T_8 : T_3 + 2 spray of 2% KNO_3 + 2% DAP during flowering to boll development stage, T_9 : T_3 + one spray of 2% urea and one spray of 1% urea + 1% $MgSO_4$ during flowering to boll development stage, T_{10} : T_4 + 2 spray of 0.5% Zn SO_4 during flowering to boll development stage. The trial was laid out in randomized block design with three replications. The soil of the experimental field was clayey in texture having pH 7.2, medium in organic carbon (0.43%) and available phosphorus and high in available potash (575 kg/ha). The crop Bt hybrit cotton was sown on 30th June, 3rd and 5th July during 2009, 2010 and 2011 respectively at the spacing of 120 × 45 cm. Full dose of P and farm yard manures (as per treatments) were placed in bunds below the seed before sowing at the time of ridging, while N was applied in five equal splits at 30, 60, 75, 90 and 105 days after sowing (DAS). Recommended practices for the region were followed for raising the crop. Biochemical analysis viz. total chlorophyll, chlorophyll a, chlorophyll b, anthocyanin (mg^{-1} FW) and nitrate reductase $\mu g\ g^{-1}\ min^{-1}$ were studied at boll developmental stage and analyzed by standard procedure [5] and the data collected for three years were pooled and statistically analyzed by the method suggested by Gomez and Gomez [6]. Seed cotton yield was recorded by picking seed cotton once i.e. composite (mixed picking). Profitability was calculated on the base of prevailing input and out prices.

Table 1. Effect of different treatments on growth and yield attributes on Bt cotton (pooled of three years).

Treatments	Plant height (cm)	No. of sympodia/ plant	No. of bolls/ plant	Boll weight (g)	Oil (%)
T_1	76.56	16.16	29.81	3.35	15.28
T_2	74.86	14.73	28.81	3.21	15.57
T_3	82.09	15.86	28.20	3.37	15.17
T_4	80.10	15.93	33.63	3.35	14.32
T_5	77.32	15.54	29.58	3.45	15.82
T_6	79.22	15.38	27.70	3.39	14.62
T_7	81.40	16.89	26.78	3.47	15.49
T_8	81.94	16.24	31.81	3.52	14.32
T_9	85.93	18.11	37.81	3.58	17.00
T_{10}	81.48	15.99	29.44	3.52	16.20
SEm±	4.27	1.19	2.21	0.13	–
CD @ 5%	NS	NS	6.01	NS	–
CV %	9.19	12.63	12.88	6.37	–

Results and Discussion

Effect on growth and yield attributes

The pooled data of growth and yield attributing characters as influenced by different treatments are presented in Table 1. Data indicated that different treatments did not showed significant influence on growth attributes viz. plant height, numbers of sympodia and boll weight. However, number of bolls / plant had significant different. In respect of treatment, T_9 (RDF based on soil test value + FYM 10 t/ha + one spray of 2% urea and one spray of 1% urea + 1% $MgSO_4$ during flowering to boll development stage) recorded significant the highest number of bolls per plant (37.81) except T_8. Foliar application of the nutrients might have helped in more photosynthetic activity and better partitioning of dry matter. These results are in association with several reporters [7—10] who opined that, foliar application of macro and micro nutrients along with RDF increased the seed cotton yield over the application of RDF alone.

Effect on biochemical parameters

Different biochemical parameters viz. total chlorophyll

Table 2. Effect of different treatments on biochemical parameters on Bt cotton.

Treatments	Total chlorophyll (mg g^{-1} FW)	Chl a: Chl b	Anthocyanin (mg^{-1} FW)	Nitrate reductase µg g^{-1} min^{-1}
T_1	2.45	2.01	0.029	0.69
T_2	2.39	2.10	0.029	0.68
T_3	2.37	2.11	0.027	0.64
T_4	2.23	2.10	0.027	0.67
T_5	2.23	2.13	0.026	0.63
T_6	2.42	2.16	0.026	0.78
T_7	2.58	2.13	0.025	0.76
T_8	2.96	2.22	0.021	0.83
T_9	2.97	2.25	0.020	0.81
T_{10}	2.61	2.14	0.025	0.76
SEm (±)	0.15	0.04	0.0007	0.03
CD @ 5%	0.45	0.12	0.002	0.10
CV %	10.4	3.25	4.65	8.25

content, chl a : b ratio, anthocyanin content and nitrate reductase activity were studied at boll developmental stage and all the parameters showed significant difference in response to various foliar applications (Table 2). Total chlorophyll content was found maximum in treatment T_9 followed by T_8. Similarly minimum anthocyanin and maximum chl a: chl b ratio was observed in T_9 followed by T_8. This was indication of less reddening in this treatment. Nitrate reductase activity was low in treatment T_1, T_2, T_3, T_4 and T_5 indicated nitrogen deficiency in these treatments during boll development stages.

Effect on seed cotton yield

Seed cotton yield was significantly influenced due to different treatments (Table 3). Treatment T_9 (RDF based on soil test value + FYM 10 t/ha + one spray of 2% urea and one spray of 1% urea+ 1% $MgSO_4$ during flowering to boll development stage) recorded significantly the highest seed cotton yield of 2,401, 2, 798, 1,885 and 2,361 kg/ha during 2009–10, 2010–11, 2011–12 and on pooled basis respectively. The higher seed cotton yield due to this treatment was associated with higher number of bolls/plant and high nitrate reductase activity. Foliar application of water soluble complex fertilizers would be act as a source of all major and micro nutrients, which helps in increasing the seed cotton yield [11]. The present results are in consonance with the findings of earlier reporters [7—9] who also reported increase in the seed cotton yield over the application of RDF alone.

Table 3. Effect of different treatments on seed cotton yield (kg/ha).

Tr.	Treatments details	2009–10	2010–11	2011–12	Pooled
T_1	RDF (240 : 40 : 0 kg NPK / ha) alone	1944	1926	1430	1767
T_2	RDF based on soil test value	1935	2033	1611	1860
T_3	T_2 + FYM 10 t/ha	1817	1910	1498	1742
T_4	T_3+2 foliar spray of 2% urea at peak flowering stage to boll development stage	2047	2285	1680	2004
T_5	T_3+2 foliar spray of 2% DAP at flowering stage	1836	2145	1605	1862
T_6	T_3+2 foliar spray of 19:19:19 at peak flowering stage to boll development stage	1781	1881	1511	1724
T_7	T_4+2 foliar spray of 2% DAP (alternatively) starting from flowering to boll development stage	1765	1818	1560	1714
T_8	T_3+2 spray of 2% KNO_3 + 2% DAP during flowering to boll development stage	2033	2038	1872	1981
T_9	T_3+one spray of 2% urea and one spray of 1% urea+1% $MgSO_4$ during flowering to boll development stage	2401	2798	1885	2361
T_{10}	T_4+2 spray of 0.5% Zn SO_4 during flowering to boll development stage	1918	2053	1670	1881
	SEm±	106.4	137	96.7	65.7
	CD @ 5%	316.2	406	287	185.4
	CV %	9.46	11.32	10.26	10.5

Table 4. Economics as affected by different treatments (pooled basis).Price : Seed cotton Rs 43.00 / kg ; Urea Rs 5.57 / kg ; DAP Rs 19.16 / kg ; 19:19:19 Rs 100.00/kg; KNO_3 Rs 82.00/kg ; $MgSO_4$ Rs 37.20 / kg ; $ZnSO_4$ Rs 13.92 / kg.

Treatments	Seed cotton yield (kg/ha)	Gross return (Rs/ha)	Cost of cultivation (Rs/ha)	Net return (Rs/ha)	BCR
T_1	1767	75981	23936	52045	2.17
T_2	1860	79980	23936	56044	2.34
T_3	1742	74906	25936	48970	1.89
T_4	2004	86172	26969	59203	2.20
T_5	1862	80066	27391	52675	1.92
T_6	1724	74132	26986	47146	1.75
T_7	1714	73702	28424	45278	1.59
T_8	1981	85183	28416	56767	2.00
T_9	2361	101523	27636	73887	2.67
T_{10}	1881	80883	27319	53564	1.96

Economics

Three year pooled results given in Table 4 showed that the treatment T_9 i.e. application of recommended dose of fertilizers based on soil test value + FYM 10 t/ha + one spray of 2% urea and one spray of 1% urea+1% $MgSO_4$ during flowering to boll development stage recorded the highest net return of Rs 73,887/ha with BCR 2.67.

Hence, it can be concluded that seed cotton yield in Bt cotton (RCH 2 BG-II) can be improved under irrigated conditions in clayey soils with incorporation of 10 t FYM/ha coupled with soil test based recommended fertilizers and one spray of 2% urea at flowering stage and one spray of 1% urea + 1% $MgSO_4$ during boll development stage.

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