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Effect of moisture conservation and nutrition management practices on leaf area, chlorophyll content and seed cotton yield of rainfed *Bt* cotton

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Abstract
A field experiment was conducted on clay soil of Regional Agricultural Research Station, Lam, Guntur to find out the effect of nutrition and moisture conservation practices on growth parameters, yield attributes and yield of rainfed *Bt* cotton. The nutrient management and moisture conservation practices influenced the leaf area and leaf area index of cotton crop at different growth stages. Application of 125%RDF (150:75:75) with opening furrow for every row during last intercultural operation + foliar nutrition with 2% KNO_3at square formation, flowering, and boll development stages recorded maximum leaf area, leaf area index and seed cotton yield and was on a par with 125%RDF (150:75:75) fertilizer application + foliar nutrition with 2%KNO_3at square formation, flowering, and boll development stages and 100%RDF (120:60:60) + opening furrow for every row during last intercultural operation + foliar nutrition with 2%KNO_3at square formation, flowering and boll development stages and lowest seed cotton yield was recorded with application of 100%RDF (120:60:60kg ha^{-1}).

Keywords: foliar nutrition, moisture conservation, growth, yield attributes and yield

Introduction

Cotton "white gold" is an important fiber as well as cash crop of India. In India *Bt* cotton is grown in an area of 12.2m.ha with an annual production of 377 lakh bales and a productivity of 524 kg lint ha^{-1}. In the state of Andhra Pradesh, *Bt* cotton occupies an area of 5.44 lakh hectares with an annual production of 22 lakh bales and productivity of 688 kg lint ha^{-1} (AICCIP, Annual Report, 2017-2018) [1]. The major constraints for low productivity of *Bt* cotton include cultivation under rainfed conditions, non adoption of proper nutrient management and moisture stress during the crop growth stages. The yield levels realized in Bt cotton are low due to poor agronomic practices, especially fertilization. In *Bt* cotton special attention must be given to agronomic management, so as to harness its economic benefits, and to sustain high productivity levels.Further improvement in cotton yields is possible only through agronomic manipulations.

Nutrient management in cotton is complex phenomenon due to its simultaneous production of vegetative and reproductive structures during the active growth stage.Squaring, blooming and boll development are the stages where cotton needs the highest nutrients demand.The *Bt* cotton has three distinct characters of synchronized flowering, retention of most of the first formed bolls and reduced crop duration to an extent of one or two weeks, therefore there is a scope to increase the productivity with foliar nutrition coupled with soil application of fertilizers (Santosh *et al*., 2016) [17]. Augmentation of nutrient supply through foliar application at such critical stages may increase yield (Bhatt and Nathu, 1986) [4], (Nehra and Yadav, 20120) [13]. Foliar nutrition when used as a supplement to the recommended soil fertilizer application is highly beneficial, as the crop gets benefitted from foliar applied nutrients when the roots are unable to meet the nutrient requirement of the crop at its critical stage.

Foliar application of nutrients is one of the most efficient ways of supplying essential nutrient to the cotton crop at appropriate stage.Through foliar nutrition, the nutrients are taken into the foliage and distributed (transported) to all parts of the plant within a short period of time to get the needy effect.It is also effective in correcting the mid season discrepancies in cotton crop growth that may be due to either intensive growth or inappropriate supply of nutrients from the soil abiotic stress condition (Kumari and Hema, 2009) [11]. It also regulates the biochemical changes in seed and increase yield of cotton (Chaudhary *et al.*, 2001) [5].

In-situ rain water conservation practice like opening furrows in between rows, often help in conserving soil moisture and ultimately enhance water use efficiency as well. The cost effective technologies for efficient utilization of rain water management as *in - situ* moisture conservation comprising the opening of furrow, may prove vital in enhancing and stabilizing the yield (Gokhale *et al.*, 2011) [7]. The significance of *in-situ* soil moisture conservation measures is to conserve maximum possible rainwater at a place where it falls and make effective efficient use of it. The practices of opening furrow in between row of crop is also beneficial for improving the drainage system in field during the high rainfall period and for decomposing the added biomass later on.Ridge may serve as micro-watershed accumulating water in furrow.Practices of making ridge by opening furrow may have an advantage in concentration of more rain water on the bed which enrich soil moisture content (Gidda and Morey,1981) [6] and the yield levels could be increased (Redder *et al.*, 1991) [16].

Materials and Methods

A field experiment was conducted during *kharif* 2017 at Regional Agricultural Research Station, Lam, Guntur. The soil of the experimental field was clay in texture, neutral in reaction (pH 7.45), low in total nitrogen (133.7 kg ha^{-1}), high in available phosphorus (43.5 kg ha^{-1}) and high in available potassium (390 kg ha^{-1}). The experiment was laid out in randomized block design with three replications and eight treatment combinations *viz.*, T_1-100%RDF (120:60:60) NPK kg ha^{-1}, T_2–125%RDF (150:75:75) NPK kg ha^{-1}, T_3-100%RDF (120:60:60) +opening furrow for every row during last intercultural operation, T_4- 125%RDF (150:75:75)+opening furrow for every row during last intercultural operation, T_5–100%RDF (120:60:60)+Foliar nutrition with 2%KNO_3 at square formation, flowering and boll development, T_6-125%RDF (150:75:75)+Foliar nutrition with 2%KNO_3 at square formation, flowering and boll development, T_7 –100%RDF (120:60:60) +opening furrow for every row during last intercultural operation +foliar nutrition with 2% KNO_3 at square formation, flowering and boll development and T_8 –125%RDF (150:75:75) +opening furrow for every row during last intercultural operation +foliar nutrition with 2%KNO_3 at square formation, flowering and boll development. Phosphorus was applied as basal in the form single super phosphate as per the treatment. Nitrogen and Potassium were applied through urea and muriate of potash in three equal splits at 30, 60 DAS and 90 DAS as per the treatments. The *Bt* hybrid Jaadoo was sown at a spacing of 105 x 60 cm and the treatments were imposed as per the protocol. The total chlorophyll content was measured with SPAD chlorophyll meter reading (SCMR) following the method of (Turner and Jund 1991) [20] from 30 DAS to 120 DAS. The data on leaf area, number of bolls per plant were recorded from randomly selected five plants from each plot and seed cotton yield and stalk yield was recorded on plot basis and subjected to statistical analysis and plant protection measures were followed as per recommendations on need basis.

Results and Discussion

The leaf area and leaf area index at different crop growth stages of cotton was recorded. The leaf area and leaf area index increased from 60 DAS to 120 DAS and there after till harvest it declined in all the treatments. The nutrient management and moisture conservation practices influenced the leaf area and leaf area index of cotton crop (Table 1). The data recorded at 60, 90,120 DAS and harvest revealed that maximum leaf area and leaf area index was recorded with 125%RDF (150:75:75) +opening furrow for every row during last intercultural operation + foliar nutrition with 2%KNO_3 at square formation, flowering and boll development (T_8) and was on a par with125% RDF (150:75:75) + foliar nutrition with 2% KNO_3 at square formation, flowering and boll development (T_6), 100%RDF (120:60:60) +opening furrow for every row during last intercultural operation + foliar nutrition with 2% KNO_3 at square formation, flowering and boll development (T_7), 125%RDF (150:75:75) +opening furrow for every row during last intercultural operation (T_4) and the lowest leaf area was recorded with 100%RDF (120:60:60) NPK kg ha^{-1} (T_1 The SPAD chlorophyll meter reading (SCMR) was recorded at 60, 90 and 120 DAS.The SPAD Chlorophyll meter reading increased from 60 DAS to 120 DAS.The nutrient management and moisture conservation practices influenced the SCMR (Table 2). The bmaximum SPAD chlorophyll meter reading at 120 DAS (50.8) was recorded with125%RDF (150:75:75) +opening furrow for every row during last intercultural operation + foliar nutrition with 2%KNO_3 at square formation, flowering and boll development (T_8) and was on a par with125%RDF (150:75:75) + foliar nutrition with 2% KNO_3 at square formation, flowering and boll development (T_6), 100%RDF (120:60:60) +opening furrow for every row during last intercultural operation + foliar nutrition with 2% KNO_3 at square formation, flowering and boll development (T_7),125%RDF (150:75:75) +opening furrow for every row during last intercultural operation and lowest SPAD chlorophyll meter reading (47.7) was recorded with100%RDF (120:60:60) NPK kg ha$^{-1.}$ Similar trend was recorded at 60 DAS and 90 DAS.

Increased fertilization made the plants more efficient in photosynthetic activity by enhancing the carbohydrate metabolism and hence resulted in increased leaf area, chlorophyll content in leaves. Squaring, blooming and boll development are the stages when cotton requires higher nutrition and augment of nutrient supply through foliar application at such critical stages help in increased growth parameters especially leaf area, which might be due to adequate supply of nutrients and favorable effect of macro nutrients on cell elongation, cell wall thickening, stem and leaf thickness and more of leaf and stem weight and increased chlorophyll content. Similar results were reported by (Rajendran *et al.* 2011) [15], (Kumar *et al.* 2011) [10], (Saravanan *et al.* 2012) [18] and (Kavimani *et al.* 2015) [9].

The maximum numbers of bolls per plant (78.1) were recorded with 125% RDF (150:75:75) +opening furrow for every row during last intercultural operation + foliar nutrition with 2% KNO_3 at square formation, flowering and boll development and was on a par with that 125% RDF (150:75:75)+ foliar nutrition with 2% KNO_3 at square formation, flowering, and boll development, (74.1 bolls plant^{-1}) and 100% RDF (120:60:60)+ opening furrow for every row during last intercultural operation + foliar nutrition with 2% KNO_3 at square formation, flowering, and boll development (71.3 bolls plant^{-1}) and were found significantly superior to that of 100% RDF (120:60:60) NPK kg ha^{-1} (56.7 bolls plant) The increase in boll number per plant was obtained with Opening furrow for every row during last intercultural operation + Foliar nutrition with 2% KNO_3 at square formation, flowering, and boll development due to better soil moisture retention that took place might have helped for better utilization of nitrogen, phosphorus and potassium fertilizer applied, Squaring, blooming and boll development are the stages when cotton requires higher nutrients and nutrient supply through foliar application at such critical stages help in increased yield parameters especially number of bolls per plant, which might be due to adequate supply of nutrients with foliar application. Narayana *et al.* (2011) [12] reported that maximum number of bolls plant^{-1} recorded with opening of soil moisture conservation furrow at last intercultural operation might be due to better soil moisture conservation that took place. Similar results were observed by Keshava *et al.* (2013) [9], Saravanan *et al.* (2012) [18], Nehra and Yadav (2012) [13], Kavimani *et al.* (2015) [8].

The seed cotton yield and stalk yield was significantly influenced by nutrient management and soil moisture conservation practices tested (Table 2). The seed cotton yield is the manifestation of yield contributing characters. These yield attributing characters were significantly affected by nutrient management and soil moisture conservation practices. Maximum seed cotton and stalk yield (3411kg ha^{-1} and 5877 kg ha^{-1}) was recorded with 125%RDF (150:75:75)+opening furrow for every row during last intercultural operation+foliar nutrition with 2%KNO_3 at square formation, flowering and boll development (T_8) and was on a par with125%RDF (150:75:75)+foliar nutrition with 2%KNO_3 at square formation, flowering, and boll development (T_6) and 100% RDF (120:60:60) + opening furrow for every row during last intercultural operation+Foliar nutrition with 2%KNO_3 at square formation, flowering and boll development (T_7) and superior to other treatments tested and lowest seed cotton yield (2285 kg ha^{-1}and 5282 kg ha^{-1}) was recorded with RDF (120:60:60) NPK kg ha-1(T_1). These results are in conformity with (Basavanneppa *et al.* 2012) [3], (Asewar *et al.* 2013) [2], (Keshava *et al.* 2013) [9], (Tayade and Meshram 2013) [18] and (Paslawar and Deotalu, 2015) [14].

Table 1: Leaf area (cm^{2}plant^{-1}) and Leaf area index at different stages of *Bt*cotton as influenced by nutrient management and soil moisture conservation practices

Treatments	Leaf area (cm^2 plant^{-1})				Leaf area index			
	60 DAS	90 DAS	120 DAS	Harvest	60 DAS	90 DAS	120 DAS	Harvest
T_1- 100% RDF (120:60:60) NPK	7364	24142	25670	22962	1.2	3.8	4.1	3.6
T_2- 125% RDF(150:75:75) NPK	10139	25388	26537	23451	1.6	4.0	4.2	3.7
T_3- T_1+ Opening furrow for every row during last intercultural operation.	8697	24906	26372	22864	1.4	4.0	4.2	3.6
T_4- T_2+ Opening furrow for every row during last intercultural operation.	10527	26071	27961	23677	1.7	4.1	4.4	3.8
T_5- T_1+ Foliar nutrition with 2% KNO_3 at square formation, flowering, and boll development.	9201	25639	27839	24093	1.5	4.1	4.4	3.8
T_6- T_2+ Foliar nutrition with 2% KNO_3 at square formation, flowering, and boll development.	10763	26837	28377	25046	1.7	4.3	4.5	4.0
T_7- T_3+ Foliar nutrition with 2% KNO_3 at square formation, flowering, and boll development.	10042	26739	27974	24496	1.6	4.2	4.4	3.9
T_8- T_4+ Foliar nutrition with 2% KNO_3 at square formation, flowering, and boll development.	10943	28114	28842	25547	1.7	4.5	4.6	4.1
S.Em ±	282.16	530.12	306.73	485.26	0.04	0.10	0.007	0.056
CD (P=0.05)	812.1	1598.4	920.6	1455.2	0.10	0.30	0.21	0.17
CV (%)	14.8	6.3	5.4	5.5	14.8	6.3	5.4	5.5

Table 2: SCMR, No: of bolls per plant, seed cotton yield and stalk yield as influenced by nutrient management and soil moisture conservation practices.

Treatments	SPAD chlorophyll meter reading			Number of bolls per plant	Seed cotton yield (kg ha^{-1})	Stalk Yield (kg ha^{-1})
	60 DAS	90 DAS	120 DAS			
T_1- 100% RDF (120:60:60) NPK	36.6	56.7	41.9	45.7	2285	5282
T_2- 125% RDF(150:75:75) NPK	39.8	64.0	42.8	49.0	2460	5505
T_3- T_1+ Opening furrow for every row during last intercultural operation.	37.0	59.6	42.6	48.3	2519	5431
T_4- T_2+ Opening furrow for every row during last intercultural operation.	41.4	70.8	43.8	49.6	2947	5654
T_5- T_1+ Foliar nutrition with 2% KNO_3 at square formation, flowering, and boll development.	39.1	68.4	43.0	47.6	2831	5580
T_6- T_2+ Foliar nutrition with 2% KNO_3 at square formation, flowering, and boll development.	41.5	74.1	44.3	50.3	3266	5803
T_7- T_3+ Foliar nutrition with 2% KNO_3 at square formation, flowering, and boll development.	40.4	71.3	45.0	49.8	3177	5712
T_8- T_4+ Foliar nutrition with 2% KNO_3 at square formation, flowering, and boll development.	41.6	78.1	45.3	50.8	3411	5877
S.Em ±	0.66	2.6	0.52	0.65	96.2	131.5
CD (P=0.05)	1.0	7.8	1.60	1.2	292.0	394.6
CV (%)	2.9	12.3	2.1	2.3	5.8	12.1

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