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Evolution of Liquid Multinutrient Fertilizer for Hybrid Cotton

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Original Research Article

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ABSTRACT

A field experiment was conducted to assess the effect of drip fertigation and foliar nutrition of liquid multi nutrient on growth, yield and quality parameters of hybrid cotton. Liquid fertilizer was formulated using micronutrient (Zn, Fe, Mn, B, Mo, Cu), Mg and S to meet the nutrient requirement of hybrid cotton. Field experiment was laid out in Randomized Block Design with three replications and seven treatments. Drip fertigation was applied with 100% recommended dose of fertilizer (RDF) through water soluble fertilizer and Liquid Multinutrient (LMN). Treatment that received 100% RDF + LMN fertigation and foliar nutrition of LMN recorded the highest growth parameters (plant height, Leaf Area Index and dry matter production), yield parameters like number of sympodial branches/plant, number of bolls/plant, boll weight, seed cotton yield and quality parameters like staple length and ginning out turn per cent and in addition to that foliar nutrition of LMN containing Mg alleviated the Mg deficiency to the tune of 52% which in turn increases the above parameters. Fertigation and foliar nutrition of LMN enhanced the nutrient uptake of hybrid cotton that would economize the cost of fertilizer input.

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1. INTRODUCTION

Cotton (*Gossypium sp)* as a white gold and king of fiber enjoys a predominant position among all cash crops in India [1]. It is the most important fiber, oil, protein yielding commercial crop in India and it occupies a major source of foreign exchange as it supplies important raw material for the textile and ginning industry. India is the third largest producer of cotton in the world with the production of around 3.95 million tons.

Drip fertigation has the added advantage as the water-soluble fertilizer can be injected through the system via fertigation in precise amount and when required to match the crop needs provides an excellent opportunity to maximize the yield [2]. By fertigation 30% fertilizer saving is possible from the recommended dose resulting in reduced rate, cost of fertilizer application and increase in fertilizer use efficiency [3].

The foliar application of plant nutrients maintains the biochemical changes in seed and increase in yield of cotton [4]. It is preferred for the immediate needs of plant and also in reducing the quantity of fertilizer. The deficiency of micronutrients has become major constraints to productivity, stability and sustainability of cotton ecosystem [5]. To overcome this, balanced nutrition and additional care through foliar nutrition assumes significance to real time nutritional requirement of crop [6]. Furthermore, cotton lends itself to foliar application because of large number of aerial application and it is one the most efficient way of supplying essential nutrients to the growing crop [7]. Recently, it is often assumed that drip fertigation in combination with foliar nutrition in cotton is most preferable.

2. MATERIALS AND METHODS

A field study was conducted in research farm, Coimbatore, India to assess the influence of drip fertigation and foliar nutrition of liquid multinutrient on growth, yield and quality parameters on hybrid cotton (RCH 659). To formulate and study the impact of liquid multinutrient with 1% / 2% $MgSO_4$ to alleviate Mg deficiency in cotton. Soil of experimental site was low in available N, medium in P and high in K with the pH of 7.73 and EC of 0.11dsm^{-1}. Zn, Fe, Mn and Cu contents in the soil is 0.8, 2.5, 10.6, and 0.9 mg kg^{-1} respectively. The experimental soil had 14.7% of field capacity, 9.4% of permanent wilting point with a bulk density of 1.17 g cm^{-3}.

The field experiment was designed in Randomized Block Design with seven treatment and three replications. Soil application of fertilizer, fertigation and foliar nutrition were included in the treatment. The seven treatments were T_1 - Untreated control (drip irrigation), T_2 - Recommended RDF (soil application of fertilizer), T_3 - 100% Recommended RDF through drip irrigation, T_4 - T_3 + fertigation LMN @ 25 lit ha^{-1}, T_5 - T_4 + fertigation LMN @ 50 lit ha^{-1}, T_6 - T_4 + 1% LMN foliar nutrition, T_7 - T_5+ 2% LMN foliar nutrition. The crop was raised by following all the recommended package of practices (POP) for hybrid cotton by adopting a spacing of 0.9 x 0.9 m^2. Meanwhile, sowing was done on raised bed with 5cm depth near the emitter and life irrigation were given by following the POP.

A venturi injector was used to provide fertilization to specific plots. Fertilizer solution was made and stored in a plastic container mounted to a suction device. Fertigation was done as per the schedule prescribed for the hybrid cotton. The recommended dose of fertilizer (RBD) is 120 N: 60 P_2O_5: 60 K_2O kg ha^{-1} were applied. Nitrogen, Phosphorus and Potassium were given in the form of urea, single super phosphate and muriate of potash respectively.

As per the treatment details, foliar nutrition of LMN that supply 1% / 2% $MgSO_4$ were imposed during the critical stages of the hybrid cotton over the plant canopy during morning hours using high volume knapsack sprayer. Various observation like growth parameters (plant height, leaf area index (LAI), dry matter production) at 30, 60, 90 and 120 days after sowing were recorded. Physiological parameters like chlorophyll content at the critical stages were recorded. Yield parameters like (No. of sympodial branches/plant, No. of bolls /plant, boll weight, seed cotton yield) and quality parameters like (staple length, lint yield and ginning out turn %) were recorded and statistically analysed. In addition to this, magnesium deficient plant per treatment were observed and correction was carried out by the foliar nutrition of LMN + 1% or 2% $MgSO_4$.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

Drip fertigation with 100% recommended dose of NPK as water soluble fertilizer and liquid multinutrient (LMN) and foliar nutrition of

micronutrient + $MgSO_4$ was observed to be more effective among other treatments and registered the highest values of plant height (139.3cm), leaf area index (LAI) (3.71) and dry matter production (5866.7Kg ha^{-1}) at 120 DAS. This treatment recorded the highest chlorophyll content at critical stages. This could be due to the precise application of water as drops exclusively at the root zone, maximizing the amount of water by ensuring that soil moisture was kept at a constant level [8,9] in addition to combined application of water-soluble fertilizer and foliar nutrition at critical growth stages of the crop [10]. [11] recorded that effective conservation of moisture and nutrients increased the crop growth and vegetative biomass. Fertilizers when applied through fertigation increased dry matter accumulation in cotton that higher the plant height and LAI could be due to the more canopy development that results in the maximum photosynthetic rate and chlorophyll content [12].

3.2 Magnesium Deficiency in Cotton

Magnesium deficiency shows red leaf malady is very common in cotton in south India which significantly decreases the yield. So, application of foliar nutrition of 2% $MgSO_4$ noticed that total plant exhibiting Mg deficiency was reduced to the tune of 52%.

3.3 Yield Parameters

Drip fertigation of 100% recommended dose of NPK + foliar nutrition of LMN- $MgSO_4$ at the flowering and boll development stage recorded the highest yield attributes viz., No. of sympodial branches (20.3), No. of bolls (92.33), boll weight (5.56 g) and seed cotton yield (9244.5 Kg ha^{-1}) over the control (5007.0 Kg ha^{-1}) and conventional method due to enhanced availability and uptake of nutrients. These results are in agreement with [13] who observed that foliar application of magnesium and zinc separately and also with combination of sulphate of zinc and magnesium increased seed cotton yield. Frequent supply of water near the root zone through drippers provides good soil moisture and thus resulting in higher yield [8]. Highest number of bolls could be due to the highest production of vegetative biomass and flowers under fertigation. [12] observed that total bolls and boll weight produced per plant were significantly higher in cotton when applied with higher level of nutrients through fertigation. [14] Foliar nutrition of Magnesium sulphate (2%) on 50th and 80th day corrected red coloration of leaves increased the seed cotton yield [15]. Foliar nutrition of 1% $MgSO_4$ also resulted in 43% higher seed cotton yield at Faridkot [16].

Table 1. Growth parameters of hybrid cotton as influenced by Liquid multi nutrient

Treatments		Plant height (cm)	Leaf Area Index	Dry Matter Production (kg ha^{-1})	Chlorophyll content	No. of Sympodial branches
T_1	Untreated contril (drip fertigation	102	2.40	4495.3	34.3	15.1
T_2	Recommended RDF (soil application of fertilizer)	109.7	2.61	4789.1	37.6	16.4
T_3	100% Recommended RDF through drip irrigation	112.4	2.82	4907.5	40.2	17.1
T_4	T_3 + fertigation LMN @ 25 lit ha^{-1}	120.6	3.01	5166.5	41.7	17.8
T_5	T_4 + fertigation LMN @ 50lit ha^{-1}	126.7	3.27	5378.5	41.4	18.6
T_6	T_4 + 1% LMN foliar nutrition	132.7	3.51	5599.7	43.6	19.1
T_7	T_5 + 2% LMN foliar nutrition	139.3	3.71	5866.7	45.7	20.3
Mean		120.5	3.05	5171.9	40.6	17.8
SEd		2.1	0.05	115.4	0.6	0.3
CD(0.05)		4.6	0.12	251.5	1.3	0.8

**SEd - standard error of difference and CD - critical difference*

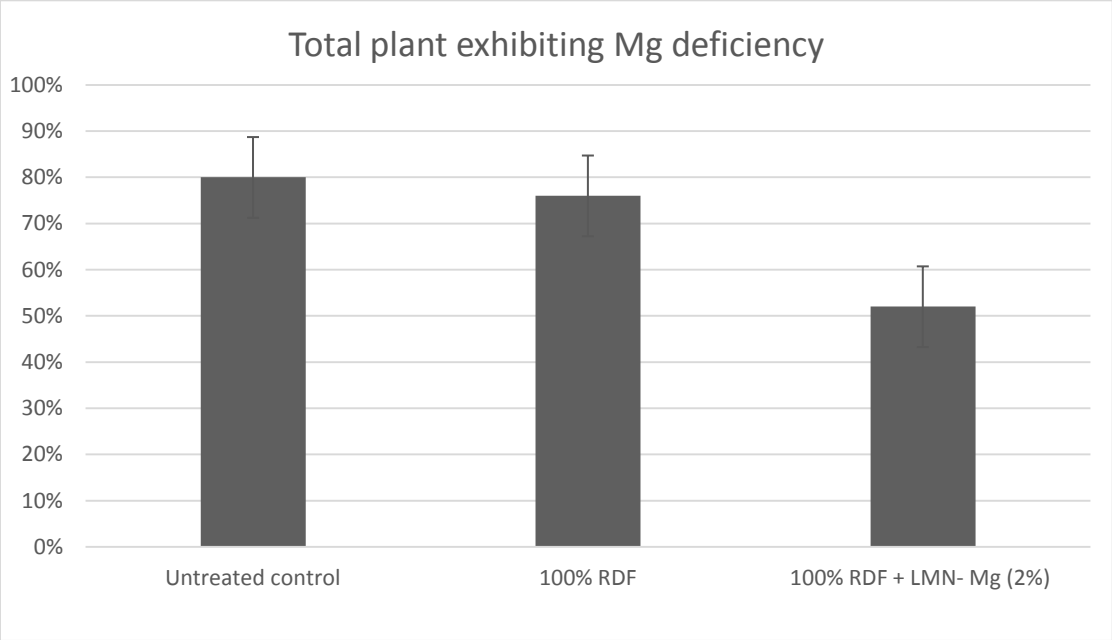

Fig. 1. Total plant exhibiting Mg deficiency influenced by liquid multinutrient

Table 2. Yield and Quality parameters of hybrid cotton influenced by multi micro nutrient

Treatments		Yield parameters			Quality parameters		
		No. of bolls	**Boll wt.(g)**	**Seed cotton yield Kg ha^{-1}**	**Staple length (mm)**	**Lint yield Kg ha^{-1}**	**Ginning out turn (%)**
T_1	Untreated control (drip irrig irrigation)	64.66	4.13	5007.0	25.4	1556.1	39.1
T_2	Recommended RDF (soil application of fertilizer)	70.33	4.32	5696.6	27.1	1700.6	40.6
T_3	100% Recommended RDF through drip irrigation	71.66	4.67	5804.4	27.4	1929.5	41.5
T_4	T_3 + fertigation LMN @ 25 lit ha^{-1}	81.33	4.93	7517.8	27.8	2460.8	42.3
T_5	T_4 + fertigation LMN @ 50 lit ha^{-1}	88.66	5.16	8272.1	28.6	2698.3	42.6
T_6	T_4 + 1% LMN foliar nutrition	89.33	5.32	8759.8	30.2	2976.8	42.8
T_7	T_5+ 2% LMN foliar nutrition	92.33	5.56	9244.5	31.9	3144.8	43.6
Mean		79.75	4.88	7186.03	28.3	2352.4	41.7
SEd		1.21	0.09	161.79	0.5	60.9	0.1
CD(0.05)		2.64	0.21	352.51	0.9	132.7	0.3

**SEd - standard error of difference and CD - critical difference*

Table 3. Nutrient uptake of hybrid cotton influenced by multi micronutrient

Treatment		N uptake (kg/ha)	P uptake (kg/ha)	K uptake (kg/ha)
T_1	Untreated control (drip irrigation)	52.8	12.1	59.2
T_2	Recommended RDF (soil application of fertilizer)	62.6	13.7	63.7
T_3	100% Recommended RDF through drip irrigation	73.7	16.9	70.6
T_4	T_3 + fertigation LMN @ 25 lit ha^{-1}	77.2	17.1	85.2
T_5	T_4 + fertigation LMN @ 50lit ha^{-1}	86.2	19.2	91.3
T_6	T_4 + 1% LMN foliar nutrition	98.6	20.2	97.4
T_7	T_5+ 2% LMN foliar nutrition	109.2	22.9	105.1
	Mean	80.1	17.4	81.8
	SEd	1.5	0.2	1.4
	CD(0.05)	3.3	0.5	3.1

**SEd - standard error of difference and CD - critical difference*

3.4 Quality Parameters

Drip fertigation of 100% recommended dose of NPK + LMN - 2% $MgSO_4$ as foliar nutrition at the flowering and boll development stages recorded the highest lint yield (3144.8 kg ha^{-1}), ginning out turn% (43.6%) and staple length (31.9 mm) over control. Drip fertigation resulted in higher lint yield over surface irrigation. This is confirmed by the earlier studies of [17] Foliar application of multinutrient consisting consisting of Mg 5%, B 0.5%, Cu 1.5%, Fe 4%, Mn 4%, Mo 0.1%, Zn 1.5% recorded the highest lint yield. The number of bolls per unit area, boll retention, and the lint per boll resulted in higher lint yield [18]. [19] reported that seed cotton yield, ginning percentage and fibre quality of cotton got increased by the foliar application of Zn, Mo, Fe, B and Mn applied @ 2.0, 0.5, 5.0, 0.5 and 2.0 lb per acre respectively on 60th DAS. [20] observed that seed cotton yield and lint yield increased by foliar application of boron at different growth stages significantly.

3.5 Nutrient Uptake

The maximum NPK uptake was significantly higher under drip fertigation of 100% recommended dose of NPK + LMN - 2% $MgSO_4$ as foliar nutrition as compared to control. The NPK uptake by cotton stalk varied from 52.81 to 109.2, 12.1 to 22.9, 59.22 to 105.1 kg ha^{-1} respectively. This was due to availability of favourable soil moisture throughout the crop growth period, which stimulated the height of plant, expansion of leaf and consequent accumulation of more dry matter. Since the nutrient uptake is a product of nutrient content and DMP, the trend of N, P and K uptake was similar as that of DMP [21]. It was due to conservation of more soil moisture in the root zone of the crop which helped in better utilisation of nutrients which in turn reflected on better growth and production of increased dry matter [22].

4. CONCLUSION

Fertigation and foliar nutrition of multinutrient as liquid fertilizer enhanced the growth, yield and quality of hybrid cotton. This balanced nutrition fertigation of nutrients enhanced the nutrient uptake thereby cost of fertilizer could be economized.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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