Physiological Role of Nutrient Consortium for Improving the Yield in Cotton

ABSTRACT

The present investigation was carried out to study the impact of nutrients and PGRs (Plant Growth Regulators) on morphological, physiological and yield attributes of the cotton crop. The statistical design used for the study is Factorial Completely Randomized Design (FCRD) with four replications. The pot culture experiment was conducted in the Glass house, Department of Crop Physiology, Tamil Nadu Agricultural University (TNAU) during February 2023 – June 2023. The study was carried out using two cotton varieties (CO 17 and MCU 5) with the treatments containing 1% foliar spray of Nutrio-hormonal consortia Ⅰ, Nutrio-hormonal consortia Ⅱ, Cotton Booster Ⅰ, Cotton Booster Ⅱ and control. The treatments were imposed during flowering and boll development stages. The morphological, physiological and yield attributes *viz*., plant height (in cm), chlorophyll index, total dry matter production (g/plant), number of sympodial branches per plant, number of bolls per plant, boll weight (g/boll) and seed cotton yield (g/plant) were recorded. Foliar application of the Cotton booster Ⅱ resulted in significant increase in the plant height (58.35 cm), total dry matter production (38.65 g/plant)**,** number of sympodial branches per plant (17.8), number of bolls per plant (15.60), boll weight (3.88 g/boll) and seed cotton yield (42.79 g/plant) followed by Cotton booster Ⅰ in CO 17 variety. Similarly, in MCU 5 cotton variety, significant difference was observed in plant height (69.37 cm), total dry matter production (45.60 g/plant), number of sympodial branches per plant (19.6), number of bolls per plant (20.0), boll weight(4.39 g/boll) and seed cotton yield (48.77 g/plant). In conclusion, foliar application of 1% Cotton Booster Ⅱ exhibited better growth and yield attributes in cotton.

Keywords: Cotton, Yield, Foliar application, TNAU Cotton Plus booster, Nutrients and PGRs

1. INTRODUCTION

Cotton is a commercial cash crop that provides huge contribution in textile industries by producing natural fibers as raw materials. The crop sustains the livelihood for 6 million people and engages 40-50 million people in allied activities like cotton processing and trade [1]. Improving the yield and productivity of the crop will increase the economic welfare of the farming community. Currently, India cultivates 34347 thousand bales of cotton in an area of 13061 thousand ha with productivity of 447 kg/ha. This is 10.38 % increase in production than the previous year, 2021-2022 [2]. Whereas, in Tamil Nadu, it is cultivated in 1.56 lakh ha with production of 3.56 lakh bales and a productivity of 388 kg/ha which is 10.56 % increment than the previous year. Hence, endeavours in increasing the production and productivity of crop should be made in order to improve the economic status of the country. One such way is boosting the crop metabolism by adapting feasible management practices like foliar application of nutrients and PGRs.

Foliar fertilization is one of the effective ways to enhance the crop growth with numerous advantages like instant response, easier application, supplementing soil fertilization, correcting nutritional deficiencies, decreasing the input cost and improving the nutrient uptake [3]. Nitrogen is a major macro-nutrient that is often found to be one of the limiting factors in the crop production. It plays an extensive role in the vegetative growth of the crop by affecting the chlorophyll production. Nitrogen application leads to more photosynthetic efficiency and dry matter accumulation [4]. Various application rates of nitrogen have been found to influence the fibre quality [5]. Phosphorus is essential for providing energy in the form of ATP (Adenosine triphosphate) to several energy transfer reactions, photosynthesis, nutrient flux and asses in development of the crop [6]. Exogenous application of potassium helps in increasing the seed cotton yield by activating the enzymes, regulating stomatal movements and leading to more biomass accumulation [7;8]

PGRs are substances that influence the crop growth and development when applied in minute concentrations. It enhances the dry matter accumulation in fruiting bodies while partitioning, assessing the crop economy. NAA (Naphthalene acetic acid) can be applied to ameliorate the shedding effect of bolls which is one of the major causes for the yield loss. Its role in cell division and cell elongation paves the way in formation of more fruiting branches and bolls [9]. Salicylic acid (SA) also found to enhance various physiological and biochemical processes that results in better growth and productivity of the crop [10].

Thus, nutrients and PGRs play various inevitable roles in mediating the plant metabolism and their physiological processes. Keeping this in consideration, a pot culture study has been conducted in the Glass house, Department of Crop Physiology during February 2023 – May 2023, to study the effect of foliar application of nutrients and PGRs on growth, physiology and the yield attributes of cotton crop.

2. MATERIAL AND METHODS

A pot culture experiment was conducted to study the impact of nutrients and plant growth regulators on cotton. The experiment was carried out in the Glass house, Department of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore. The statistical design used for the study was factorial experiment under completely randomized design with four replications. This experiment was conducted using two varieties of cotton, namely CO 17 and MCU 5. The seeds were delinted using conc. H_2SO_4 and treated with Chlorpyriphos 20% EC recommended by the TNAU Crop Production Guide 2020 (CPG 2020). As there were five treatments with four replications, 20 pots were used for each variety. The large sized pots were filled with Red soil, Clay soil and Farm Yard Manure in the ratio of 2:1:1. The average weight of a pot was around 20 kg. Three seeds were sown per pot at the depth of 3 cm. The crop management practices and pest control measures were followed throughout the crop growth period based on CPG 2020.

The treatments *viz*., control (T_1), foliar spray of Nutrio-hormonal consortia Ⅰ (T_2), Nutrio-hormonal consortia Ⅱ (T_3), Cotton booster Ⅰ (T_4) and Cotton booster Ⅱ (T_5) were imposed at flowering and boll development stages. Nutrio-hormonal consortia (T_2 and T_3) is the formulation containing macro and micro nutrients along with phytohormones in which T_3 differs from T_2 in having additional $MgSO_4$. Cotton booster (T_4 and T_5) is a booster formulation released by the Department of Crop Physiology, TNAU, Coimbatore. It consists of essential macro and micro nutrients such as nitrogen, phosphorus, potassium, boron and magnesium in which T_5 differs from T_4 in having plant growth regulators (NAA, SA and melatoninin a definite proportion) along with nutrients aimed to enhance the yield and to prevent the shedding of bolls.

The morpho-physiological parameters like plant height, chlorophyll index and dry matter production and yield attributes *viz*., number of sympodial branches, number of bolls, boll weight (g/boll) and seed cotton yield (g/plant) were also recorded. The plant height was measured from the base of the stem to the last leaf and expressed in centimeters. Chlorophyll index was recorded using portable chlorophyll meter (Minolta, SPAD 502). The number of sympodial branches and bolls were counted and expressed in number/plant. For boll weight, weight of fully opened five bolls per plant was taken and average value was calculated. Seed cotton yield was recorded by weighing every kapas (seed cotton) collected from the plant. After recording the yield attributes, total dry matter production was arrived by shade drying the whole plants for two days followed by kept in hot air oven for 48 hrs. All the values which were influenced by treatment effects were recorded and expressed in mean values with appropriate standard units. The data were analyzed in FCRD using SPSS 16.0 software and graphical charts were illustrated using Microsoft excel application.

3. RESULTS AND DISCUSSION

Plant height is an important morphological trait, where the productivity of crop can be determined by the number of sympodial branches. In this study, the plant height was significantly increased when the plants are subjected to foliar spray of Cotton Booster Ⅱ (T_5) in both varieties (Fig. 1). The maximum plant height was recorded in MCU 5 variety (69.37 cm) than CO 17 (58.35 cm). Among the treatments, T_5 recorded more plant height when compared to other treatments. This increase in height based on treatment effect was mainly due to the role of phytohormones like NAA which might have influenced cell division and elongation processes. Similar results were found [11], when NAA was applied at 30 ppm in cotton. Significant raise in plant height was observed by the application of boron and zinc which might be due auxin biosynthesis leading to cell elongation [12]. It also has been reported that high levels of NPK and different micronutrients played a significant role in plant height [13].

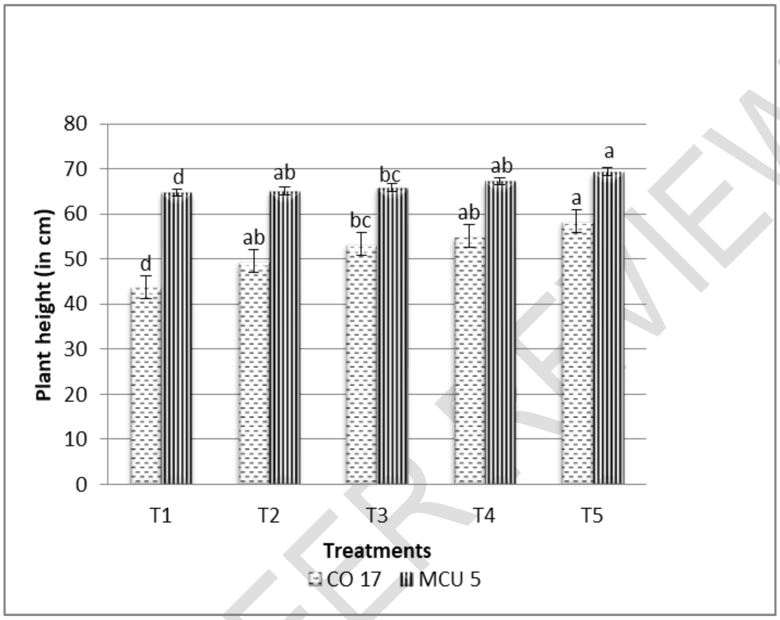

Fig. 1.Influence of nutrients and plant growth regulators on plant height in cotton

Chlorophyll index shows the PS II photochemistry which contributes in the yield of the crop [14]. From Fig. 2., it can be described that, chlorophyll index of T_5 treated plants were on par with T_4 treated plants after first foliar spray at flowering stage. However, after second spray (at boll development stage), chlorophyll index of T_5 significantly differed from all the treatments. The mean value of chlorophyll index recorded by both varieties after first and second sprays was 46.86 and 47.62 respectively. This might be due to the foliar application of nitrogen which impacts the chlorophyll production. A report revealed that the chlorophyll meter values (SPAD values) were used for nitrogen management in cotton [15]. Effective utilization of nitrogen fertilizer might be due to application of magnesium fertilizer containing sulphate ions [16]. Thus, the application of nitrogen fertilizer positively influenced the chlorophyll rate [17].

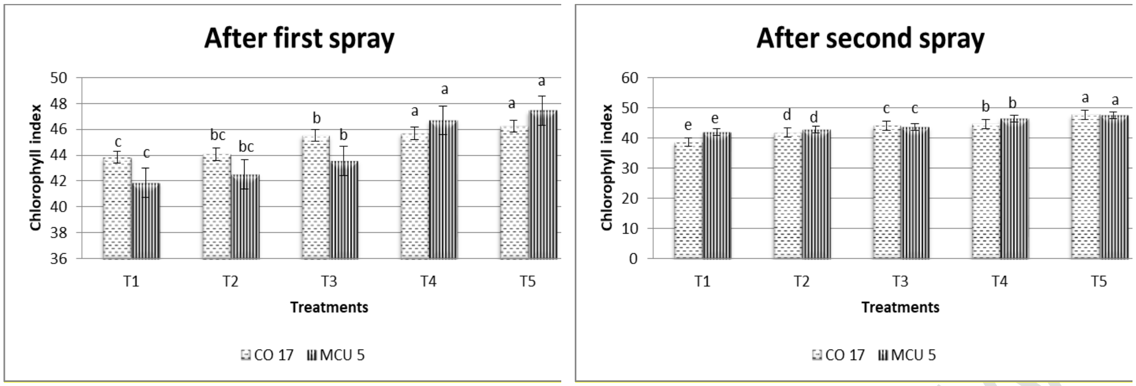

Fig. 2. Influence of nutrients and plant growth regulators on chlorophyll index in cotton

The growth and development of the crop is reflected in total dry matter production. In the present study, foliar spray of Cotton Booster Ⅱ (T_5) significantly increased the dry matter production in both the varieties when compared to control (Fig. 3). The treatment T_5 resulted in 30% increase in dry matter production which was due to the foliar formulation containing macro and micro nutrients along with plant growth regulators. Different nitrogen application rates were found to be positively influence the dry matter production in cotton [18]. Boron application also resulted in more DMP because of its role in influencing other nutrient uptake and enhancing the physiological processes [19]. Similar pattern of results were obtained [20; 21] and concluded that micronutrient application does have effect on dry matter production of crops.

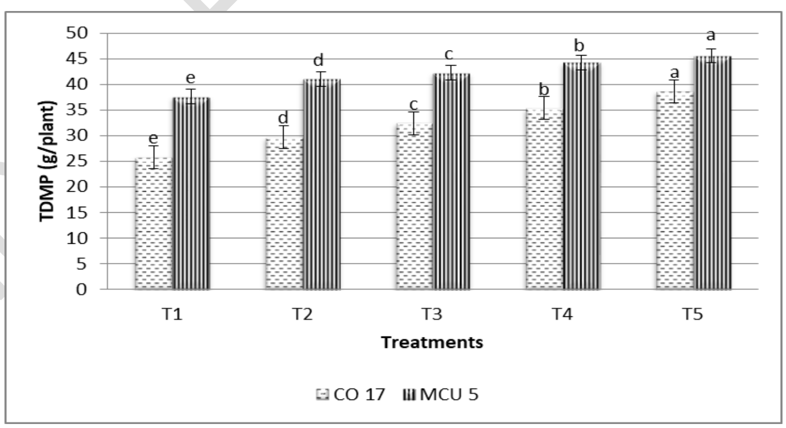

Fig. 3.Influence of nutrients and plant growth regulators on the total dry matter production in cotton

Attaining maximum yield by optimizing better crop management practices is the ultimate goal of this study. The yield attributes like number of sympodial branches per plant, number of bolls per plant, boll weight (g/boll) and seed cotton yield (g/plant) were recorded to determine the treatment effect on crop growth. Seed cotton yield can be highly impacted by number of sympodial branches and bolls (Table 1). The sympodial branches were significantly increased in Cotton booster Ⅱ formulation followed by T_4 having the mean value of 17.6 and 19.8 in CO 17 and MCU 5 respectively. The results were same in case of number of bolls where mean value of the number of bolls were 15.6 and 20.6 in CO 17 and MCU 5 respectively. Significant increase in boll numbers was observed in plants treated with Cotton booster Ⅱ (T_5) which might be due to role of major nutrients and PGRs. Sympodial branches extend its role in bearing reproductive bolls. Literature studies revealed that count of fruiting branches was influenced due to application of $MgSO_4$ and $ZnSO_4$ due to increased enzymatic activity [22]. Application of plant growth regulators like MC and NAA also increased the sympodial branches and boll numbers due to higher cell division and cell elongation processes [9]. Micronutrient mixtures like boron and zinc also increased the sympodial branches and boll numbers which might be due to production of metabolite [12; 23].

In this study, the T_5 treated plants resulted in better boll formation with increased boll weight which significantly differed from other treatments. From Table 1, the mean value of maximum boll weight obtained in CO 17 and MCU 5 varieties were 3.88 g and 4.40 g respectively. These results were in line with studies [24] and [25], where effective partitioning efficiency might have happened due to nutrient application especially potassium. Previous study revealed that micronutrient application along with basal NPK also significantly affected boll weight by increasing photosynthates translocation efficiency [22].

Seed cotton yield was significantly increased in foliar application of Cotton booster Ⅱ (T_5) followed by T_4 in both varieties. Increase in seed cotton yield is mainly due to the application of nutrients and plant growth regulators. Foliar fertilization of micronutrients such as zinc, iron, copper and boron has increased the seed cotton yield [23]. Potassium fertilization diverts the photosynthates to sink tissues [26]. According to the report [27], foliar application of K_2SO_4 resulted in high seed cotton yield. It has also been reported that, application of naphthalene acetic acid at 30 ppm resulted in more seed cotton yield [28]. Along with NAA, SA also contributes in increasing the seed cotton yield of the crop [29]. Similar to our results, increment in seed cotton yield was reported by [30], upon the application of cotton booster. Apart from cotton, nutrients and PGRs enhanced the yield attributes in crops like finger millet [31] and pulses [14].

Table 1. Influence of nutrients and plant growth regulators on the yield attributes in cotton crop

Treatments	Number of sympodia per plant		Number of bolls per plant		Boll weight (g/boll)		Seed cotton yield (g/plant)	
	CO 17	MCU 5	CO 17	MCU 5	CO 17	MCU 5	CO 17	MCU 5
T1	11.0	14.4	13.8	18.0	3.16	3.37	33.72	38.77
T2	13.0	15.0	14.0	18.8	3.36	3.52	35.10	40.29
T3	14.2	15.6	14.4	19.4	3.47	3.40	37.36	43.29
T4	16.6	18.8	14.8	19.6	3.57	3.61	39.79	45.87
T5	17.8	19.6	15.6	20.6	3.88	4.40	42.79	48.77
Mean	14.5	16.7	14.5	19.3	3.5	3.7	37.8	43.4

	T	V	T*V	T	V	T*V	T	V	T*V	T	V	T*V
SEd	0.45	0.29	0.64	0.39	0.25	0.55	0.13	0.08	0.18	0.42	0.27	0.60
CD(P<0.05)	0.76	0.48	1.08	0.66	0.42	0.93	0.22	0.14	0.31	0.71	0.45	1.00

4. CONCLUSION

It can be concluded that, the foliar application of Cotton booster Ⅱ (T_5) at two stages *viz*., flowering and boll development stages significantly increased the growth, physiology and yield attributes of cotton crop. MCU 5 variety performed well than CO 17 in our pot culture study. However, CO 17 is designed for high density planting system under field condition. Thus, the increment in plant height, chlorophyll index, dry matter production and yield attributes like number of sympodial branches, number of bolls, boll weight (g/boll) and seed cotton yield (g/plant) was due to the application of new foliar formulation containing PGRs, essential macro and micro nutrients.

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