RESEARCH ARTICLE

IMPACT OF FOLIAR NUTRITION AND HORMONAL APPLICATION ON THE STATUS OF SOIL APPLIED NUTRIENTS IN RICE FALLOW COTTON

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Abstract: A field experiment was carried out to analyze and critically evaluate the foliar fertilization of plant growth hormones and foliar nutrients in rice fallow cotton. The field experiment was conducted in a rice fallow condition with 11 treatments which were replicated thrice in Randomized block design (RBD). The impact of foliar fertilization in cotton through NAA, Fantac plus, Mepiquat chloride and TNAU cotton plus were statistically analyzed by means of growth, yield, nutrient uptake, and availability of nutrients in soil. The treatment, foliar application of NAA @ 40 ppm at flowering and Fantac plus @ 1ml l^{-1} at boll formation stages (T_8) resulted in increased growth and yield components, as a result, they recorded maximum uptake of nutrients NPK while holding the minimum soil available NPK status.

Keywords: Rice fallow cotton, NAA, Fantac plus, Nutrition uptake, Soil

INTRODUCTION

Cotton, a major cash crop grown in developing countries, where agricultural contribution in national economy is inevitable. Small farmers prefer varieties, since the hybrid seed costs is higher as well as they demand higher doses of fertilizers. Varieties belonging to *G. hirsutum* were the most preferred and popularly cultivated as they can be used in multiple cropping systems (Eshanna *et al*., 2003). Though varieties are early maturing and do require narrow spacing, low fertilizer requirement added their advantage as they become a part of many cropping systems including rice fallows.

Soil applied nutrients tends to remain inaccessible to plants due to soil factors like pH, CEC or nature of fertilizers like volatilization, fixation, leaching *etc*., Moreover the plants has to be given essential nutrients at their critical stages for better yield attainment. Though soil application during critical stages were not so effective as foliar application, the later was preferred widely for better fertilization process along the former one. Foliar application eliminates the negative aspects of soil pH (Ali, 2012), fixation on soil complex as insoluble forms or else leaching (Alshaal and El-Ramady, 2012) while its more effective and less costly than soil-based application (Ali *et al*., 2007; Yaseen *et al*., 2013). Foliar application is the technique of feeding the plants with liquid fertilizers, phyto-hormones, foliar nutrients in the form of spray directly on the leaves (Alshaal and El-Ramady, 2012) as their nutrient uptake is faster than the soil application (Smolen, 2012).

Plant growth regulators are the new generation agrochemicals when added in small quantities can either stimulate or inhibit the growth characteristics of crops when applied (Rademacher, 2015). Plant growth regulators can be employed at early growth stages of cotton (Wenchao *et al*., 2017) as their exogenous application improves the crop productivity and nutritional quality (Niu *et al*., 2016) through modulation of plant growth and physiological processes (Anjum *et al*., 2016). PGR's tends to promote crop earliness, improvise square, flower, boll retention including increased nutrient uptake (Deol *et al*., 2018) and influence the development of fiber cells (Ahmed *et al*., 2018). Naphthalene Acetic Acid (NAA), a well popular plant hormone poses a major importance in cotton production as it holds positive impacts on the growth and yield of cotton. It prevents the shedding of squares, flowers and bolls (Kranthi, 2016) besides increasing the seed cotton yield (Jadhav *et al*., 2015). Manipulation of crop geometry using plant growth retardants is an agronomic strategy for getting higher yields. Mepiquat chloride (1, 1 dimethyl piperidinium chloride) is used to control excess vegetative growth in cotton (Geethanjali *et al*., 2018), by reducing cell elongation (Edmisten, 2012) and thus helped in large scale mechanical harvesting (Ren *et al*., 2013).

Bio-stimulants are referred as positive plant growth regulators or metabolic enhancers which when applied in small quantities enhance the growth and overall development of plants. One such bio-stimulant is Fantac plus, a mixture of 5% N-acetyl thiazolidine carboxylic acid (N-ATCA) and 0.1% of folic acid, which helps in enhancing the crop yields in terms of quantity and quality (Srivastava *et al*., 2010). Intending to maximize the yield, growers use bio-regulators in view to increase the yield by improving the yield attributes (Debashish *et al*., 2018). TNAU cotton plus is a consortium of macro and micronutrients as well as plant growth regulators in a definite proportion, when given as a foliar spray acts as a growth booster in cotton (Sritharan *et al*., 2013).

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MATERIALS AND METHODS

Field experiments were conducted at a farmer's field, Thottiyappatti village of Namakkal district, (T.N) India, to study the effect of foliar nutrition and hormonal application on rice fallow cotton var. MCU-7. The cotton seeds were sown at a spacing of 60x30 cm. The treatment of the study is furnished below,T_1 – Foliar application of TNAU Cotton plus @ 5 kg ha^{-1} at flowering and boll formation, T_2 - Foliar application of Naphthalene Acetic Acid (NAA) @ 40ppm at flowering and boll formation, T_3 - Foliar application of Fantac Plus @ 1ml l^{-1} at flowering and boll formation, T_4 - Foliar application of Mepiquat Chloride @ 100 ppm at boll formation, T_5 - Foliar application of TNAU Cotton Plus @ 5 kg ha^{-1} at flowering and NAA @ 40ppm at boll formation, T_6 - Foliar application of TNAU Cotton Plus @ 5 kg ha^{-1} at flowering and Fantac Plus @ 1ml l^{-1} at boll formation, T_7 - Foliar application of TNAU Cotton Plus @ 5 kg ha^{-1} at flowering and Mepiquat Chloride @ 100 ppm at boll formation, T_8 - Foliar application of NAA @ 40ppm at flowering and Fantac Plus @ 1ml l^{-1} at boll formation, T_9 - Foliar application of NAA @ 40ppm at flowering and Mepiquat Chloride @ 100 ppm at boll formation, T_{10} - Foliar application of Fantac Plus @ 1ml l^{-1} at flowering and Mepiquat Chloride @ 100 ppm at boll formation, T_{11} – Control (Water spray). The observations on growth characters, yield attributes and seed cotton yield were recorded.

RESULTS

Nutrient Uptake

Application of plant hormone *i.e.,* NAA and foliar nutrient *i.e.,* Fantac plus significantly influenced the uptake of nitrogen, phosphorus, and potassium.

Nitrogen: The maximum nitrogen uptake was recorded in the treatment T_8, (NAA @ 40ppm applied at flowering followed by Fantac plus @ 1ml l^{-1} at boll formation stage) which registered a value of 76.86 kg ha^{-1}. It was followed by the application NAA @ 40ppm at flowering and boll formation (T_2), with 75.69 kg ha^{-1}. The lower value of nitrogen uptake was noticed in the treatment of T_{11} (63.42 kg ha^{-1}).

Phosphorus: The maximum phosphorous uptake was recorded in the treatment NAA @ 40ppm applied at flowering followed by Fantac plus @ 1ml l^{-1} at boll formation stage (T_8) with a value of 21.46 kg ha^{-1}. The least phosphorous uptake was noticed in the treatment of water spray, T_{11} (16.19 kg ha^{-1}).

Potassium: Significantly higher potassium uptake by rice fallow cotton was recorded with the application of plant hormone and foliar nutrient. The maximum potassium uptake was recorded in the treatment T_8, NAA @ 40ppm applied at flowering followed by the application of Fantac plus @ 1ml l^{-1} at boll formation stage of 59.86 kg ha^{-1}. It was followed by the application of NAA @ 40ppm at flowering and boll formation (T_2) of 59.14 kg ha^{-1}. The least potassium uptake was noticed in the treatment of T_{11} (53.13 kg ha^{-1}).

Post harvest soil available nutrient status

The application of plant growth regulator along with the foliar nutrient, influenced the availability of post-harvest soil available nutrient status.

Soil available nitrogen: The available nitrogen status in soil was significantly influenced by the application of NAA along with Fantac plus. The minimum soil available nitrogen of (316. 40 kg ha^{-1}) was recorded in the treatment T_8 (NAA @ 40ppm applied at flowering followed by Fantac plus @ 1ml l^{-1} at boll formation stage). The maximum soil available nitrogen was noticed in the treatment of T_{11} (327.35 kg ha^{-1}).

Soil available phosphorus: The minimum soil available potassium was noticed in the treatment T_8 - NAA @ 40ppm applied at flowering and Fantac plus @ 1ml l^{-1} applied at boll formation stage of (12.62 kg ha^{-1}). The maximum soil available phosphorus (16.87 kg ha^{-1}) was recorded under the treatment of water spray, T_{11}.

Soil available potassium: The soil available potassium was significantly influenced by the application of NAA along with the Fantac plus. The minimum soil available potassium was noticed under the treatment T_8, (Application of NAA @ 40ppm at flowering and Fantac plus @ 1ml l^{-1} at boll formation stage) of 279.32 kg ha^{-1}. The maximum soil available potassium was recorded in the treatment T_{11} (control) with 301.64 kg ha^{-1}.

Table 1. Effect of foliar nutrition and hormonal application on NPK uptake of rice fallow cotton and post-harvest soil NPK status (kg ha^{-1})

Treatment details	NPK uptake of rice fallow cotton (kg ha^{-1})			Available NPK in post-harvest soil (kg ha^{-1})		
	N	P	K	Available nitrogen	Available phosphorus	Available potassium
T_1 – Foliar application of TNAU Cotton plus @ 5 kg ha^{-1} at flowering and boll formation	70.15	19.48	56.43	322.49	14.82	288.24
T_2 - Foliar application of Naphthalene Acetic Acid (NAA) @ 40ppm at flowering and boll formation	75.69	21.05	59.14	318.54	13.12	281.56
T_3 - Foliar application of Fantac Plus @ 1ml	71.35	19.93	57.14	321.38	14.33	282.24

l^{-1} at flowering and boll formation						
T_4 - Foliar application of Mepiquat Chloride @ 100 ppm at boll formation	65.31	17.41	53.86	326.26	16.41	293.16
T_5 - Foliar application of TNAU Cotton Plus @ 5 kg ha^{-1} at flowering and NAA @ 40ppm at boll formation	74.53	20.67	58.41	319.62	13.61	282.98
T_6 - Foliar application of TNAU Cotton Plus @ 5 kg ha^{-1} at flowering and Fantac Plus @ 1ml l^{-1} at boll formation	73.60	20.35	57.85	320.29	13.82	283.91
T_7 - Foliar application of TNAU Cotton Plus @ 5 kg ha^{-1} at flowering and Mepiquat Chloride @ 100 ppm at boll formation	66.54	18.08	54.58	325.18	15.92	291.76
T_8 - Foliar application of NAA @ 40ppm at flowering and Fantac Plus @ 1ml l^{-1} at boll formation	76.86	21.46	59.86	316.40	12.62	279.32
T_9 - Foliar application of NAA @ 40ppm at flowering and Mepiquat Chloride @ 100 ppm at boll formation	68.83	19.00	55.70	323.57	15.31	287.21
T_{10} - Foliar application of Fantac Plus @ 1ml l^{-1} at flowering and Mepiquat Chloride @ 100 ppm at boll formation	67.61	18.42	54.95	324.65	15.78	290.78
T_{11} – Control (Water spray)	63.42	16.19	53.13	327.35	16.87	301.64
S. Ed	0.56	0.18	0.38	0.48	0.22	0.53
C.D.	1.17	0.38	0.80	1.08	0.46	1.11

DISCUSSION

Nutrient Uptake

The foliar application of NAA @ 40ppm at flowering followed by Fantac plus @ 1ml l^{-1} at boll formation stage (T_8), recorded the highest nitrogen, phosphorus, and potassium uptake by the plant. This might be due to availability and effective translocation of nutrients, which resulted in highest uptake. As the application of NAA increased the plant height, LAI and because of increased photosynthetic activity, the plant required more nutrients to meet its metabolic activity. In addition to that, it mobilizes nutrients to cotton bolls by attracting assimilates to storage sinks. Similar results were reported by Singh (2009) and Deol *et al*. (2018). Bio-stimulants tend to promote the transport of mineral nutrients and increase nutrient accumulation in plants that in turn resulted in increased boll weight. Similar findings were reported by Srivastava *et al.* (2016), Silva *et al.* (2016) and Debashish *et al.,* (2017).

Post harvest soil analysis

The results of treatment T_8 - NAA @ 40ppm at flowering and Fantac plus @ 1ml l^{-1} at boll formation stage recorded the least amount of available nitrogen, phosphorus, and potassium in the post-harvest soil. This might be due to increased uptake and utilization of nutrients by the crop in the treatment (T_8). Similar finding was observed by Gobi (2012). Lesser amount of soil available nutrients was obtained due to removal of more amount of nutrients during growth and reproductive stages of cotton which reflected in increased height, LAI, DMP and thereby in the final yield. Increased vegetative growth tends to take more amount of nutrients to meet its nutrient requirements. As application of NAA tends to increase the growth parameters in the early stages, the soil nutrients were utilized by the plants to the maximum.

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