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Response of cotton (*Gossypium hirsutum* L.) to potassium fertilization and potassium releasing bacteria (KRB)

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ABSTRACT

A field experiment was conducted at Regional Agricultural Research Station, Lam during *kharif*, 2023, to study the effect of potassium fertilizer doses and potassium releasing bacteria (KRB) on the growth and yield of cotton (*Gossypium hirsutum* L.). The experiment was laidout in a randomized block design with ten treatments replicated thrice. The treatments comprised of T_1: control; T_2: RDF; T_3: RDNP; T_4: KRB; T_5: RDF + KRB; T_6: RDF +KNO_3 1% (FA) at 60 DAS; T_7: 75% RDK + KRB; T_8: 75% RDK + KRB + KNO_3 @ 1% (FA) at 60 DAS; T_9: 50% RDK + KRB; and T_{10}: 50% RDK + KRB + KNO_3 @ 1% (FA) at 60 DAS. The application disclosed that the application of RDF + KRB+ KNO_3 1% (FA) at 60 DAS had a significant effect on plant height, drymatter accumulation, monopodia, sympodia, number of bolls plant^{-1}, seed cotton yield and stalk yields over the rest of the treatments and was found to be on a par with RDF + KRB.

Keywords*: Cotton, KRB and Potassium*

Cotton (*Gossypium hirsutum* L.) holds a significant economic importance in India, serving as a major textile fibre and hence known as the "King of fibres" or "White Gold." Cotton plays a crucial role in the textile industry, supporting the livelihoods of millions involved in cultivation, processing, manufacturing, trade and related industries. In India, cotton occupies an extensive area of 124.69 Lakh hectares, contributing as a major raw material to the textile industry with a production of 323.11 Lakh bales with an average productivity of 441 kg lint ha^{-1} in 2023-2024. Cotton cultivation covered 4.27 lakh hectares, resulting in a production of 11.58 lakh bales and an average productivity of 461 kg ha^{-1} in Andhra Pradesh during 2023-24 (ICAR-AICRP on Cotton Annual Report, 2023-24).

Cotton cultivation is highly nutrient-demanding, necessitating significant quantities of macronutrients, particularly Nitrogen (N), Phosphorus (P) and Potassium (K). Due to cotton's indeterminate growth habit, a steady nutrient supply is essential for both its vegetative and reproductive components.

Potassium, following nitrogen and phosphorus, is a vital macronutrient essential for plant metabolism and required in large quantities by most crops. In cotton, potassium fertilization enhances boll development, increases fruiting points and fruit retention, and improves fibre quality, micronaire length, and strength. It also reduces wilt disease incidence. Potassium deficiency negatively impacts fibre quality, emphasizing its crucial role in boosting both yield and fibre quality in cotton cultivation.

Although soils often contain significant potassium, they frequently lack sufficient amounts for plant needs, which affects optimal crop yields, requiring supplementation. This highlights the need to understand and manage potassium dynamics in soils for sustainable agriculture. Additionally, the cost of potassium fertilizer has risen considerably over the years, prompting consideration of alternative potassium sources

Potassium-releasing microorganisms (KRMs), including bacteria, fungi, and actinomycetes, play a crucial role in solubilizing potassic minerals, solubilize minerals, making potassium available for plant uptake. Potassium-releasing bacteria (KRB), a group of heterotrophic bacteria, are especially notable for their ability to solubilize rock potassium minerals like illite, orthoclases, and micas through organic acid production, significantly enhancing soil fertility. Microbial inoculants capable of dissolving potassium from minerals and rocks not only enhance plant growth and yield but also prove to be economically viable and eco-friendly. Additionally, they produce substances that stimulate plant growth or inhibit root pathogens. Considering all these factors, the current study is carried out to examine the impact of inorganic potassium fertilizer doses and KRB on the growth and yield of cotton .

MATERIAL AND METHODS

A field experiment was carried out during *kharif* season, 2023 to evaluate the influence of potassium fertilizer at different doses and potassium releasing bacteria (KRB) on growth and yield of cotton (*Gossypium hirsutum* L.). The experiment was laid out in a randomized block design with ten treatments and replicated thrice. The treatments comprised of T_1: control; T_2: RDF (150: 60: 60 kg N: P_2O_5: K_2O ha^{-1}); T_3: RDNP; T_4: KRB; T_5: RDF + KRB; T_6: RDF +KNO_3 1% (FA) at 60 DAS; T_7: 75% RDK + KRB; T_8: 75% RDK + KRB + KNO_3 @ 1% (FA) at 60 DAS; T_9: 50% RDK + KRB; and T_{10}: 50% RDK + KRB + KNO_3 @ 1% (FA) at 60 DAS. The hybrid used in the study was Jadhoo (KCH-14K59) Bollgard II cotton hybrid. The soil of the experimental site was clay in texture with a pH of 7.5, electrical conductivity of 0.15 dSm^{-1}, low in organic carbon (0.32 %) and available nitrogen (182.4 kg ha^{-1}); and high in available phosphorus (46.8 kg ha^{-1}) and available potassium (873.6 kg ha^{-1}). Recommended dose of nitrogen, phosphorus and potassium were supplied through urea, single super phosphate (SSP) and muriate of potash (MOP), respectively as per the treatments. The entire quantity of phosphorus was applied as basal two days before sowing, whereas nitrogen and potassium were applied in three equal splits ($^1/_3$ rd each at 30 DAS, 60 DAS and 90 DAS). Potassium Releasing Bacteria (KRB) was applied along with FYM before sowing as per the treatments.

RESULTS AND DISCUSSION

Plant Height

The data pertaining to plant height of cotton at 30 DAS, 60 DAS, 90 DAS, 120 DAS and 150 DAS (Table 1) was assessed and can be concluded that application of recommended doses of fertilizers along with potassium releasing bacteria resulted in significant difference on plant height at all stages of crop growth except at 30 DAS. Among all the treatments tried, significantly highest plant height was recorded with the application of RDNP+ 75% RDK+ KRB+ KNO_3 1% (FA) at 60 DAS (T_8) which was on a par with RDF+ KRB (T_5), RDNP + 75% RDK + KRB (T_7), RDF + KNO_3 1% (FA) at 60 DAS (T_6) and RDF (T2) at 120 DAS. The lowest plant height was recorded with control (T_1). The increase in plant height might be due to the supply of more nutrients through RDF and foliar nutrition. The increase in plant height might be due to the addition of additional fertilization which might have improved the soil health and consequently higher uptake of available nutrients from the soil. Increase in the number of nodes in the plant stem due to increase in the levels of inorganic potassium application might have resulted in increased plant height.

Drymatter Accumulation

The data on drymatter accumulation was recorded during 30 DAS, 60 DAS, 90 DAS, 120 DAS and 150 DAS of crop growth. The data presented in Table 2 indicated that the maximum dry matter accumulation was noticed with the application of RDF+ KRB (T_5) and was on a par with RDF+ KNO_3 @ 1% (FA) at 60 DAS (T_6), RDF (T_2), RDNP + 75% RDK + KRB (T_7), and RDNP+ 75% RDK+ KRB+ KNO_3 @ 1% (FA) at 60 DAS (T_8) DAS, 120 DAS and at harvest. The drymatter accumulation content increased significantly by the application of liquid biofertilizers along with inorganic fertilizers. Biofertilizers might have converted the unavailable nutrient forms to available forms and increased the nutrient concentration availability to plant thus resulted in positive influence on drymatter accumulation (Naik *et al.,* 2020).

Seed Cotton Yield (kg ha^{-1})

Data on seed cotton yield presented in Table 3 revealed that KRB and potassium nutrition had resulted in significantly higher seed cotton yield over the other treatments. The maximum seed cotton yield (3013 kg ha^{-1}) was noticed in the treatment RDNP+ 75% RDK+ KRB+ KNO_3 @ 1% (FA) at 60 DAS (T_8) and was found on a par with T_5 (2977 kg ha^{-1}), T_7 (2879 kg ha^{-1}), T_6 (2827 kg ha^{-1}) and T_2 (2724 kg ha^{-1}) followed by T_{10} (2205 kg ha^{-1}) and T_9 (2150 kg ha^{-1}) succeeded by T_3 (1799 kg ha^{1}). The lowest seed cotton yield (951 kg ha^{-1}) was recorded in the control plot (T_1) and it was comparable with T_4 (1189

Table 1: Plant height (cm) at different stages of cotton as influenced by potassium releasing bacteria and potassium nutrition.

Treatment	Plant height (cm)				
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
T_1 – Control	21.9	45.9	77.1	99.5	109.3
T_2– RDF	22.9	68.5	138.8	160.5	173.2
T_3– RDNP	24.1	55.7	100.4	121.1	124.2
T_4– KRB	23.2	47.3	82.4	102.1	113.0
T_5 – RDF + KRB	22.4	70.9	149.1	174.0	189.4
T_6– RDF+ KNO_3 @ 1% (FA) at 60 DAS	23.5	69.4	140.7	162.7	175.6
T_7– RDNP + 75% RDK + KRB	23.6	70.4	143.1	164.7	181.3
T_8– RDNP + 75% RDK + KRB + KNO_3 @ 1% (FA) at 60 DAS	24.4	71.1	152.7	175.5	192.3
T_9– RDNP + 50 % RDK+ KRB	22.5	57.8	119.6	139.3	148.7
T_{10}– RDNP + 50 % RDK + KRB+ KNO_3 @ 1% (FA) at 60 DAS	23.4	58.7	120.2	140.2	150.1
SEm±	**1.3**	**2.7**	**5.8**	**5.9**	**6.7**
CD (P=0.05)	**NS**	**8.1**	**17.2**	**17.6**	**19.9**
CV (%)	**9.7**	**7.7**	**8.2**	**7.1**	**7.5**

Table 2: Dry matter accumulation (kg ha^{-1}) at different stages of cotton as influenced by potassium releasing bacteria and potassium nutrition.

Treatment	Dry matter accumulation (kg ha^{-1})				
	30 DAS	60 DAS	90 DAS	120 DAS	At harvest
T_1 – Control	178	1105	2226	3298	3959
T_2– RDF	206	2177	4914	7129	7719
T_3– RDNP	208	1528	3305	4772	5498
T_4– KRB	201	1251	2660	3853	4139
T_5 – RDF + KRB	212	2308	5269	7727	8439
T_6– RDF + KNO_3 @ 1% (FA) at 60 DAS	205	2280	4991	7371	7993
T_7– RDNP + 75% RDK + KRB	214	2115	5036	7522	8119
T_8– RDNP + 75% RDK + KRB + KNO_3 @ 1% (FA) at 60 DAS	196	2106	5388	7860	8571
T_9– RDNP + 50 % RDK+ KRB	198	1796	4051	5896	6470
T_{10}– RDNP + 50 % RDK + KRB+ KNO_3 @ 1% (FA) at 60 DAS	194	1833	4107	6049	6532
SEm±	**8.4**	**88.8**	**191.1**	**330.8**	**313.3**
CD (P=0.05)	**NS**	**264**	**568**	**983**	**931**
CV (%)	**7.2**	**8.3**	**7.9**	**9.3**	**8.0**

Table 3. Seed cotton yield (SCY), stalk yield and the harvest index (%) as influenced by potassium releasing bacteria and potassium nutrition in cotton.

Treatment	Seed cotton yield (kg ha^{-1})	Stalk yield (kg ha^{-1})	Harvest Index (%)
T_1 – Control	951	2776	25.43
T_2– RDF	2724	4983	35.44
T_3– RDNP	1799	3393	34.72
T_4– KRB	1189	2805	29.86
T_5 – RDF + KRB	2977	5298	35.98
T_6– RDF +KNO_3 @ 1% (FA) at 60 DAS	2827	5007	36.14
T_7– RDNP + 75% RDK + KRB	2879	5174	35.85
T_8– RDNP + 75% RDK + KRB + KNO_3 @ 1% (FA) at 60 DAS	3013	5386	35.94
T_9– RDNP + 50 % RDK+ KRB	2150	4079	34.58
T_{10}– RDNP + 50 % RDK + KRB+ KNO_3 @ 1% (FA) at 60 DAS	2205	4137	34.76
SEm±	**104.2**	**185.8**	**1.31**
CD (P=0.05)	**310**	**552**	**3.88**
CV (%)	**7.9**	**7.5**	**6.68**

kg ha^{-1}).

Superior yields might be due to increased fertilization which made the plants more efficient in photosynthetic activity by enhancing the carbohydrate metabolism and resulted in more yield attributes and hence in increased seed cotton yield (Ganapathi *et al.*, 2018).

Stalk Yield

The data on stalk yield was presented in table 3 which indicated significant effect of different treatments in terms of stalk yield in cotton. The maximum stalk yield (5386 kg ha^{-1}) was noticed in the treatment RDNP+ 75% RDK+ KRB+ KNO_3 @ 1% (FA) at 60 DAS (T_8) and it was on a par with T_5 (5298 kg ha^{-1}), T_7 (5174 kg ha^{-1}), T_6 (5007 kg ha^{-1}) and along with inorganic fertilizers, which helped in nutrient uptake and higher growth parameters that resulted in higher biomass accumulation . Basak and Biswas (2009) also reported higher biomass yield with T_2 (4983 kg ha^{-1}) followed by T_{10} (4137 kg ha^{-1}) and T_9 (4079 kg ha^{-1}). Lowest stalk yield (2805 kg ha^{-1}) was recorded with control plot (T_1) and it was found at par with application of KRB alone (T_4) (2776 kg ha^{-1}). The application of RDNP (T_3) (3393 kg ha^{-1}) alone recorded significantly higher values of stalk yield than T_4 and T_1.

The increase in stalk yield in T_6 and T_5 treatments might be due to combined action of microbial inoculation application of waste mica inoculated with potassium solubilizing microorganism (*Bacillus mucilaginosus)*.

Harvest Index (%)

The data presented in Table 3. revealed that the harvest index increased significantly due to combined application of inorganic fertilizers and biofertilizers over control. The higher harvest index (36.14 %) was noticed withT_6 and the lowest values were recorded with T-$_1$- control (25.43 %).

The improvement in yield and yield traits under integrated use of fertilizers with biofertilizers might be due to higher absorption of nutrients responsible for increased photosynthate accumulation and high biomass production and finally resulting in increase in the yield and yield components (Naik *et al.,* 2020). Solanki *et al.*(2023) stated that the increased grain output, biological yield, and harvest index may be due to enhanced nutrient availability.

CONCLUSION

From the study, it can be concluded that soil application of potassium releasing bacteria in addition to the supply of recommended dose of N, P_2O_5 and K_2O and foliar application of one percent KNO_3 at 60 DAS to cotton resulted in higher yield over RDF alone with higher nutrient uptake by the plant. The incorporation of potassium-releasing bacteria into the soil not only enhances the availability of potassium but also improves the overall growth and yield parameters of the crop. Further exploration and implementation of such integrated approaches could contribute significantly to enhance crop yield.

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