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Effect of potash fertilizer on spatial distribution of whitefly and Cotton Leaf Curl Disease (CLCuD) in hybrid cotton

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Abstract

A field experiment was conducted to evaluate the effect of potassium fertilization and foliar application of 1% KNO_3 on seed cotton yield, whitefly population, and incidence of Cotton Leaf Curl Disease (CLCuD) under medium and high potassium fertility soils. The results indicated that seed cotton yield was significantly influenced by potassium application. Overall, the mean seed cotton yield was significantly higher in high K fertility soil compared to medium K fertility soil. Application of potassium through soil as well as foliar spray significantly increased yield over the treatment receiving only the recommended dose of nitrogen and phosphorus ($N_{175}P_{60}$). The highest seed cotton yield was recorded in treatment T_7 ($N_{175}P_{60}$ + K_{60} + foliar spray of 1% KNO_3) under medium K fertility soil, which was statistically at par with the recommended dose of N, P, and K (T_6). Soil application of K at 30 kg per ha (T_4) and its combination with foliar KNO_3 spray (T_5) resulted in numerical increases in yield but were statistically non-significant. In high K fertility soil, treatments T_3 ($N_{175}P_{60}$ + foliar spray of 1% KNO_3) and T_4 ($N_{175}P_{60}$ + K_{30}) showed comparable yields. Potassium fertilization also significantly reduced whitefly population and CLCuD incidence. The highest whitefly population (6.16) was observed in T_2 ($N_{175}P_{60}$ + water spray), whereas the lowest population (5.52) was recorded in T_7. Similarly, maximum disease intensity (21.29% PDI) was observed in T_1 (N175P60), while the minimum (11.30% PDI) occurred in T_7. Higher potassium fertility levels further reduced whitefly population and disease intensity compared to medium K fertility soil. The study indicates that balanced potassium fertilization, particularly K_{60} combined with foliar application of 1% of KNO_3, improves seed cotton yield and effectively reduces whitefly infestation and CLCuD incidence in cotton.

Keywords: Cotton, potassium, per cent disease index, cotton leaf curl disease, whitefly

Introduction

Cotton is one of the major commercial crops and backbone of textile industry in India which provides employment to vast majority of population directly or indirectly. It provides livelihood of 60 million people depending on cotton cultivation, processing trade and textiles. Textile industry contributes 4% of GDP, 14%

of total industrial product, 20% of total work force, 17% of country's exports earning and employment to 30 million people (Anupam, B., 2010). It is also one of the major sources that accounts for more than 30% of exports, making it India's largest net foreign exchange industry to the tune of $10 - 12 billion annually from exports of cotton yarn, thread, fabrics, apparel and made-ups [1]. In India, cotton occupies an area of 129.57 lakh hectares, yielding 371.0 lakh bales with a productivity rate of 486.7 kg/ha (Ram et al, 2021). The pest spectrum of cotton is quite complex and as many as 1326 species of insects have been recorded in the world (Hargreaves, H., 1984). Cotton has the most fragile ecosystem amongst the field crops where approximately 162 insect pests damage the crop in India (Dhawan, A.K., 2000). Cotton plat is liable to be attacked all over its growing season by certain vast array of insect pests, major insect-pests which cause economic losses in cotton are bollworm complex includes American bollworm (*Helicoverpa armigera),* pink bollworm (*Pectionphora gossypiella*) and spotted bollworm (Earias spp.) while sucking pests are whitefly, *Bemisia tabaci* (Gennadius); leafhopper, *Amrasca biguttula biguttula* (Ishida); mealy bug, *Pnenacoccus solenopsis* Tinsley; thrips, *Thrips tabaci* Lindeman; and aphid, *Apis gossypii* Glover (Kumar et. al., 2016. However, *Bemisia tabaci* (Gennadius) (Hemiptera: Aleyrodidae) is a major threat to the cultivation of Bt cotton throughout the country. It is most notorious pest in tropical and subtropical agriculture and is quite devastating on cotton, brinjal, okra, tomato and several other fruits and ornamental plants. Since the introduction of *Bt* cotton in agriculture in 1987 in USA by Monsanto, Delta and Pine companies' scenario has been changed as *Bt* replaced the conventional cotton and provided growers with a new tool for managing bollworms in cotton. In this context, amazingly, *Bt* cotton is one of the few technologies that have the safest bio-safety profile. It comes as an alternative to the previously used hazardous concoction of insecticides mixtures and fertilizer management. Insecticides used on cotton were known to have ravaged ecology, disrupted the environment, played havoc with human and animal health, and were toxic to honey bees, insect-parasitoid and predators. *Bt* cotton removed that to a great extent (Aumaitre, A., 2004). Criticism also focused on the bio-safety issues starting from adverse impact on soil microbes, pet animals and reported presence of *Bt* in human blood and placenta. Most of these reports were characterized by methodology errors and clearly lacked scientific credence in establishing a clear, cause and effect relationship (Klaus, A., 2009). Result showed significant differences were observed between two foliar applications with 8.165 kg/feddan and 16.33 kg/feddan of potassium fertilizer and untreated plants in studies from Egypt (Round et. al., 2005). Potassium has been considered a key component of plant nutrition that significantly influences crop growth and some pest infestation. Thus, Phosphorous had a highly significant negative impact on plant sucking insect-pests in cotton crop (Sonalkar, VU., 2019). Results for the incidence of CLCuV disease significantly not only reduced due to potassium (K) levels, but also increase in yield. The K fertilizer application resulted in the reduction of CLCuV disease spread at its mild infection levels, boll weight, and seed index were also significantly improved by addition of K application in cotton. An increase of 25 per cent population of natural enemies in *Bt* cotton fields was observed (Buranakanonda, A., 1999) than non-*Bt* fields. Keeping in the mind regarding the assumption of adverse effect on living organism particularly of natural enemies of insect-pests in cotton, in present studies the attempt has been made to study the population dynamics and correlation of important insect-pests along with natural enemies on *Bt* as well as non-*Bt* cotton hybrids.

Material and Methods:

Location: A farmer's Agricultural Farm, Chandan Nagar, Hisar, Haryana.
DOS : 20.5.2017
***Bt* Hybrid** : Bioseed 6588
Replication : 4
Design : RBD
Plot Size : 5.4x7.0 M **Treatments:**
T1 - N175P60,
T_2 - $N_{175}P_{60}$ + Water spray,
T_3 - $N_{175}P_{60}$+ 1% foliar spray of KNO_3,
T4 - N175P60+ K30,
T_5 - $N_{175}P_{60}$+ K_{30}+1% foliar spray of KNO_3,
T6 - N175P60+K60 and
T_7 - $N_{175}P_{60}$+K_{60}+ 1% foliar spray of KNO_3

Result Achieved:

Seed cotton yield:

Data pertaining to seed cotton yield (kg/ha) are presented in table 1. The result showed the mean seed cotton yield in high K fertility soil was significantly higher than medium K fertility soil. The seed cotton yield (kg/ha) increased significantly in all the treatments except T_2 ($N_{175}P_{60}$ + Water Spray) as compared to T_1 where only recommended dose of N and P was applied. The seed cotton yield increased significantly by the application of potassium in soil as well foliar spray of KNO_3. Highest yield was recorded in the treatment where two foliar sprays of KNO_3 along with recommended doses of N, P and K @ 60 kg/ha in the medium K fertility soil. Highest mean seed cotton yield was recorded in the treatment where two foliar sprays of 1% KNO_3 were applied along with recommended dose of N & P, but the yield was statistically at par with that of recommended dose of N, P & K (T_6).

Table 1: Effect of potassium application on seed cotton yield (kg/ha)

Treatments	**Medium K fertility**	**High K fertility**	**Mean**
T1 (N175P60)	2031.40	2498.70	2265.05
T_2 ($N_{175}P_{60}$ + Water Spray)	2092.20	2536.80	2299.50
T_3 ($N_{175}P_{60}$ + Foliar spray of 1% KNO_3)	2376.22	2606.11	2491.16
T4 (N175P60 + K30)	2511.25	2616.28	2563.73
T_5 ($N_{175}P_{60}$ + K_{30} + Foliar spray of 1% KNO_3)	2613.60	2666.70	2640.15
T6 (N175P60 + K60)	2690.20	2679.20	2684.70
T_7 ($N_{175}P_{60}$ + K_{60} + Foliar spray of 1% KNO_3)	2796.40	2704.60	2750.50
Mean	2444.46	2611.19	2527.83
C.D.(p= 0.05) Soil fertility	46.60		
Treatments	88.77		
Interaction	125.26		

Effect of soil application of potassium @ 30 kg/ha (T_4) on mean seed cotton yield was nonsignificant over foliar application of 1% KNO_3 applied at flowering and boll development stage. Similarly effect of foliar application of 1% KNO_3 along with soil application of K @ 30 kg/ha (T_5) on seed cotton yield was non-significant over soil fertility over medium K fertility. In the treatments T_4 ($N_{175}P_{60}$ + K_{30}) and T_5 ($N_{175}P_{60}$ + K_{30} + Foliar spray of 1% KNO_3) the yield increased numerically but statistically it was non-significant. In the high K fertility soil yield in the T_3 ($N_{175}P_{60}$ + Foliar spray of 1% KNO_3) and T_4 ($N_{175}P_{60}$ + K_{30}) was at par with each other. In the treatments T_6 ($N_{175}P_{60}$ + K_{60}) and T_7 ($N_{175}P_{60}$ + K_{60} + Foliar spray of 1% KNO_3), the yield in the high K fertility soil was lower as compared to respective treatments in medium K fertility soil. The highest seed cotton yield was recorded in the treatment T_7 ($N_{175}P_{60}$ + K_{60} + Foliar spray of 1% KNO_3) in medium K fertility soil, however in the high K fertility soil, the seed cotton yield was recorded at the same level of K application of K @ 30 kg/ha alone (T_4). However, mean seed cotton yield was significantly higher over where only fertilizer application of 1% KNO_3 was applied along with recommended dose N & P (T_3). Application of recommended dose of K @ 60 kg/ha (T_6) significantly increase of the seed cotton yield over 50% recommended dose of K (i.e. 30 kg/ha). However, no significant increase in seed cotton yield was observed when foliar spray of 1% KNO_3 was applied along with 50% recommended dose of K (T_5). Between the two soils having different K levels, the yield increased significantly up to the treatment T_3 ($N_{175}P_{60}$ + Foliar spray of 1% KNO_3) in the respective treatment of high K the seed cotton/plant followed the similar trend. Similar to present investigations, When the total amount of K was applied at early boll development, higher yields, boll weights and lint turnouts were obtained compared with split applications (Gormus, 2002), likewise, increase in yield seemed to have resulted largely from the higher K concentration of leaf tissues at bloom stage and available soil-K because of potassium application (Pervez et al, 2005), According to Sawan et al (2011), dry matter yield, total chlorophyll concentration, K, Zn and P uptake plant^{-1}, seed yield ha^{-1}, seed weight, seed viability, seedling vigor, and cool germination test performance increased with the addition of K, Zn, and P as the case of present studies.

Table 2. Seasonal mean of whitefly population/leaf with respect to potash (K) levels.

Treatments	Whitefly/leaf		
	Medium K fertility	**High K fertility**	**Mean**
T1 (N175P60)	6.58	5.72	6.15
T_2 ($N_{175}P_{60}$ + Water Spray)	6.55	5.78	6.16
T_3 ($N_{175}P_{60}$ + Foliar spray of 1% KNO_3)	6.28	5.50	5.89
T4 (N175P60 + K30)	6.17	5.56	5.86
T_5 ($N_{175}P_{60}$ + K_{30} + Foliar spray of 1% KNO_3)	5.99	5.67	5.83
T6 (N175P60 + K60)	5.70	5.59	5.64
T_7 ($N_{175}P_{60}$ + K_{60} + Foliar spray of 1% KNO_3)	5.50	5.54	5.52
Mean	6.11	5.62	

Effect of potassium application on infestation of whitefly has been presented in Table 2. With a mean value of 6.16, T2 ($N_{175}P_{60}$ + Water Spray) had the largest whitefly population, closely followed by T1 ($N_{175}P_{60}$) with 6.15. In comparison to the control treatments, the foliar spray of 1% KNO_3 and potassium fertilization decreased the population of whiteflies. With a mean value of 5.52 in T7 ($N_{175}P_{60}$ + K_{60} + Foliar spray of 1% KNO_3) had the lowest whitefly population of all the treatments, followed by T6 ($N_{175}P_{60}$ + K_{60}) with 5.64. The most effective way to reduce the incidence of whiteflies was to combine foliar spraying 1% KNO_3 with greater potassium fertility levels (K_{60}). Higher potassium fertility contributed to the suppression of whitefly populations, as evidenced by the average whitefly population across fertility levels being 6.11 under medium K fertility and 5.62 under high K fertility. It is clear that application of K in balanced dose with other fertilizers has resulted in lower whitefly population buildup that was recorded and apparent during weekly observations. Mean whitefly population during the entire crop season in high K fertility was lower as compared to medium K fertility soils. Potassium based silicate treatment was more effective in reducing whitefly population on faba beans and green beans (Thabet et al., 2021), and in potato (Shah et al., 2019). Higher potassium (K) levels result in decline in population, reproductive rate and intrinsic rate of population increase of aphids and whiteflies in cotton (Prudic et al. 2005).

Table 3. Seasonal mean of PDI of CLCuD incidence with respect to potash (K) levels

Treatments	CLCuD (%)		
Treatments	**Medium K fertility**	**High K fertility**	**Mean**
T1 (N175P60)	22.16	20.43	21.29
T_2 ($N_{175}P_{60}$ + Water Spray)	20.50	20.39	20.44
T_3 ($N_{175}P_{60}$ + Foliar spray of 1% KNO_3)	19.66	17.80	18.73
T4 (N175P60 + K30)	17.16	16.00	16.58
T_5 ($N_{175}P_{60}$ + K_{30} + Foliar spray of 1% KNO_3)	14.66	14.56	14.61
T6 (N175P60 + K60)	13.66	12.89	13.27
T_7 ($N_{175}P_{60}$ + K_{60} + Foliar spray of 1% KNO_3)	12.00	10.60	11.30
C.D.(p= 0.05)	2.3	2.6	

Data for per cent disease intensity of CLCuD differed significantly due to treatments. In medium K fertility soil, minimum PDI was observed (12.0) in the treatment T_7 where recommended dose (CCS HAU, Hisar) of K was supplemented with 1 per cent of KNO3 and Maximum PDI (22.16) in T_1 where potassium was not applied. Similar trend was observed in High K fertility soil where maximum disease was observed in T_1 and minimum in T_7 but PDI was lower in High K fertility soil as compared to respective treatment of medium K fertility soil. The application of K fertilizer resulted in reduction of the disease. The mean disease intensity of CLCuD reduced from 21.29 to 11.30 by application of recommended dose of K supplemented with two sprays

of 1per cent of KNO3. The decreasing trend in disease intensity indicated that plant's capacity to withstand an infection towards CLCuD through well-balanced fertilizer usage. Thus, it can be concluded that foliar application of 1 per cent of KNO_3 and rising potassium (K) levels reduced the incidence of Cotton Leaf Curl Disease (CLCuD). With a mean PDI of 21.29 per cent, T1
(N_{175}+P_{60}) had the highest illness intensity, whereas T7 (N_{175}+P_{60} + K_{60} + 1% KNO_3 spray) had the lowest, with a mean PDI of 11.30 per cent. Compared to medium K fertility soil, high K fertility soil generally had slightly lower disease intensity. These findings suggest that foliar KNO_3 spray and increased potassium treatment effectively lower the incidence of CLCuD. The K fertilizer application resulted in the reduction of CLCuV disease spread at its mild infection levels. Pervez et al. (2005) reported that, the application of potassium fertilizer resulted in reduction of spread of CLCuV disease at its mild infestation level. The intensity of disease was reduced by 12 to 38 per cent by the application of 62.5 to 250 kg K per ha.
According to Wang et al. (2013) in a K-adequate plant, the synthesis of high-molecularweight compounds (which includes proteins, starches and cellulose) was significantly increased, in that way depressing the concentrations of low-molecular-weight compounds i.e. soluble sugars organic acids, amino acids and amides, in the plant tissues. These low-molecular-weight compounds are vital for the insect attack and development of disease, so lower concentrations, thereby, leave plant less susceptible to disease and pest attacks in potassium sufficient plants (Marschner, 2012). Potassium enhances phenol amount, which play a crucial role in the resistant development in plants (Prasad et al., 2010). As per findings of Mengel and Kirkby (1978), K encourages the development of outer walls in epidermal cells, thus preventing disease infestation. Besides, potassium influenced the plant metabolism greatly; consequently, plant's resistance against diseases may be favored by changes in metabolism associated with high plant potassium content.

Conclusion

The present study demonstrated that potassium fertilization plays an important role in improving seed cotton yield and reducing pest and disease incidence in cotton. Application of potassium along with the recommended dose of nitrogen and phosphorus significantly enhanced seed cotton yield compared to treatments without potassium application. Treatment T_7 (N175P60 + K60 + foliar spray of 1% KNO_3) recorded the highest seed cotton yield, particularly under medium K fertility soil. Yield improvement was mainly attributed to balanced nutrient supply and the beneficial effect of foliar potassium application during critical growth stages. Potassium fertilization also contributed to the suppression of whitefly population and Cotton Leaf Curl Disease (CLCuD) intensity. The lowest whitefly population and minimum disease intensity were recorded in the treatment receiving both soil-applied potassium and foliar spray of 1% KNO_3. Higher potassium fertility levels further reduced pest population and disease incidence compared to medium K fertility soil. Overall, the results indicate that balanced potassium nutrition improves crop productivity and enhances plant resistance against pests and diseases. Therefore, the application of recommended potassium dose (K60) combined with foliar spray of 1% KNO_3 can be considered an effective nutrient management strategy for increasing seed cotton yield and minimizing whitefly infestation and CLCuD incidence in cotton cultivation.

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