Incidence of Mealybug and Red cotton bug in Bt cotton hybrids under protected and unprotected condition

ABSTRACT

The study investigated the influence of mealybug and red cotton bug populations on different cotton hybrids under protected and unprotected conditions. The results revealed that under protected conditions, the mealybug population was significantly lower (0.23/plant) compared to unprotected conditions (1.14/plant). Among the hybrids, G. Cot. Hy. 10 BG II (0.35/plant) and Ajeet 155 BG II (0.40/plant) showed the lowest mealybug populations, while RCH 2 BG II recorded the highest (1.19/plant). Significant differences were observed in the interaction between protection levels and hybrids with lower pest populations recorded under protected conditions. Similarly, for the red cotton bug, the population was significantly lower under protected conditions (0.23/plant) compared to unprotected (0.87/plant). G.Cot.Hy.10 BG II showed the lowest red cotton bug population (0.24/plant), while RCH 2 BG II had the highest population under unprotected conditions (1.24/plant). Significant differences were found in the interaction of protection levels, hybrids, and periods with protected conditions consistently showing lower pest incidences.

Key words: Bt cotton, Mealybugs, Red cotton bugs, Protected and Unprotected condition

INTRODUCTION:

Cotton is a globally important fiber crop often referred to as white gold due to its multifaceted uses. It provides five essential products such as lint, oil, seed meal and hulls. India ranks first in the world for cotton cultivation accounting for 21 per cent of the global cotton output [1]. This vital natural fiber crop thrives in various climatic conditions across tropical and subtropical regions in over 83 countries. Cotton plays a significant role in the national economy by generating both direct and indirect employment in agricultural and industrial sectors. Since the introduction of Bt cotton seeds in 2002, their widespread use and distinct advantages over non-Bt varieties have led to their rapid adoption in India. This transition in cotton farming has resulted in notable changes in the insect pest population due to shifts in the microclimate [2].

Recently, Bt cotton has drawn an increased presence of various insect pests, particularly sucking pests. Due to their high reproductive capacity, sap-sucking pests have now become a significant challenge in Bt cotton cultivation [3]. These pests damage the crop throughout its entire growth cycle from seedling emergence to harvest, significantly reducing yield by extracting sap from the plants and leaving them debilitated [4]. Among the sucking pests, the mealy bug, *Phenacoccus solenopsis* Tinsley, is a significant pest in cotton cultivation showed impact on both the quantity and quality of fiber and lint. As a polyphagous pest, it thrives on various host plants, including field crops, horticultural, fruit, vegetable, and ornamental plants. Mealy bugs feed by extracting large amount of sap from leaves and stems, depriving the plants of vital nutrients. This results in symptoms such as stunted growth, delayed boll opening, and even complete plant desiccation. Yield losses due to mealy bugs can reach up to 50 percent. These small, oval-shaped, soft-bodied insects are covered in a white, cotton-like wax, making them difficult to control. An individual mealy bug can survive for 25 to 38 days [5].

The cotton stainer, commonly known as the red cotton bug, was previously considered a minor pest. However, the widespread adoption of certain cotton varieties has enabled *Dysdercus cingulatus* Fabricius to emerge as a significant pest in cotton cultivation [6]. The red cotton bug can inflict damage of up to 40 percent in Bt cotton by feeding on developing cotton bolls and mature seeds [7]. Their feeding habits promote the spread of fungi to immature lint and seeds, resulting in a distinctive yellow stain on the lint, which is how they earned the name Cotton Strainer [8]. Heavy infestation on cotton seeds can adversely affect oil content, crop weight, and the overall marketability of the crop [9]. Keeping all this in view the present investigation was performed to know upto what extinct these pests cause damage in cotton.

Material and Methods:

The present investigation was conducted during the *Kharif* season of 2023-24 at the Main Cotton Research Station, Navsari Agricultural University, Surat, Gujarat by using four Bt cotton hybrids *i.e.*, ATM BG II, Ajeet 155 BG II, RCH 2 BG II and G. Cot. Hy.10 BG II. The populations of mealy bugs and red cotton bugs were recorded on five randomly selected plants, both under protected conditions and in unprotected environments. This study aimed to assess the differences in pest populations between these two conditions. The protected plants received pest control measures, while the unprotected plants were exposed to natural pest pressures without any intervention. By comparing the population dynamics of these pests in both scenarios, we can gain insights into the effectiveness of protection strategies and the impact of pest pressure on cotton plants.

Fig.1 a) Mealybug b) Red cotton bug

Result and Discussion

Mealy bugs

Mealy bug population was observed from the 43rd SMW and the pooled results on mealybug populations, presented in Table 1, indicate that different cotton hybrids influenced the mealybug populations under both protected and unprotected conditions. In the protected condition, the population was significantly lower (0.23 mealybugs/plant) compared to the unprotected plot (1.14 mealybugs/plant). Among the hybrids, G. Cot.Hy.10 BG II (0.35 mealybugs/plant) and Ajeet 155 BG II (0.40 mealybugs/plant) exhibited lower populations. The hybrid ATM BG II recorded a moderate population of 0.69 mealybugs/plant, while RCH 2 BG II had the highest population at 1.19 mealybugs/plant. The interaction effect between protection and hybrid (P × H) showed significant differences. However, the combined effect of protection, hybrid, and period (P × H × Y) did not demonstrate significant differences in

mealybug incidence across various periods and hybrids. Under protected conditions, the hybrids recorded the following populations G. Cot.Hy.10 BG II (0.12), Ajeet 155 BG II (0.14), ATM BG II (0.24), and RCH 2 BG II (0.42) mealybugs/plant. All these treatments were significantly better than those in unprotected conditions. In contrast, under unprotected conditions, RCH 2 BG II had the highest population at 2.19 mealybugs/plant, while lower incidences were noted for G. Cot.Hy.10 BG II (0.62), Ajeet 155 BG II (0.69), and ATM BG II (1.27).

Table 1: Impact of hybrids and protection on incidence of mealybug in cotton (Pooled)

Treatments	**No. of mealybug/plant**				
Main\ Sub plot	**H_1 (ATM BGII)**	**H_2 (Ajeet 155 BGII)**	**H_3 (RCH 2 BGII)**	**H_4 (G.Cot.Hy. 10 BGII)**	**Mean**
P_1 (Protected)	0.86^{ab} (0.24)	0.80^{a} (0.14)	0.96^{bc} (0.42)	0.78^{a} (0.12)	0.85^{a} (0.23)
P_2 (Unprotected)	1.33^{e} (1.27)	1.09^{d} (0.69)	1.64^{f} (2.19)	1.06^{cd} (0.62)	1.28^{b} (1.14)
Mean	1.09^{b} (0.69)	0.95^{a} (0.40)	1.30^{c} (1.19)	0.92^{a} (0.35)	1.07 (0.64)
Interactions	**Protection (P)**	**Hybrid (H)**	**P x H**	**C.V. (%) Main**	
S. Em. ±	0.04	0.04	0.03	16.93	
C. D. at 5%	0.16	0.12	0.10		
	Period (Y)	**P x Y**	**H x Y**	**P x H x Y**	**C.V. (%) Sub**
S. Em. ±	0.03	0.04	0.06	0.09	16.83
C. D. at 5%	0.10	0.13	0.17	NS	

Notes:

Figures in parentheses are retransformed values, those outside are $\sqrt{X+0.5}$ value

Treatment means with the letter(s) in common are non-significant by DNMRT at 5% level of significance

Red cotton bug

Red cotton bug population was observed from 45th SMW in the field, the pooled results pertaining to red cotton bug population over periods presented in Table 2 revealed that the red cotton bug population was influenced by different hybrids in the protected and unprotected condition. Under protected condition significantly lowest (0.23/plant) population recorded as compared to unprotected plot (0.87/plant). Data on various hybrids showed significant difference were lowest red cotton bug population observed in G. Cot.Hy.10 BG II (0.24/plant). The hybrids, Ajeet 155 BG II (0.56/plant), ATM BG II (0.58/plant) and RCH 2 BG II (0.71/plant) recorded higher red cotton bug population and at par with each other. Looking to the interaction effect between protection and hybrid (P × H) was found non-significant difference. The interaction effect between protection, hybrid and period (P × H × Y) shows significant difference in red cotton bug incidence at different periods on different hybrids at different protection levels. The red cotton bug population as result of interaction between protection level and hybrids differed significantly. Under protected hybrids, G. Cot.Hy.10 BG □, ATM BG □, RCH 2 BG □ and Ajeet 155 BG □ recorded 0.12, 0.24, 0.26

and 0.29 red cotton bug/plant. Among the different treatment combinations, the hybrid RCH 2 BG under unprotected condition recorded significantly higher population of 1.24/plant as compared to the remaining treatment combinations. Among the remaining treatment combinations under unprotected conditions, lower incidence was noticed in G. Cot.Hy.10 BG (0.38/plant) followed by Ajeet 155 BG (0.87/plant), ATM BG (1.01/plant).

Table 2: Impact of hybrids and protection on incidence of red cotton bug in cotton (Pooled)

Treatments	**No. of red cotton bug/plant**				
Main\ Sub plot	**H_1 (ATM BGII)**	**H_2 (Ajeet 155 BGII)**	**H_3 (RCH 2 BGII)**	**H_4 (G.Cot.Hy. 10 BGII)**	**Mean**
P_1 (Protected)	0.86 (0.24)	0.89 (0.29)	0.87 (0.26)	0.78 (0.12)	0.85^{a} (0.23)
P_2 (Unprotected)	1.23 (1.01)	1.17 (0.87)	1.32 (1.24)	0.94 (0.38)	1.17^{b} (0.87)
Mean	1.04^{bc} (0.58)	1.03^{b} (0.56)	1.10^{c} (0.71)	0.86^{a} (0.24)	1.01 (0.52)
Interactions	**Protection (P)**	**Hybrid (H)**	**P x H**	**C.V. (%) Main**	
S. Em. ±	0.03	0.05	0.07	13.56	
C. D. at 5%	0.14	0.16	NS		
	Period (Y)	**P x Y**	**H x Y**	**P x H x Y**	**C.V. (%) Sub**
S. Em. ±	0.02	0.03	0.07	0.09	19.53
C. D. at 5%	0.07	0.10	0.19	0.27	

Notes:

Figures in parentheses are retransformed values, those outside are $\sqrt{X+0.5}$ value

Treatment means with the letter(s) in common are non-significant by DNMRT at 5% level of significance

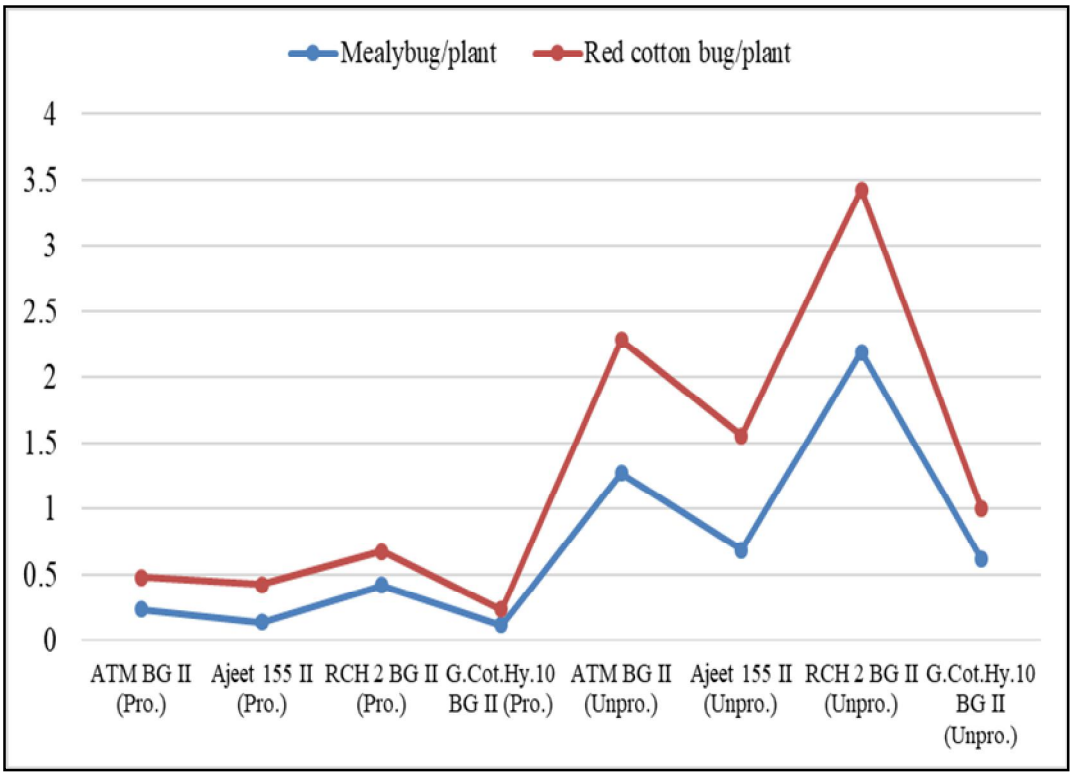

Fig 2: Mealybug, Red cotton bug population under protected and unprotected condition

Mealybugs were first recorded in the 12th week of the growing season, with infestations peaking at 47.33 ± 2.84 individuals per three leaves in Bt cotton and 39.86 ± 1.83 in non-Bt cotton by the 49th week [10, 11]. The infestation persisted from the 42nd to the 52nd week of the season, spanning from the 3rd week of October to the 4th week of December [12]. In terms of population density, mealybugs showed a range of 1.74 to 1.94 per 5 cm of top shoot area in protected plots, with average severity grades varying from 0.80 to 1.37 and severity percentages from 16.67 to 34.17. In contrast, unprotected plots exhibited higher mealybug populations, ranging from 7.83 to 10.12 per 5 cm of top shoot area, with average grades from 1.11 to 1.99 and severity percentages between 27.71 and 49.79 [13], Additionally, the red cotton bug (*Dysdercus cingulatus*) was first recorded in the 34th week of the growing season, reaching peak populations by the 37th week [14]. These findings highlight the significance of pest management strategies in mitigating mealybug and red cotton bug infestations, particularly in relation to their varying population dynamics throughout the growing season.

CONCLUSION

This study demonstrated that protective measures effectively reduce populations of mealybugs and red cotton bugs in cotton hybrids. In protected conditions, mealybug populations decreased to 0.23 per plant, significantly lower than the 1.14 per plant observed in unprotected plots. Notably, hybrids G. Cot.Hy.10 BG II and Ajeet 155 BG II exhibited the lowest infestations. Similarly, for red cotton bugs, populations were reduced to 0.23 per plant under protection compared to 0.87 per plant in unprotected conditions, with G. Cot.Hy.10 BG

II showing the least incidence. The significant interaction between protection levels and hybrid varieties emphasizes the need for tailored pest management strategies for different cotton types. These findings underscore the importance of adaptive pest management practices to maintain sustainable cotton production in the face of evolving pest pressures.

Reference

1. Pawar SR, Desai HR, Bhanderi GR, Patel CJ. Biology of the mealybug, Phenacoccus solenopsis Tinsley infesting Bt cotton. *Int. J. Curr. Microbiol. App. Sci*. 2017; 6(8), 1287-1297.
2. Nagrare VS, Kranthi S, Kumar R, Dhara JB, Amutha M, Deshmukh AJ, Kranthi KR. Compendium of cotton mealybugs. *Central Institute for Cotton Research, Nagpur*. 2011; 42.
3. Pal M, Swaminathan R, Ameta OP. Seasonal incidence of sap sucking insect pests of cotton. *Indian J. Appl. Ent.* 2014; 28: 46-49.
4. Boda V, Ilyas M. Population dynamics of sucking pests of Bt cotton and their correlation with abiotic factors. Bull. Environ. *Pharmacol. Life Sci*. 2017;6: 167-71.
5. Joshi MD, Butani PG, Patel VN, Jeyakumar P. Cotton Mealy Bug, Phenacoccus Solenopsis Tinsley–A Review. *Agricultural Reviews*. 2010); 31(2), 113-119.
6. Rafiq M, Shah SI, Jan MT, Khan IR, Shah SA, Hussain Z. Efficacy of different groups of insecticides against cotton stainer (Dysdercus koenigii) in field conditions. Pakistan Entomologist. 2014; 36(2):105-110.
7. Sammaiah C, Laxman P, Samatha Ch. Study on infestation of cotton insect stainers on BT-cotton and non Bt-cotton in Warangal, Andhra Pradesh. International Journal of Environmental Sciences. 2012; 3(3):11551160.
8. Gadewad MG, Pardeshi AB. Insecticidal activity of chrysanthemum indicum against red cotton bug, Dysdercus cingulatus Fab. International Journal of Recent Scientific Research. 2017; 8(12):22380-22383.
9. Sontakke H, Baba I, Jain SM, Saxena A, Bhagel AK, Jadhaw B. Fecundity and fertility control of red cotton bug (Dysdercus cingulatus) by the extract of Psoralea corylifolia. International Journal of Research in Pharmaceutical and Biomedical Sciences. 2013; 4(2):633-635.
10. Bhute NK, Bhosle BB, Bhede BV, More DG. Population dynamics of major sucking pests of Bt cotton. Indian J. Entomol. 2012; 74(3): 246-252.
11. Laxman P, Samatha CH, Sammaiah CH. Study on infestation of sucking insect pests on Bt-cotton and non Bt-cotton fields in Warangal Telangana. Int. J. Adv. Biol. Res. 2014;4(2): 172-177.
12. Bhanderi GR, Patel RD, Desai HR, Patel RK. Assessment of yield losses due to mealybug (Phenacoccus solenopsis Tinsley) infestation in the cotton farmers' field of south Gujarat. J. Entomol. Zool. Studies. 2020;8(2): 73-79.
13. Pawar SR, Desai HR, Pingle SV, Patel CJ, Kumar V. Assessment of avoidable loss of seed cotton yield due to the infestation of mealybug, Phenacoccus solenopsis Tinsley in south Gujarat. In: World Cotton Research Conference held on November, 2011;7-11.

14. Kaur N, Bajaj K, Kaur G, Kaur N. Sucking insect-pests incidence in relation to weather parameters under Bt cotton in North-western region of Punjab, India. Journal of Entomological Research. 2024;48(2), 256-260.