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Impact of Protective Measures on Mealybug and Red Cotton Bug Incidence in *Bt* Cotton Hybrids

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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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, *Phenacoccus solenopsis* 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, *Dysdercus cingulatus* population (0.24/plant), while RCH 2 BG II had the highest

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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.

Keywords: Bt cotton; mealybug; red cotton bug; protected and unprotected condition.

1. INTRODUCTION

Cotton (*Gossypium* spp.) 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 Phenacoccus solenopsis*, Hemiptera, Pseudococcidae Tinsley, is a significant pest in cotton cultivation and showed an 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 a large amount of sap from leaves and stem, 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 per cent. These small, oval-shaped, soft-bodied insects are covered in 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 *Dysdercus cingulatus*, Hemiptera, Pyrrhocoridae, 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 (*Nematospora gossypii*) 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 under protected and unprotected condition there by we can improve the crop yield and also we can reduce the incidence of these sucking pests.

2. MATERIALS 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 at fortnight interval on five randomly selected plants with four replications, 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 from 120 to 195 DAS.

Fig. 1. a) Mealybug b) Red cotton bug

Statistical analysis: The data was subjected to square root transformation methods to stabilize variance and ANOVA was carried out using OPSTAT software to assess the impact of hybrids and protection on the incidence of mealybug and red cotton bug. The means were compared based on the DNMRT at a 5% level of significance.

3. RESULTS 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, particularly in unprotected fields.

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

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

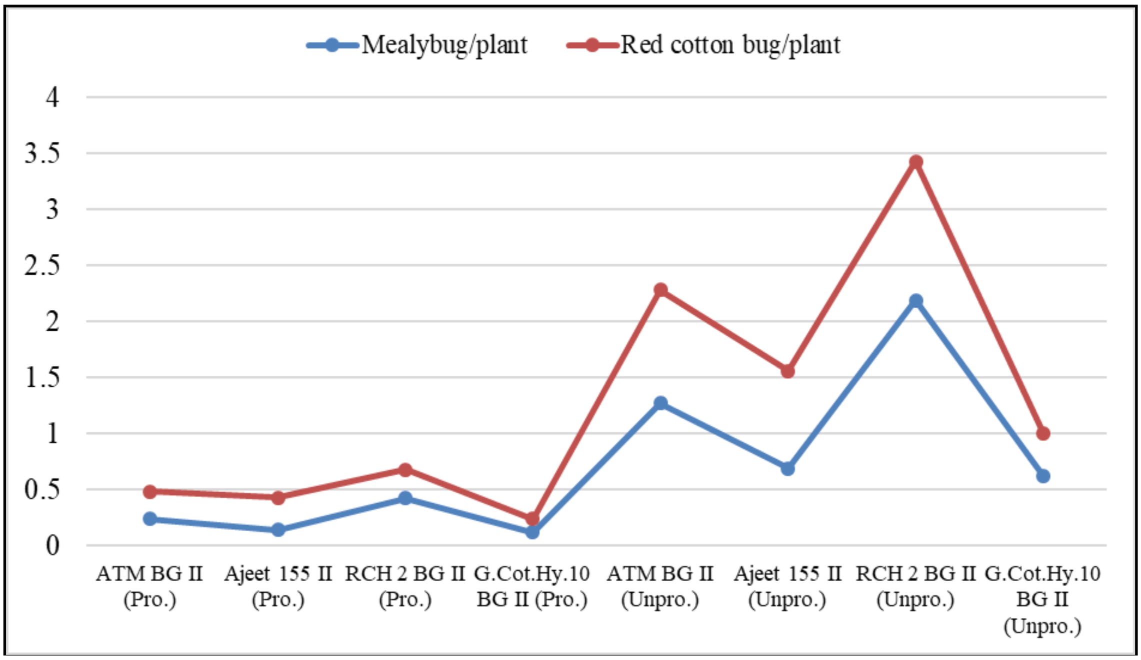

Fig. 2. Mealybug, Red cotton bug population under protected and unprotected condition

Red cotton bug: Red cotton bug population was observed from the 45th SMW in the field, the pooled results pertaining to red cotton bug population over periods presented in Table 2 revealed that 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.

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.

4. 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.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of this manuscript.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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