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Efficacy and Sex Ratio of White grub, H. consanguinea Captured in Methoxy Benzene-Baited Pheromone Traps at Varying Installation Heights

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Abstract

White grubs (*Holotrichia consanguinea*) are significant agricultural pests causing substantial damage to a wide range of crops across India. This study evaluated the efficacy of methoxybenzene (anisole)-baited pheromone traps installed at varying heights (0.5 m, 1.0 m, 1.5 m, 2.0 m, and 2.5 m) and assessed the sex ratio of captured beetles under field conditions at the Research Farm, RARI, Durgapura, during the *Kharif* season of 2025. Traps were arranged in a Complete Randomized Block Design (CRBD) with four replications, including a control treatment (1.0 m without lure). Results demonstrated that trap height significantly influenced capture efficiency, with the highest beetle catches recorded at 0.5 m (929.50 beetles/trap) and 1.0 m (829.75 beetles/trap), which were statistically at par. Capture rates progressively declined with increasing height, with the lowest catch (559.50 beetles/trap) at 2.5 m. The control traps captured negligible beetles (0.75/trap), confirming methoxybenzene as the primary attractant. Sex ratio analysis revealed a consistent male-biased ratio of approximately 7:1 across all heights, with no significant differences among treatments ($\chi^2 = 2.471$, $p = 0.7859$). These findings suggest that for optimal monitoring and management of *H. consanguinea*, pheromone traps should be installed at heights between 0.5 m to 1.5 m above ground level.

1 Introduction

The white grub beetle *Holotrichia consanguinea* (Coleoptera: Scarabaeidae) is a polyphagous pest of considerable economic importance in India, particularly in the semi-arid regions of Rajasthan and neighboring states. Following emergence, adult beetles feed on the foliage of various host plants, including *Azadirachta* spp., *Acacia* spp., *Ziziphus* spp., *Prosopis*, and drumstick (*Moringa* spp.)

However, the most severe damage occurs during the larval stage, where subterranean grubs feed on root systems of cultivated crops, leading to substantial yield losses (Ritcher 1958). White grub infestations can cause up to 70% damage in commercial crops, with a single grub per square meter sufficient to cause economically significant losses (Yadava and Sharma 1995). Recent surveys indicate that damage levels ranging from 15–40% have been observed across various fruit crops, with the diversity of pest species also expanding (Sreedevi et al. 2019). The economic impact extends across multiple cropping systems, including corn, soybeans, vegetables, fruit orchards, plantations, and timber production.

Adult beetles typically emerge synchronously with the onset of monsoon rains (June-July), initiating a reproductive cycle that perpetuates crop damage throughout the growing season. After mating, females oviposit in soil, and the emerging grubs continue root-feeding, causing progressive plant decline. The concealed nature of larval feeding makes early detection challenging, necessitating effective monitoring strategies for timely intervention. Semiochemicals, particularly pheromones, have emerged as environmentally benign alternatives to conventional insecticides in pest management. Pheromone-based strategies serve multiple functions, including: Surveillance and monitoring: Detecting pest presence and population densities; Mass trapping: Reducing pest populations through large-scale trapping; Mating disruption: Interfering with reproductive behaviors; Attract-and-kill: Combining attractants with toxic or

biological control agents (Huiting et al. 2006). The identification of anisole (methoxybenzene) as the aggregation pheromone for *H. consanguinea* (Leal et al. 1996) has facilitated the development of targeted monitoring and management programs. Pheromone trapping offers a sustainable, environmentally friendly approach to pest control (Sohrawardy et al. 2021).

While pheromone-based trapping has demonstrated efficacy against *H. consanguinea*, the optimal trap placement parameters, particularly installation height, remain inadequately characterized. Trap height significantly influences capture efficiency due to its effect on pheromone dispersion and beetle flight behavior (Klein et al. 1972; Alm et al. 1996; Kong et al. 2014). Additionally, understanding sex ratio dynamics in trap captures is crucial for interpreting population structure and designing effective management strategies.

2 Methods

The evaluation of the efficacy of methoxy benzene baited pheromone trap at different heights against, *H. consanguinea* was assessed through installing the pheromone traps at different heights at Research Farm, RARI, Durgapura, Jaipur. The experiment was designed to use complete Randomized Block Design (CRBD) with four replications and five different heights (i.e. 0.5 m, 1.0 m, 1.5 m, 2.0 m and 2.5 m) where pheromone traps were installed served as treatments, and lure used in each of the pheromone traps was methoxy benzene and one treatment was at height 1.0 meter above the ground level having no lure i.e. to prove that methoxy benzene is the only factor to attract the white grub beetles toward trap and only the height of trap without lure could not attract beetles. These traps were installed at each the above given selected height on wooden/ bamboo poles or metal stand and it was ensured that the minimum spacing of 20 m between each of the traps were maintained to avoid interference. Set up of pheromone traps as given above was done before adult emergence period.

The Research Farm, RARI located in semi arid region of Rajasthan the winds generally flow from Southwest to Northeast direction during the monsoon season (June- July). So the traps were installed in the prevailing wind direction to allow pheromone plumes to disperse effectively in the direction of beetle movement. Pheromone traps were baited with the single formulation of methoxy benzene lure in all traps in same quantity for uniform attraction. The numbers of beetles collected data every morning were subjected to statistical analysis by using the CRBD design and generated the ANOVA (Analysis of Variance) and compared the efficacy of different heights of pheromone traps with the number of adult beetles of white grub, *H. consanguinea* trapped.

The assessment of the sex ratio of white grub beetles, *H. consanguinea* trapped in methoxy benzene baited pheromone trap at different heights were also assessed from the pheromone traps installed at different heights at Research Farm, RARI, Durgapura. With the help of morphological character of hind tibial spur with the pointed is male and broad is female. (Jacob and Kumar 2010) Then we had calculated the male-to-female sex ratio for each trap heights and also performed a sex ratio was

analyzed for each treatment (trap height) by the application of a Chi-square test to assess the significance of differences in sex ratios across trap heights.

3 Results

The data pertaining to the evaluation of efficacy of methoxy benzene baited pheromone traps installed at different heights against beetle; *Holotrichia consanguinea* were initiated with the emergence of beetle trapped in pheromone traps from 16th June, 2025 to till there was no beetles were trapped in pheromone trap i.e. 13th July, 2025. The average numbers of beetles trapped at different heights were recorded during the observation period were 929.50, 829.75, 771.75, 682.25, 559.50, and 0.75 at height of 0.5m, 1.0m, 1.5m, 2.0m, 2.5 and pheromone trap without lure, respectively. The beetles were continuously trapped in pheromone trap for nearly about 28 days with daily average of 34.43, 30.73, 28.58, 25.57,20.72 and 0.03 at height of 0.5m, 1.0m, 1.5m, 2.0m, 2.5 and pheromone trap without lure, respectively (Table 1).

Among the various treatments, the pheromone traps installed at 0.5 m above ground level recorded the highest beetle catch throughout the observation period, followed by 1.0 m. The traps installed at 1.5 m and 2.0 m exhibited moderate performance, whereas the traps installed at 2.5 m recorded comparatively lower beetle catches. No beetle capture was observed in the pheromone trap without lure during the entire experimental period (Table 1).

On statistically evaluation it was observed that the average number of the highest beetles trapped were 929.50 and 829.75 at the pheromone height of 0.5 m and 1.0 m, respectively. But both the above treatments of pheromone heights i.e. 0.5 m and 1.0 m were statistically at par with each other. As on further we had analysed that at the next level of pheromone height i.e. 1.5 m, the average beetles trapped were 771.75, and which was statistically significant with the number of beetles trapped in treatment at 0.5 m (Table 1).

Table 1
Number of adult white grub, *Holotrichia consanguinea* trapped in pheromone trap lured with methoxy benzene placed at different heights in the field.

Treatment Details	Average per trap	Per day catch in trap
0.5 m	929.50[a] (30.39)*	34.43
1.0 m	829.75[ab] (28.80)	30.73
1.5 m	771.75[bc] (27.79)	28.58
2.0 m	682.25[c] (26.11)	25.27
2.5 m	559.50[d] (23.66)	20.72
1.0 m Without lure	0.75[e] (1.00)	0.03
CD	1.82	
SE (m)	0.60	
SE (d)	0.85	

*Figures in parenthesis are square root transformed; Table values followed by the same letter are not significantly different (P = 0.05).

The overall sex ratio (male: female) beetles, *H. consanguinea* trapped in pheromone trap was evaluated for the given period and it was around ~ 7:1 in all the treatments that were installed at different heights. It was observed that the ratio of male: female decrease with the increase in the height of the pheromone trap. The proportionate sex ratio (male: female) across treatments clearly indicated a strong male dominance. The pooled proportion of males ranged approximately from 0.88 to 0.87 across different heights of pheromone traps.

Table 2
Chi-square analyses of sex ratio and the number of male and female beetle, *H. consanguinea* trapped in the pheromone traps placed at different heights.

Treatment Details (Pheromone trap height)		**Total Number of Male and Female beetles**	**Sex Ratio (Male: Female)**	**Pooled Proportionate Sex Ratio**
Male	0.5 m)	3276	7.41	0.88
female		442	1.0	0.12
Male	1.0 m	2923	7.38	0.88
Female		396	1.0	0.12
Male	1.5 m	2704	7.06	0.88
female		383	1.0	0.12
Male	2.0 m	2394	7.15	0.88
female		335	1.0	0.12
Male	2.5 m	1947	6.69	0.87
female		291	1.0	0.13
Male	1.0 m (without lure)	3.0	0.00	0.0
female		0.0	0.0	0.0
***Chi-Square**		2.471		
p-value		0.7859 NS		

4 Discussions

It was clearly observed (Table 1) that as there was increased in the height of the pheromone trap the average number of beetle trapped were decreased. It was observed the pheromone trap installed without any lure had attracted three beetles, *H. consanguinea* with exception of error that three beetles were in one of its replication. These findings were in agreement with Klein et al. (1972) who reported that traps baited with virgin female *Popilla japonica* Newman exposed 11 inches above ground captured significantly more male beetles, than those exposed 44 inches above ground. Alm et al. (1996) and Cai et al. (2021) who reported that trap height significantly influences beetle capture and that traps placed near ground or canopy level recorded higher catches. Similarly, Kong et al. (2014) also reported that trap height and positioning affect pheromone trap efficiency due to insect flight dynamics.

Overall, the results clearly indicated (Table 2) that methoxy benzene-baited pheromone traps were more effective in attracting male beetles than females, thereby exhibiting a male-biased sex ratio under field conditions. But on statistically analysis by evaluating the chi-square test it was observed that sex ratio

i.e. male: female was non-significant among the pheromone traps installed at different heights. Leal et al. (1996), who reported that anisole (methoxy benzene) attracts both male and female beetles of *Holotrichia consanguinea*, resulting in nearly equal or slightly male-biased sex ratio under field condition, similarly Weslien et al. (1988) observed variations in sex ratio in pheromone trap catches due to differences in behavioural responses and pheromone release rates. Further, Zapponi et al. (2023) also reported that pheromone-based trapping systems can capture both sexes, although male dominance was often observed due to higher responsiveness.

Declarations

Declaration of AI Use

This manuscript was prepared through the intellectual contributions of the author(s) to the study design, data analysis, interpretation of results, and scholarly content. The author(s) accept full responsibility for the accuracy, integrity, and final content of the manuscript.

Competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Author Contribution

PT and MN framed the trial and conducted the experiment in the field and MN also prepared the manuscript and all the calculation part, whereas AJ and BLJ worked on the refinement of manuscript.

Data Availability

All the data regarding the number of beetles trapped in the pheromone traps installed at different heights were generate through daily observation.

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