



Impact of trapping density on the performance of aggregation pheromone against *Rhynchophorus ferrugineus* (Coleoptera: Dryophthoridae)

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Abstract

Red palm weevil (RPW), *Rhynchophorus ferrugineus* (Coleoptera: Dryophthoridae) is world-wide pest of palms causing severe losses, eventually loss of entire trees. Although, synthetic chemicals are ultimately used for its management, but, aggregation pheromone (Ferrugineol) is widely used for the monitoring and a key component of IPM of RPW. Therefore, this study was conducted in a date palm orchard at district Khairpur, Pakistan to determine the appropriate trapping density that should be utilized for the better monitoring and management of RPW. Three trapping densities i.e., 3, 4, 5 and 6 traps per acre were used in randomized complete block design, where each block was separated by a 1 acre. Each treatment was replicated thrice. Bucket type plastic traps were used where RPW aggregation pheromone (P028 Ferrolure+® ChemTica International, Costa Rica) was attached to the lid of trap. Results obtained indicated that maximum attraction and capture of RPW was recorded at 4 traps per acre density, but not significantly different from 3 traps per acre density. Relatively lower RPW capture was recorded at 5 and 6 traps per acre density. Moreover, traps remained effective for eight weeks after installation. Therefore, RPW aggregation pheromones should be installed at 3 or 4 traps per acre for the better monitoring and management of RPW in date palm orchards, however, level of infestation and environmental conditions may be considered in the decision making.

Keywords: Red palm weevil, aggregation pheromone, trap, density; Khairpur

1. Introduction

Red palm weevil (RPW), *Rhynchophorus ferrugineus* (Coleoptera: Dryophthoridae) is one of the invasive pests of palms throughout the world [1, 2, 3]. It is native of sub-continent including Pakistan and then spread to different regions of the world [4]. It attacks on more than 26 palm trees belonging to 16 different genera in almost all palm growing areas of Asia, North Africa, Europe, Oceania and Caribbean countries [5, 6, 7]. It is very difficult to detect the presence of the pest in the early stage of its attack because it mostly remained concealed inside the tree. Varying levels of economic losses are reported due to attack of pest with the loss of whole palms in case of severe attack [2, 8, 9, 10].

In Pakistan, management of RPW is mainly dependent on the use of pesticides applied through trunk injections, but due to the cryptic habitat of the boring stages of this weevil, frequent applications of chemicals are needed to get an effective control of RPW [11, 12, 13]. However, there are deep concerns about the human and animal health along with environmental pollution due to the large-scale usage of chemicals [2]. Therefore, in recent years, aggregation pheromone (ferrugineol; 4-methyl-5-nonanol and 4-methyl 5-nonanol) is used as a basic tool for the population sampling, monitoring and sustainable management of RPW in many countries of the world. Moreover, addition of the bait (fermented dates) and kairomone (ethyle acetate) could increase the effectiveness of pheromones to achieve more effective control [14, 15, 16, 17, 18]. However, the use of aggregation pheromone is yet not common as a management tool against *R. ferrugineus* and growers still depend on large scale use of synthetic chemicals [19, 20]. Moreover, studies are lacking in many countries about the appropriate densities of

traps to be used for an effective control of RPW with minimum cost of traps. Therefore, this study was conducted to evaluate the different densities of aggregation pheromone to determine the appropriate trap density to be used against RPW.

2. Materials and methods

2.1 Study location

The study was carried out at a highly infested orchard in Khairpur district, the main date palm growing area of Pakistan. The orchard area was 25 acres which comprised of date palm trees of mixed ages, with majority of trees belonging to Aseel variety. The experiment was started on 1st June, 2018 considering the active period of RPW owing to favorable conditions because of the plantation of new suckers for propagation.

2.2 Preparations of pheromone traps

The traps were set in plastic buckets (36 cm L and 26, 20 cm diameter at top and bottom, respectively). Each trap and its lid have four equidistant rectangular (3 x 7 cm) openings to allow the entrance of *R. ferrugineus*. Moreover, the outer surface of the trap was rubbed to have rough surfaces to help *R. ferrugineus* to climb on and enter the trap. Red palm weevil aggregation pheromone (P028 Ferrolure+® ChemTica International, Costa Rica) containing 700 mg pheromone lure (ferrugineol; 4-methyl-5-nonanol) was attached to the lower surface of the lid with iron wire. Two liters of water containing detergent was placed at the bottom of the trap, so that attracted weevils will never come out when trapped. Water along with detergent was regularly changed after each weekly basis to avoid foul odor.

2.3 Trapping densities

Four trap densities per acre i.e., three, four, five and six were used in the study and described as treatments. The selected 25-acre orchard was divided into three blocks, with one-acre distance separating each block and each treatment. Each treatment was allocated randomly to a one-acre piece of the orchard so that equal distances were maintained between individual traps in the specified treatment (trap density) i.e., 1333 m² for three traps per acre, 1000 m² for four traps per acre, 800 m² for five traps per acre and 667 m² for six traps per acre. Each treatment in the study was replicated three times.

2.4 Data collection and analysis

The observations were taken on weekly basis since the installation of traps where number of weevils attracted to the individual treatments were collected and counted. Experiment was continued till the effectiveness of pheromones lures lasts (same was assumed when no weevil captured for two consecutive weeks). The collected data was analyzed using Analysis of Variance, whereas, the Least Square Difference (LSD) test at 5% probability was used to separate means with significant differences. All analysis was done using STATISTIX 8.3 computer software.

3. Results

The findings of study confirmed significant (F = 35.71, P < 0.001, df = 3) role of trapping densities on the catching efficiency of RPW. It has been also observed that all the Ferrolure+ pheromone traps remained effective for eight

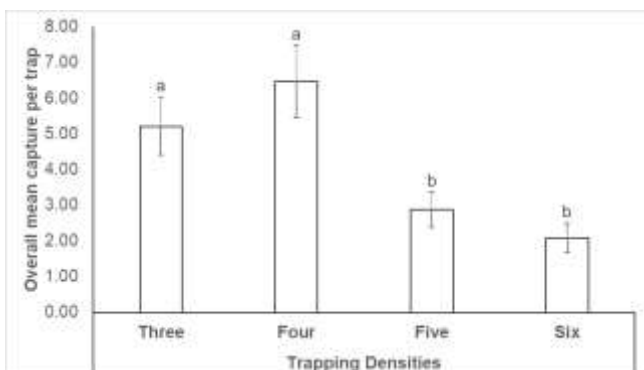
weeks after the installation. According to results, RPW attracted towards pheromone traps installed at various densities immediately after their installation with average capture of 2.33±0.88 weevils/trap, 2.67±0.33 weevils/trap, 1.33±0.33 weevils/trap and 0.67±0.33 weevils/trap recorded in three, four, five and six traps per acre densities, respectively recorded on 08th June, 2018. (Table 1). Afterwards, an increase was recorded for RPW per trap capture at various densities with relative higher captures recorded in trapping densities of four and three. Accordingly, weekly the highest per trap capture of RPW recorded in various trapping densities i.e., three, four, five and six per acre was 8.67±1.76 weevils/trap, 10.33±2.73 weevils/trap, 5.33±1.20 weevils/trap and 4.00±1.15 weevils/trap, respectively. A decline in effectiveness was observed in all the pheromones traps as their effectiveness declines gradually and no more RPW was captured after week eight after installation (Table 1).

Fig. 1 showed the overall mean capture of RPW attracted towards various densities of pheromone lures. According to results, the highest overall mean attractiveness (6.46±1.01 weevils/trap) of RPW was recorded in treatment where Ferrolure+ pheromones were installed at density of four traps acre, but the same was not significantly different from the RPW catches recorded in three/acre trap density (5.21±0.81 weevils/trap). Moreover, relatively less number of RPW was captured in treatments when traps were installed at five (2.87±0.50 weevils/trap) and six (2.08±0.41 weevils/trap) traps/acre densities.

Table 1: Effect of various pheromone densities on the mean capture of *Rhynchophorus ferrugineus* (RPW)

Observation Dates	Trap Densities				Mean
	Three	Four	Five	Six	
08/06/2018	2.33±0.88hij	2.67±0.33ghij	1.33±0.33ij	0.67±0.33j	1.75±0.46d
15/06/2018	3.00±0.58fghij	3.33±0.67fghij	1.67±0.33hij	1.00±0.58j	2.25±0.55cd
22/06/2018	4.33±0.33efgh	5.67±0.33cdef	1.67±0.88hij	1.33±0.88ij	3.25±1.05c
29/06/2018	8.67±1.76ab	10.33±2.73a	5.33±1.20defg	4.00±1.15efghi	7.08±1.46a
04/07/2018	7.33±1.20bcd	9.00±1.53ab	4.33±0.67efgh	3.33±1.45fghij	6.00±1.31ab
11/07/2018	6.33±0.67bcde	8.00±0.58abcd	3.33±0.33fghij	2.00±0.88hij	4.92±1.37b
18/07/2018	6.33±1.20bcde	8.33±0.67abc	3.00±1.00fghij	2.67±0.33ghij	5.08±1.36b
25/07/2018	3.33±0.88fghij	4.33±1.20efgh	2.33±0.33hij	1.67±0.88hij	2.92±0.58cd

*Means followed by same letters are not significantly different (LSD, P<0.05)



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Fig 1: Overall mean capture of *Rhynchophorus ferrugineus* (RPW) at different trapping densities

4. Discussion

The aggregation pheromone i.e., ferrolure and ferrolure+ containing errugineol; 4-methyl-5-nonanol are now widely

used against RPW in various palm growing areas of the world with varying degrees of success [15, 16, 17, 20, 21]. However, its use in Pakistan in general and Sindh province yet not well adopted [19]. Initially, Oehlschlager [22] recommended that one trap per 100 acres is sufficient to get effective monitoring of RPW. However, subsequent studies in various countries of the world, use various trapping densities ranging from 1.5 traps/hectare to 10 traps per hectare [23, 24]. However, various factors like infestation percentage, climate of the area of the orchards in different geographical regions, type of varieties cultivated, various topographic features of the area etc. hold a key role in determining the adequate trap density to be utilized. The study conducted at Goa, India in a coconut plantation, one trap/ hectare gave promising results against RPW [25]. However, it is also suggested that for an area-wide management of RPW, the distance among the traps should be increased to separate the areas with higher infestation from no or low infested areas [26, 27]. Accordingly, this study suggested that four traps per acre density of aggregation

pheromones catches maximum number of RPW, followed by three traps per acre density but with not-significant difference. The least number of RPW catches were recorded when pheromones were installed at densities of five and six traps per acre. These findings are in accordance with that of Faleiro ^[28], who suggested that 10 traps/hectare gave highest capture of RPW in comparison to lower trapping densities/hectare (1, 2, 4 and 7) when infestation level was more than 1%. Mohammadpour *et al.* ^[29] also found that attraction of pheromone lure decreased when distance between two traps is increased, whereas, maximum capture of weevils was recorded when traps were placed below 5 meters apart. Therefore, damage percentage of RPW in palm orchards should be considered as a base in determining the appropriate Ferrolure+ density to be used for its monitoring and management ^[28, 30]. Moreover, along with following the appropriate trapping density for the placement of aggregation pheromone against RPW to get maximum control of weevils, the performance of traps can also be enhanced by the addition of various plant materials i.e., palm shoots, dried dates, sugarcane, banana stems etc. and kairomones such as ethyl acetate and ethyl propionate ^[17, 31, 32].

5. Conclusion

Significant impact of trapping densities of aggregation pheromone (Ferrolure+) was recorded on the attractiveness of RPW as overall the highest capture of weevils was recorded at trapping density of four traps / acre, followed by three traps / acre with no significant difference recorded in both the treatments. Comparatively very less number of RPW was captured at five and six traps / acre densities. Moreover, aggregation pheromones remained effective for eight weeks after the installation. Thus, incorporation of aggregation pheromones as a monitoring as well as an integral part of integrated management against RPW could give its better control in the date palm growing areas.

6. References

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