Original Research Paper

Accuracy of Trained Dogs for Early Detection of Red Palm Weevil, *Rhynchophorus ferrugineus Oliv.* Infestations in Date Palm Plantations

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The date palm is an important part of the religious, cultural and economic heritage of the Arabian Peninsula, Egypt and all countries of the Middle East. In Egypt, a national campaign for control of RPW by containment /destruction of infested plants, injection and spraying of biochemical and chemical pesticide treatments in heavily and newly infested areas, and the use of pheromone traps for monitoring and reduction of RPW populations has been only partially successful in controlling its spread. Detection of low level RPW infestation is essential for early intervention, confirming eradication of infestations and reducing the spread of RPW. Despite the importance of detection, few effective tools and methods exist for detecting low number of infested trees. Scent dogs were developed as a tool for detecting RPW in recent years. However, there are no data demonstrating the reliability of trained dogs under natural field conditions. The difference in the number of infected trees and discovered dogs (33 trees discovered by dogs; 18 trees discovered by naked eye) equal to 15 trees and the efficacy of dogs reached 54.54% (2013).The results in the second year (2014) compared with those of the first (2013) year, show that the efficiency of dogs in search of palm trees newly infected trees has reached 63.85%. We evaluated the accuracy of three dog detection teams in naturally infested trees. The main problem when using dogs is the difficulty to discover the top infestation. The data suggest that more research is needed to develop it and understand factors affecting the accuracy of dog's teams for RPW detection in naturally infested trees. At the moment a combination of methods and technologies is required to form an optimal solution.

Keywords: *Rhynchophorus ferrugineus Oliv.*, *Phoenix dactylifera*, dogs, early detecting of infestations.

INTRODUCTION

The date palm, *Phoenix dactylifera L.* is the most important fruit crop in the Middle East, where it has been cultivated since ancient times. Since the mid 1980s the red palm weevil (RPW), *Rhynchophorus ferrugineus* Oliv. (Coleoptera, Curculionidae), has caused serious damage to date palms in the Gulf region (Abraham, et al. 1998). The pest crossed the Red Sea into North Africa and was recorded in Egypt in 1993 (Cox, 1993). Eggs of the target pest are laid in the trunk of the palms and the larval stages feed on the soft plant tissue within the trunk of palms, which leads to the formation of tunnels inside the palm.

In infested plantations, yields have been estimated to drop from 10 to only 0.7ton /ha (Gush, 1997). Because of the concealed nature of the grubs, early detection by pest management specialists is difficult and often the pest is detected only after most damage has already been inflicted. This is because the openings of the tunnels are concealed under the trunk fibers, beneath the base of the leaflets or hidden between the tree trunk and the offshoots. In this respect, pheromone traps may serve as a general warning device, indicating the presence of the pest in the area (Oehlschlager, 1994). However, the actual detection of such trees at their early stage of infection still remains a problem. Early detection of infected trees would allow their rescue by various treatments of trunk injection with insecticides or soil applications (Abraham et al. 1998). Late detection of infected trees results in heavy damage that cannot be cured and such trees have to be destroyed. Conventionally, food baited pheromone traps are commonly used to detect the red palm weevil, however, this traditional method is labor–intensive, expensive to implement, particularly over large areas, and unreliable for early detection (Al-Saqer, 2012).

There has been a growing interest in finding and implementing non-destructive methods for detecting insects inside plants (Mankin and Fisher 2002). Acoustic sensors with probes were inserted into the palm trunk to detect sounds produced by the feeding activity of early larval stages of the weevil. However, it was difficult to distinguish the sound produced by the larvae from background noise

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when insects were hidden in stiff, fibrous structures (Mankin et al., 2008). Electronic gas sensors have been used to detect volatiles emitted by plants infested by insects. Soroker et al., 2013 reviewed recently developed RPW detection methods, developing approaches, discussed their advantages, pitfalls and potential future implementation in RPW management.

Following the detection and the immediate control operations, efforts were aimed at developing better and more effective methods for early detection of infested trees. Preliminary results regarding the possibility of using animals such as dogs for detecting date palms infested with RPW are presented in this evaluation. Because the existence of plant insects, chemical signatures are well established, it seemed reasonable that dogs could be taught to recognize them. One study that demonstrates this, in which some dogs were trained to find gypsy moth, egg masses and pheromone market items (Wallner and Ellis,1976).

Allen et al., (1999) 2011, mentioned that the possibility of chemical detection of insects as follows: plant feeding by insects produces chemical compounds that often are exploited by natural enemies (Lewis and Tumlinson, 1988 and Turling et al., 1990). Germany dogs were trained to find gypsy moth, *Lymantriadispar*L., eggs masses and pheromone market items (Wallner and Ellis, 1976). Many authors study the use of animals for detecting insect infestations (Anon, 1996; Zeno, 1998).

MATERIALS AND METHODS

After many trials of developing electronic noses as a tool for detecting insect infestations, four dogs (Golden Retriever) were trained and used for this study in El-sadat region, Menofyia Governorate (special farm of date palm plantation).The experiments were carried out during two successive seasons, 2013 and 2014. Selected farm cultivated by different types of vegetables and palm trees that grow in individual or in small groups (4-5 trees).The total number of date palm trees in the experimental area is about 189 trees.

The number of infected trees in the first year were remarked and used in the second season as a base data.The fertilizer was added during drip irrigation system and not received any chemical control. The dogs were trained to detect the smell of the ooze that exudes from RPW infested date palm trees. This ooze was collected from infested trees and stored in a refrigerator. Small quantities of it were picked within small ball-shaped, plastic netting (50 meshes). The small quantity of ooze, used as bait was to ensure that dogs would respond to infected trees even the initial stage of infestation.

The training course is about two (April & May) months before the beginning of field experiments. The cores and methods for training the dogs were as follows: The dogs are allowed to play with the net balls containing the ooze. After the dogs start to enjoy the game and to bring back the net balls, the trainer begins to hide the bags and let the dog find them. Every time the dog finds a hidden ball, it is rewarded with food (as a gift). The balls are hidden in date palm trees and the dogs are sent to find them. Every time they find one, they sit down near the tree waiting to get their reward. The training is based on a conditional chain process comprised of game, ball, tree, the word, search, and rewarding the dogs. The period of these cores is about three months, (3 days/week, and 2feddans/day). The infected trees which discovered monthly are marked every month until it is not counted again. Control area is about one 1.038 acres (feddan) and contains fifty date trees, also the assessment process was by naked eye only.

RESULTS AND DISCUSSIONS

These studies were carried out during the beginning of new activity peak (June to October) during summer 2013 &2014. The dogs were released in date palm orchards where oozing balls had been hidden within a few trees. In all cases, the dogs found the hidden baits very quickly in a short time (15 min.). At the last time of the activation period of weevils, the dogs were sent out to search in a plantation where high RPW captures were recorded previously. The dogs successfully found infested trees that had not been detected previously.

Table (1) (2013) shows that the numbers of infected trees increased gradually from June to October (8 to 33.0 trees discovered by using dogs) while in the case of naked eye process, the number of trees reached 26 (8 to 26 trees). The efficiency of dogs reached 54.54% compared with examination by naked eye (Table1). The results in Table (2) show that in the second 2013 year , the efficiency of dogs in search of newly infected palm trees reached 63.85% compared to 54.54% in the first year (2013). From these results, it is clear that the experience of dogs in search and discovery in the second year was a result of the acquisition of dog's experience of the first year, although the number of trees discovered was less than that the first year. That is why this result was due to the lack of insects from trees and search for other hosts, also due to the less crowding of larvae and adults inside the trunk. On the other hand, the total number of infected trees discovered by the naked eye is about ten trees compared with 15.66 trees discovered by dogs with 63.85% efficiency of dogs.

The possibility of using dogs for early detecting of red palm weevil infestations might contribute to better management to use different and better methods for controlling the target pest immediately at the optimal time. The data revealed that the use of dogs for early detecting of RPW infestation can prevent many trees from the larval damage due to its feeding and destruction of the tissues of the trunk and then the control by insecticides if use directly, not enough to prevent the trees from falling. The data and the observation by naked eye ravealed that the length of larval tunnels inside trunk within two months arrived to 15 cm and the ooze clearly observed, in this case the chemical control is too late to be applied. With early detection of the infestation, it was easy to remove ooze; larvae and small tissue without wounding to tree.

Table (1): shows the actual assessment of the ability of dogs to early detection of RPW infestation(2013)

Inspection methods	Inspection date					Total no.of infected trees		Newly infected trees	Efficiency of dogs
	Jun.	July	Aug.	Sept.	Oct.	Before treatment	After treatment		
Dog no.1	8	4	7	11	18	8	40	32	
Dog no.2	8	5	5	12	19	8	41	33	
Dog no.3	8	5	6	12	19	8	42	34	54.54%
Mean ± S.E	8.0± 0.0	4.66± 0.01	6.0± o.o2	11.66± 0.01	18.66± 0.01	8.0	41.0	33.0	
Control [naked eye]	8	3	5	5	13	8	26	18	

Table (2): shows the actual assessment of the ability of dogs to early detection of RPW infestation (2014)

Inspection methods	Inspection date					Totalno. of infected trees		Newly infected trees	Efficiency of dogs
	Jun.	July	Aug.	Sept.	Oct.	Before treatment	After treatment		
Dog no.1	40	7	10	15	25	40	57	17	
Dog no.2	41	7	9	15	24	41	55	14	
Dog no.3	42	7	10	15	26	42	58	16	63.85%
Mean ± S.E	41.0± 0.0	7.0± 0.05	9066± o.1	15.0± 0.01	25.0± 0.07	41.0	56.66	15.66	
Control [naked eye]	26.0	4.0	6.0	11.0	15.0	26.0	36	10.0	

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