Control of the Apical and Trunk Infestations of Date Palm by Red Palm Weevil, *Rhynchophorus ferrugineus*, Using a Simple and Inexpensive Injection Technique

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Abstract

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Red palm weevil (RPW) is the most dangerous pest of palms worldwide. In date palms, RPW attacks mainly the trunk, but apical infestation can occur and is being observed in the Kingdom of Saudi Arabia (KSA). Currently not managed by the farmers, those apical infestations become sources of heavy infestations to other healthy palm trees. In this study carried out during 2020 in 6 locations in the KSA, a trial to control RPW on date palm by using a simple, easy, and low-cost trunk injection method against apical and trunk infestations with insecticides namely emamectin benzoate (50 g/L), imidacloprid (200 SL) or deltamethrin (2.5%) was carried out. Results obtained showed that trunk injection of the apically infested date palm, by using non-diluted emamectin benzoate, indicated that 90.6% of the palm trees totally recovered. The same technique was used with the date palm infested trunk, with 100% success in killing all RPW instars in the palm trunk. The use of the other non-diluted insecticides (imidacloprid and deltamethrin) was not too efficient against the date palm trunk infestation, killing only 64.25% and 53.91% of the RPW instars, respectively.

Keywords: Apical infestation, date palm, emamectin benzoate, red palm weevil, trunk infestation, trunk injection.

Introduction

Red palm weevil (RPW), *Rhynchophorus ferrugineus* Olivier (Coleoptera: Curculionidae), is known as the most dangerous palm pest worldwide. Most of the damage due to RPW in date palm, *Phoenix dactylifera* L., occurs in the basal part of the trunk and their symptoms are well described (Anonymous, 2020; FAO, 2020). There is other damage that can occur at the top of the date palm tree. This type of infestation began to appear more and more since few years ago in most regions of the Kingdom of Saudi Arabia (KSA) in varying rates, with a general rate of around 11% of the total number of infested palm trees in the whole country in 2022. These rates are high, especially in the regions of Asir, Qassim, Ha'il, Tabuk and Najran (between 9% and 25% of the total number of infested palms) (Anonymous, 2022). Those palm apical infestations are currently not managed, mainly because of the absence of a practical method. Even though such apical infestations are relatively not common, they become sources of trunk and/or apical new infestations in the neighboring healthy palm trees and thus contributed largely to the RPW spread.

On the another hand, new research demonstrated that RPW infestation of the ornamental Canary palm, *Phoenix canariensis* hort. ex Chabaud, which is usually attacked at the apex, can be managed using a trunk injection with the non-diluted insecticide emamectin benzoate that killed all RPW instars in the Canary palm top and protected it for one year from any new RPW infestations (Chihaoui-Meridja *et al.*, 2020; Gomez & Ferry, 2019). The insecticide was also used by trunk injection to control the RPW trunk infestation (Mashal & Obeidat, 2019; Rasool *et al.*, 2021). This technique, called "endotherapy", is based on the injection of the insecticide inside the low part of the palm trunk; then the insecticide diffuses inside the trunk and migrates to the top of the palm tree to act curatively by killing all RPW instars and/or preventively by protecting the palm head from later RPW infestations (Ferry & Gomez, 2014; Gómez *et al.*, 2009; Hernández Marante *et al.*, 2003).

Accordingly, this study was implemented during 2020 in the KSA and inspired by the trunk injection technique used to control RPW of the Canary palm, to evaluate this simple, easy and low-cost trunk injection technique for the first time against the RPW date palm apical infestation, in the hope to extend this simple technique to the control of the RPW date palm trunk infestation.

Materials and Methods

Experimental sites

For the apical infestation treatment, the study was performed at 3 different sites, where several randomly infested palm trees heads were identified, two sites Riyadh (Dirab) and Kharj (AlSahba) in the Riyadh province, and one site at Tayma (AlBalad) in the Tabuk province (Figure 1). For the trunk infestation treatment, three sites in the province of Riyadh [Riyadh (Hayer), Kharj (AlShadida) and Dawadmi (Sajer)] were identified (Figure 1).

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Figure 1. Sites in the Kingdom of Saudi Arabia, where experiments on the control red palm weevil infestations (red color dots) were carried out during 2020.

In each site of Riyadh (Dirab), Kharj (AlSahba) and Tayma (AlBalad), an orchard with several date palm trees moderately infested at the top with RPW were selected. Twelve palm trees (cv. Khlas at Riyadh and Kharj, and cv. Helwa at Tayma) in each orchard, of approximately the same age and height, were selected. Six trees were trunk injected and the other six were top sprayed with insecticides (as control). Regarding the trunk infestation, 15 trunk infested palm trees (cv. Khlas) of approximately the same age and height were selected in an orchard in each site of Riyadh (Hayer), Kharj (AlShadida) and Dawadmi (Sajer). Three insecticides were compared, and each one of them was injected into five infested palm trees.

Materials used

To treat the apical infestation by injection, the palm tree trunk was injected by the non-diluted insecticide emamectin benzoate 50 g/L (Proact 50 EC), used successfully earlier to control the apical infestation of the Canary palms with RPW (Chihaoui-Meridja *et al.* 2020; Gomez & Ferry, 2019). Apical spray with imidacloprid 200 SL (Imidor 200 SL) was used as a control treatment.

Emamectin benzoate was also used to treat trunk infestation by the injection method, in comparison with two other insecticides commonly utilized against RPW in classical injection or spray applications. All non-diluted insecticides used were: emamectin benzoate 50 g/L (Proact 50 EC), imidacloprid 200 SL (Imidor 200 SL), and deltamethrin 2.5% (Deciban 25EC).

For the injection of the insecticide in the palm trunk (against both apical and trunk infestations), a drill (with 1 cm diameter × 35 cm long bit) was used to bore holes in the trunk and a 100 ml-syringe (without needle) was utilized to inject the insecticide inside the holes. As a control treatment, a motorized large sprayer was used to pulverize insecticides against apical infestations.

Treatment methods

The insecticide trunk injection of the palm tree was performed as per the following three steps: (i) dig four opposite down-inclined holes around the trunk at nearly 1 m above the ground level for the apical infestation and at the ground level for the trunk infestation. Each hole is 35 cm long and 1 cm diameter (around 27.5 ml volume), (ii) using the syringe, 25 ml of the insecticide used (100 ml/tree) was injected in each hole, (iii) holes were closed with mud. For spraying, the insecticide was diluted in water (200 ml/hl) and pulverized on the palm head until full wash.

Monitoring effects of infestation treatments

For the evaluation of the apical infestation treatments (injection and spray), a monthly visual follow up was carried out for 6 months. The evaluation of the trunk infestation was done one month after the treatment, by desiccating the infested tissue and assessing the state of the RPW individuals.

With respect to the apical infestation development, the state of each palm tree was evaluated using a recovery 0-5 scale, where: 0= dead trees (0% recovery), 1= very heavy infestation symptoms (1-25% recovery), 2= heavy infestation symptoms (26-50% recovery), 3= medium infestation symptoms (51-75% recovery), 4= low infestation symptoms (76-99% recovery), 5= No infestation symptoms, trees completely recovered (100% recovery).

As for the trunk infestation development, the treatment effect was evaluated by the number or by % of killed RPW individuals found in the trunk in each desiccated palm tree.

Statistical analysis

Since the infested palms were randomly distributed, each orchard/site was considered as a completely randomized design (CRD) experiment. Statistical analysis was performed online https://www.socscistatistics.com/tests/anova/default2.aspx at P=0.05.

Results

Apical infestation symptoms

Apical infestation symptoms of date palm are generally read according to the following steps (Figure 2): (i) At first, imbalanced and deformed growth of some fronds with deviation from their original place, creating voids in the date palm head was observed. In addition, RPW infestation was observed in the trunk top and at the basis of some fronds, (ii) Fronds showed partial and then complete wilting and browning due to their damage at the base level by RPW, (iii) The growing apex and most of the fronds dyed and fell down, with RPW cocoons scattered on the ground around the date palm trunk, (iv) Finally, the remaining fronds were falling down leaving only the palm tree trunk. The infestation symptoms sometimes were observed without the presence of RPW, because the insect left the palm head earlier, but tunnel damage in the trunk and frond bases was visible.

RPW apical infestation treatment

Riyadh site - Results obtained showed that the trunk injection method produced almost full recovery from infestation (Figure 3-A) with significant difference with the spray method.

Kharj site - During the first three months, changes in recovery from apical infestation was not visible, but starting from the fourth month, the injected palm trees started to show recovery reaching almost full recovery 6 months after treatment, with significant difference compared with the control (spray) treatment (Figure 3-B).

Tayma site - Best results were obtained in Tayma site, where injected palm trees reached almost full recovery one month after injection treatment. Injected palms had almost totally recovered (very close to degree 5), with significant difference compared with the control (spray) treatment (Figure 3-C).

When results of the three sites were compared 6 months after treatment (Figure 4), all injected palm trees had almost fully recovered with an average recovery value of 4.53 (around 90% recovery). On the other hand, all sprayed palms (control) did not exceed 50% recovery. In all three sites, the difference between the two treatment methods was always significant (Figure 5).

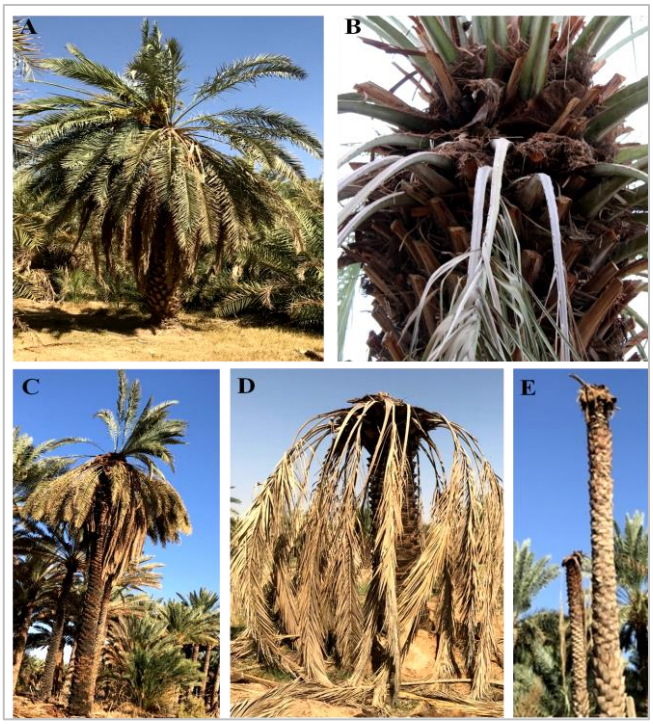

Figure 2. Evolution of the date palm apical infestation symptoms following invasion with red palm weevil observed during 2020. (A) imbalanced and deformed growth of some fronds with deviation from their original place, (B) red palm weevil infestation observed on the trunk top (characteristic shewed fibers), (C) fronds showing partial wilting and browning due to damage by red palm weevil, (D) growing apex and most of fronds dying and falling down, (E) Date palm trunk after the fall down of the growing apex and all fronds.

RPW trunk infestation treatment

Riyadh site- Among the three insecticides injected in the palm trunk, only emamectin benzoate killed all the RPW instars (Figure 6-A). The imidacloprid insecticide killed around three-quarters of the insect individuals, whereas deltamethrin killed only around 50%.

Kharj site - Results obtained (Figure 6-B) showed that emamectin benzoate injected in the date palm trunk killed all the RPW instars. The two other insecticides, imidacloprid and deltamethrin, left 25 and 50% of individual insects alive, respectively.

Dawadmi site - Again, emamectin benzoate injected in the date palm trunk was the only insecticide that killed all the RPW instars. The other insecticides (imidacloprid and deltamethrin) killed around 66% of the insect individuals (Figure 6-C).

When the effect of the three insecticides injected in the date palm trunk base at the three locations were compared, only emamectin benzoate killed all of the RPW instars infesting the plant. Insecticides imidacloprid and deltamethrin killed around 60% and 50% of the total insect individuals, respectively (Figure 7). The effect of imidacloprid and deltamethrin were not significantly different, but the effect of both was statistically different from that of emamectin benzoate (Figure 8).

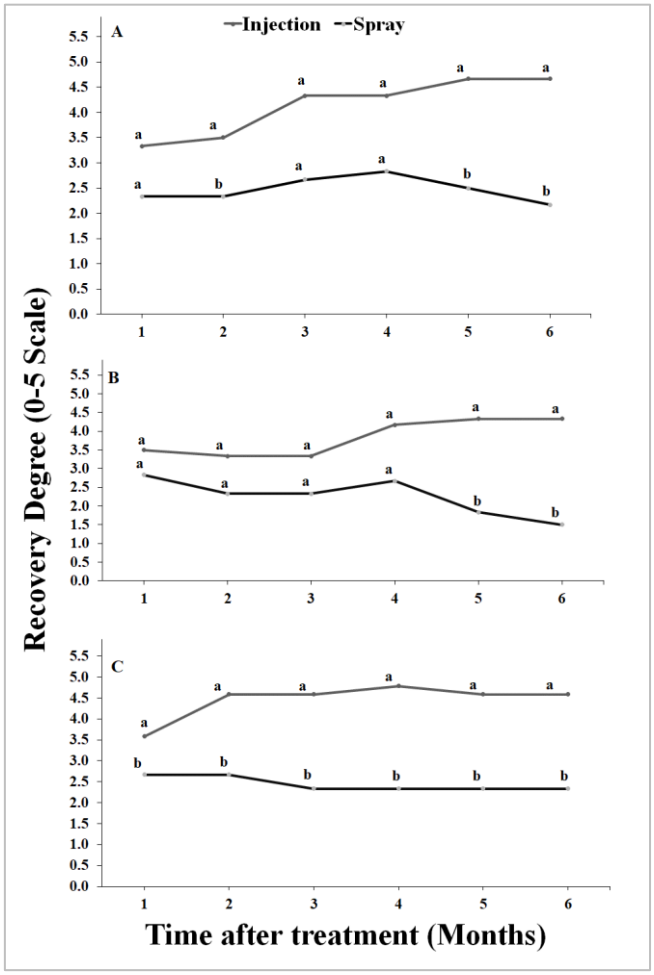

Figure 3. Effect of insecticide trunk injection by emamectin benzoate compared with tree top head spray by imidacloprid on the development of red palm weevil apical infestation of date palm trees, recorded monthly at Riyadh site (A), Kharj site (B), Tayma site (C) in 2020. For each month, values marked with the same letter in the same curve are not significantly different at P=0.05.

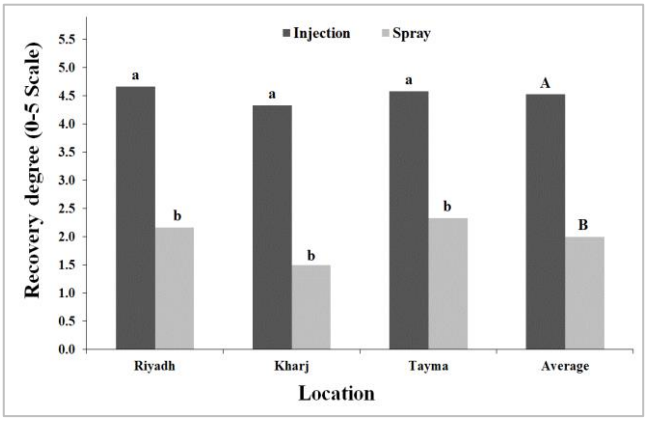

Figure 4. Comparison between trunk injection by emamectin benzoate compared with top head spray by imidacloprid, 6 months after treatment, against the red palm weevil apical infestation, at 3 different sites in 2020. For each site, values marked by the same letter are not significantly different at P=0.05.

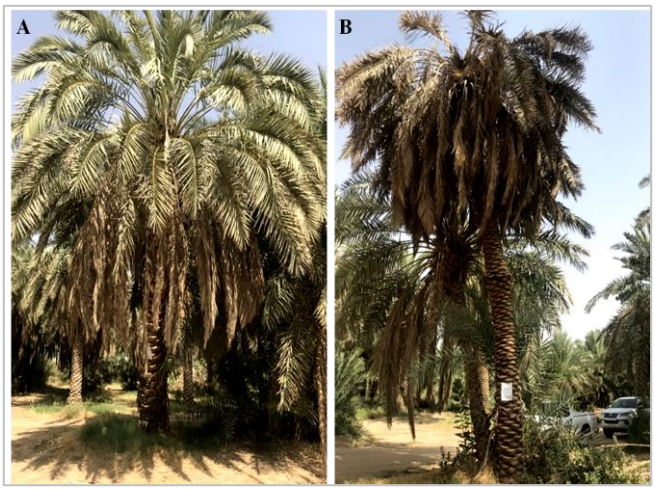

Figure 5. Comparison between injected and sprayed date palm trees infested with the red palm weevil at Kharj site in 2020. (A) Date palm tree completely recovered, 3 months after trunk injection by the insecticide emamectin benzoate, (B) Date palm tree dying, 3 months after its head spray with the insecticide imidacloprid.

Discussion

The trunk injection against Canary palm apical infestation with RPW was first reported by Hernández Marante *et al.* (2003). This approach was inspired from the trunk injection reported by Navarro *et al.* (1992) in olive trees to study pesticide movement inside the trunk. Gómez *et al.* (2009) improved and simplified this injection technique and called it "endotherapy". They utilized it as an important component of integrated RPW management. Later, trunk injection became a common technique used against RPW by several researchers (Chihaoui-Meridja *et al.*, 2020; Estévez *et al.*, 2011; Ferry & Gomez, 2014; Ferry *et al.*, 2019; Gomez & Ferry, 2013; 2019). The non-diluted insecticide emamectin benzoate injected in the palm trunk diffuses in the trunk, migrates to the top of the palm tree, and acts curatively by killing all RPW instars and/or preventively by protecting the palm head for around one year from potential new RPW infestations (Chihaoui-Meridja *et al.*, 2020; Gomez & Ferry, 2019). In the present work, the Canary palm injection method (slightly modified) was applied for the first time on the date palm and succeeded in reaching around 90% recovery of the treated date palm trees, using the same non-diluted insecticide emamectin benzoate. The small number of date palm infestations that escaped from the insecticide action was likely due to the too advanced stage of the infestation. In this case, unrecovered infested palms should be safely removed. Manufactured to basically control lepidopteran plant pests, emamectin benzoate is a translaminar but not systemic insecticide (Fanigliulo & Sacchetti, 2008).

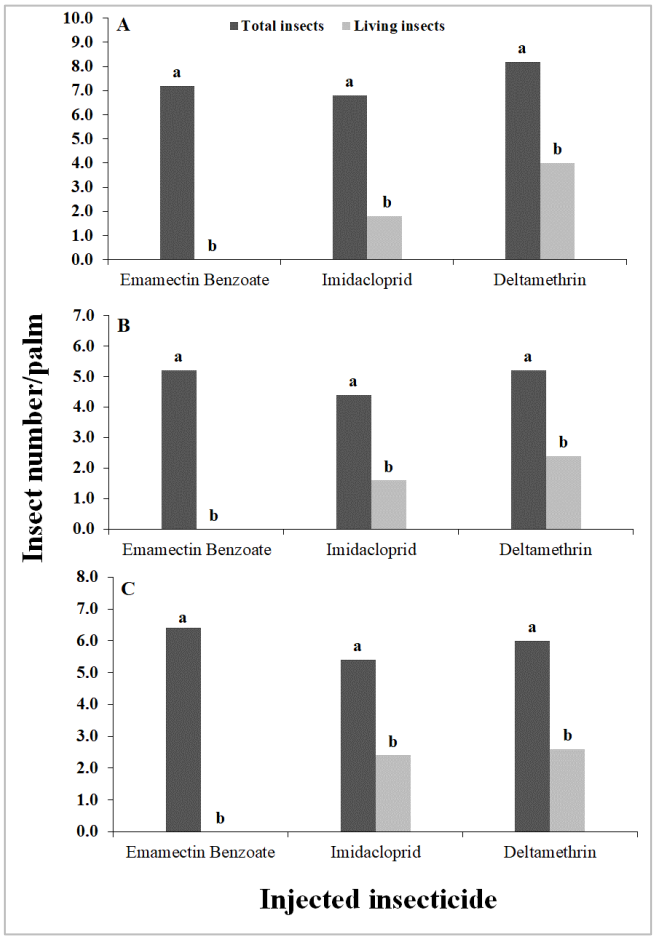

Figure 6. Comparison of the effects of three insecticides injected in the date palm trunk base, on the red palm weevil trunk infestation at (A): Riyadh site, (B): Kharj site and (C): Dawadmi site in 2020, one month after treatment. For each insecticide, values marked with the same letter are not significantly different at P=0.05.

Once injected inside the trunk, it seems to slowly migrate up and down in all plant tissues, not necessarily only in the plant vascular vessels, to reach and kill all RPW individuals. Its exceptionally very long-lasting active action protected the palm tree for one year (Chihaoui-Meridja *et al.*, 2020; Gomez & Ferry, 2019). In the present study, 86.7% to 93.3% of infested head date palm have totally recovered.

This encouraging result is obtained with an easy, simple and low-cost technique that needs only insecticide, a drill and a syringe. If extended, this method would be very much welcomed by farmers.

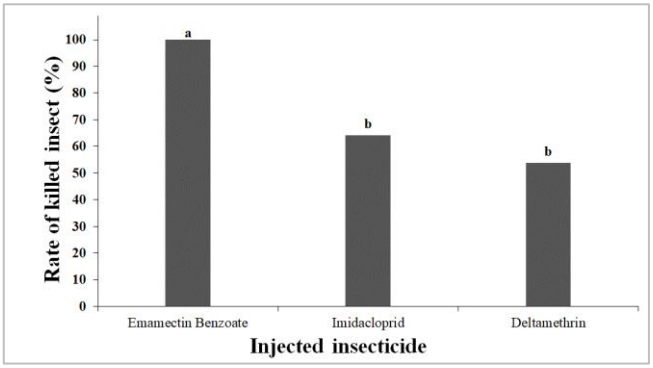

Figure 7. Comparison between the effect of three insecticides used at all sites in 2020, one month after their injection in the trunk of date palms infested with red palm weevil. Values marked with the same letter are not significantly different at P=0.05.

Regarding the injection method used against the RPW date palm trunk infestation, the non-diluted emamectin benzoate insecticide was again very efficient in killing all the RPW individuals. Such results were also recorded earlier by Mashal & Obeidat (2019) and later by Rasool *et al.* (2021). The other tested insecticides (imidacloprid and deltamethrin) were not equally efficient. The extension of this practical technique applied against the date palm trunk infestation would be good news for farmers that help them to replace an old expensive approach with a simple, effective and less costly approach.

As for trunk infestation, the number of RPW individuals per date palm tree was low, and this was similar to what was reported by Rasool *et al.* (2021), very likely because of the degradation of a certain number of larvae inside the palm trunk, one month after trunk injection. Our observation of the presence of slimy material inside the tissue of the desiccated trunk supports such view.

Figure 8. Red palm weevil individuals killed inside the date palm trunk, one month after the trunk injection with the insecticide emamectin benzoate at Kharj site in 2020.

In the future, the issue of insecticide residues in the date fruits should be investigated. In a previous work where emamectin benzoate was injected in the date palm trunk, no insecticide residues in the date fruits were detected (Mashal & Obeidat, 2019), which is very promising. In any case, more work is needed to investigate further emamectin benazoate residues in date fruits harvested from injected date palms.

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الملخص

نصراوي، بوزيد، مروان الجدوع، زكريا مسلم، عبد العزيز الشريدي، يوسف الفهيد، حمدة الشابي، موسى عسيري وأيمن الغامدي. 2024. مكافحة الإصابة بسوسة النخيل الحمراء (*Rhynchophorus ferrugineus*) في قمة وجذع نخيل التمر باستخدام تقنية حقن بسيطة وغير مكلفة. مجلة وقاية النبات العربية، 42(1): 82–87. https://doi.org/10.22268/AJPP-001222

تعدّ سوسة النخيل الحمراء أخطر آفات النخيل في جميع أنحاء العالم. بالنسبة إلى نخيل التمر، تهاجم سوسة النخيل الحمراء بشكل رئيسي الجذع، ولكن يمكن أن تُحدث أيضاً إصابات قمية كالتي تُلاحظ في المملكة العربية السعودية. إنّ هذه الإصابات القمية التي لا يمكن للمزارعين إدارتها حالياً، أصبحت مصدراً للإصابات الشديدة لأشجار النخيل السليمة الأخرى. في هذه الدراسة، أجريت تجارب لمكافحة سوسة النخيل الحمراء على نخيل التمر بطريقة حقن الجذع في ستة مواقع بالمملكة العربية السعودية خلال عام 2020، وهي طريقة بسيطة وسهلة ومنخفضة التكلفة لمعالجة الإصابات القمية والجذعية، وذلك باستخدام المبيد الحشري إيمامكتين بنزوات (50 غ/ل) أو إميداكلوبراید (200 SL) أو دلتاماثرين (2.5%). بينت النتائج أن حقن جذع نخيل التمر المصاب قميًّا باستخدام المبيد إيمامكتين بنزوات غير المخفف بالماء، يؤدي إلى تعافي 90.6% من هذه الأشجار بصورةٍ تامة. كما نتج عن استخدام تقنية الحقن المذكورة ضد الإصابات الجذعية لنخيل التمر، تحقيق نجاحٍ بنسبة

100% في قتل جميع أطوار سوسة النخيل الحمراء داخل جذع النخلة. لم يكن استخدام المبيدات الحشرية الأخرى غير المخففة، إميداكلوبراید ودلتاماثرين، فعالاً كثيراً ضدّ الإصابة الجذعية لنخيل التمر، حيث لم يتم القضاء إلا على 64.25% و 53.91% من مختلف أطوار الحشرة، على التوالي.

كلمات مفتاحية: إصابة قمية، نخيل التمر، إيمامكتين بنزوات، سوسة النخيل الحمراء، إصابة جذعية، حقن الجذع.

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