Agricultural Sciences, 4(1), 5 - 9 (1999)

A Technique to assess the Longevity of the Pheromone (Ferrolure) used in Trapping the Date Red Palm Weevil *Rhynchophorous ferrugineus* Oliv.

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طريقة لتحديد فترة دوام الفرمون المستخدم في مكافحة سوسة النخيل الحمراء *Rhynchophorus ferrugineus* Oliv. حقليا

الملخص : أصبح استخدام الفرمون التجمعي فيروجونول (٤ – ميثايل – ٥ – نونانول) من أهم العوامل في إستراتيجية المكافحة المتكاملة للقضاء على سوسة النخيل الحمراء *Rhynchophorus ferrugineus* Oliv التي تصيب نخلة التمر *Phoenix dactyliferra* L. في كافة أنحاء الشرق الأوسط . هناك نوعان من الفرمون ، فيرولور وفيرولور+ يستخدمان على نطاق واسع في الوقت الحاضر. من أجل المحافظة على استمرارية وكفاءة نظام الصيد يجب الحصول على معدل ثابت لانبعاث الفرمون في الجو الخارجي وتبديل عبوات الطعم المستهلكة بعبوات جديدة. يصبح تحديد العبوة المستهلكة أمرا صعبا خاصة عند توزيع المصايد على نطاق واسع . تهدف هذه الدراسة إلى تطوير طريقة سهلة للتعرف على تحديد فترة بقاء عبوات الفرمون صالحة والاختلاف في فترة بقائها خلال فصلي الشتاء والصيف وتحديد الكمية المنبعثة عندما تكون العبوة معرضة لأشعة الشمس. بالإضافة إلى تطوير التقنية لمعرفة حالات الطعم في عبوات الفرمون بطريقة سهلة ، أثبت هذا البحث سرعة استهلاك الطعم في الصيف عنها في الشتاء. يمكن الحصول على صلاحية أطول لعبوات الفرمون بوضع العبوة في مكان مظلل . يتساوى المركبين فيرولور وفيرولور+ في كمية إنبعاث المادة الفعالة في الجو الخارجي عند وضع العبوات في الظل ، ولكن إذا تعرضت العبوات الفرمونية لأشعة الشمس فإن الفيرولور + يبقى لفترة أطول مقارنة بالفيرولور.

ABSTRACT: The use of the aggregation pheromone, Ferrugineol (4-Methyl-5-Nonanol) has become an important component of the Integrated Pest Management strategy currently adopted to trap the red palm weevil *Rhynchophorous ferrugineus* Oliv., a pest which infests date palm *Phoenix dactylifera L.* throughout the Middle East. At present two formulations of the pheromone, Ferrolure and Ferrolure+ are widely used. In order to maintain the continuity and efficiency of the trapping system, it is essential to have a constant release of the pheromone into the environment and replace exhausted lures with fresh stocks. Identification of exhausted lures becomes difficult, especially when the pheromone trapping program is undertaken on a large scale. The present study aimed to develop an easy method to assess the field longevity of the lure, to find out the difference in longevity of lures during winter and summer and to assess the release of the chemical, when the trap is exposed to direct sunlight or is set under shade. This investigation, besides developing a handy scoring technique to assess the status of the pheromone lures, revealed that (i) the lures were exhausted faster in summer as compared to winter (ii) longer field longevity of the pheromone could be obtained by setting traps under the shade (iii) both Ferrolure and Ferrolure+ released the same quantity of the chemical into the environment under shaded conditions, but when traps had to be exposed to sunlight, Ferrolure+ lasted longer than Ferrolure.

The red palm *Rhynchophorous ferrugineus* Oliv. (Coleoptera: Curculionidae) is a tissue borer and has attained a major status on date palm in the Middle Eastern region during the mid-eighties. This pest was

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reported in Saudi Arabia during 1987. The Ministry of Agriculture and Water, Kingdom of Saudi Arabia, has adopted an integrated pest management (IPM) programme for the suppression of the pest (Abraham *et al.*, 1998).

Trapping the weevil and destroying the floating population is an effective component of the IPM strategy currently used to combat the pest. Hagley (1965) reported the use of a chemical mixture to attract both sexes of *R. palmarum* while Maharaj (1973) used metal traps with coconut petioles to trap *R. ferrugineus*. However, Kurian *et al.* (1979) proved the effectiveness of coconut logs over metal traps in trapping red palm weevil. Subsequently, Kurian *et al.* (1984) found that coconut logs treated with coconut toddy, yeast and acetic acid were significantly superior over other food combinations in trapping red palm weevil. However, Abraham (1987) in laboratory studies revealed the presence of pheromones in the male *R. ferrugineus*. Further Hallett *et al.* (1993) identified, tested and synthesized a male produced aggregation pheromone ferrugineol (4-methyl-5-nonanol), while Oehlschlager *et al.* (1993) designed a trapping system containing the pheromone, food (sugar cane) and insecticide solution to trap the pest using bucket traps. This trap was further modified by the Ministry of Agriculture and Water, Kingdom of Saudi Arabia (Anonymous, 1984) to achieve better weevil captures.

The commercial formulations of the pheromone ferrugineol viz. FERROLURE (F) and FERROLURE+ (F+) are manufactured and supplied by Chem Tica International, Costa Rica in polyethylene sachets (dispensers) each containing 700 milligram of the chemical. Ferrolure is the normal commercial formulation of ferrugineol while, Ferrolure+ contains an additive/synergist. These pheromone formulations are widely used to manage palm weevil populations in date palm through out the Middle East. In Saudi Arabia, both Ferrolure and Ferrolure+ have been used in the palm weevil management programme since 1994, using the Saudi weevil trap which is a standard 5 L capacity plastic bucket containing 1 kg of date palm stem bits or 250 g of low quality dried dates along with one liter solution of 0.1 per cent carbaryl (Abraham *et al.*, 1998). Weevil captures are related to the amount of pheromone released (Oehlschlager, 1995). It is therefore, essential to have a uniform release of the chemical into the surrounding environment, so as to maintain continuous weevil captures and efficiency of the pheromone trapping program. Hence, it is important to monitor the quantity of pheromone being released from the sachet from time to time and replace exhausted lures with fresh ones. A study was therefore, conducted in date palm groves at Al-Hassa, Kingdom of Saudi Arabia with a view to (i) determine the impact of seasonal weather conditions on the release of the pheromone into the environment (ii) assess the influence of trap placement (trap exposed to direct sun or under shade) on the release rate and (iii) find out differences in the release rate of the pheromone between F and F+, if any. The results obtained are furnished below.

Materials and Methods

During 1996, studies were conducted in Al-Hassa on the amount of chemical remaining intact in a given lure at different periods of exposure in the field by observing the status of 10 sachets each of F and F+ lures at fixed periodic interval of 21 days until the sachets were nearly empty. The study was conducted over a period of one year to represent the highly varying winter and summer weather conditions of the Middle East, as per the treatment schedule mentioned below from 3 October 1995 to 16 November 1996. To cover the entire period of one year, the longevity of three batches of pheromone lures had to be assessed. The treatments were as follows:

Treatments	Type of lure	No. of Traps
T1 : Trap exposed to direct sunlight	F+	5
T2 : Trap in shade of palm canopy	F+	5
T3 : Trap exposed to direct sunlight	F	5
T4 : Trap in shade of palm canopy	F	5

In order to measure the amount of pheromone in a given lure at different intervals and assess its longevity in the field, the quantity of intact pheromone in the sachet was assessed by visual observation, using the following grade index. The bluish color of the pheromone in the sachet made visual observation easy.

Grading Index

Score values	Status of pheromone lures
4	100% of the pheromone intact (new lure)
3	75% of the pheromone intact
2	50% of the pheromone intact
1	25% of the pheromone intact
0	No pheromone left in the sachet

The quantity of the lure remaining intact between two score values was assigned a score in decimal units, wherein one percent of the chemical was scored as 0.04. For example, if 90 percent of the pheromone was intact, then a score of 3.6 was assigned.

The average percent pheromone remaining intact was measured using a formula:

$$\frac{Y}{n} \times 25$$

Where Y is the total of the assigned score obtained in a batch and n the number of lures observed. 25 is the constant obtained by dividing 100 by 4 which represents a new lure.

Results and Discussion

From Table 1 it is evident that the amount of chemical remaining in the sachet decreased progressively with time. Initial studies on mating disruption of the black-headed fire worm *Rhopobota naevana* (Hubner) using pheromones showed that the amount of pheromone remaining in the dispenser in the field declined linearly and slowly over a period of time (Fitzpatric *et al.*, 1995). In the present study, however, besides the progressive decline of the chemical in the dispenser, a distinctive difference in the winter and summer release of the pheromone was seen. Lures set in the winter months released the chemical at a slower rate as compared to the pheromones set in the field during the summer months.

Lures set during October 1995 (batch-I) remained in the field for 27 weeks throughout the winter season and had to be replaced by the middle of May 1996 when on an average 4.22 percent of the pheromone was intact. It may be noted that the weevil capture during the last week prior to replacement with new sachets was 381 weevils in Al-Hassa, while 307 weevils were trapped during the first week following replacement. The decrease in the weevil catch using new lures can be attributed to the sudden increase in the maximum daily temperature. However, even at low quantity of less than 4.22 percent of the pheromone, the weevil attracting capability of these lures was maintained.

TABLE 1

Quantity of the red palm weevil pheromone remaining intact in the sachets at periodic intervals when exposed in the field under different conditions

Treatments	Percent pheromone remaining intact at week								
	3	6	9	12	15	18	21	24	27
Batch I (03.10.1995 to 02.05.96)									
T1 : Trap exposed to sunlight with F+	97.50	62.50	51.20	40.80	31.30	28.13	16.25	10.63	4.38
T2 : Trap in shade with F+	97.50	87.50	75.40	63.20	52.92	43.13	28.12	20.63	5.00
T3 : Trap exposed to sunlight with F	97.50	70.83	46.21	32.13	21.30	12.50	5.00	1.20	0.00
T4 : Trap in shade with F	97.50	88.13	76.30	64.60	54.80	46.50	31.50	23.50	7.50
Average pheromone intact	97.50	77.24	62.27	50.18	40.08	32.57	20.22	13.99	4.22
Batch II (12.05.96 to 10.08.96)									
T1 : Trap exposed to sunlight with F+	*	13.50	3.00	1.50					
T2 : Trap in shade with F+	*	22.50	6.67	2.50					
T3 : Trap exposed to sunlight with F	*	8.75	2.50	0.00					
T4 : Trap in shade with F	*	25.00	8.33	1.25					
Average pheromone intact	*	17.43	5.13	1.31					
Batch III (21.08.96 to 16.11.96)									
T1 : Trap exposed to sunlight with F+	47.50	21.00	9.00	2.50					
T2 : Trap in shade with F+	70.00	38.33	10.83	3.33					
T3 : Trap exposed to sunlight with F	43.75	18.75	2.50	0.00					
T4 : Trap in shade with F	76.50	40.00	17.50	6.50					
Average pheromone intact	59.31	29.52	9.96	3.08					

* not observed

Further, it was seen that lures set in May 1996 released the chemical much faster as compared to batch-I and had on average 1.31 percent of the chemical intact at the end of 12 weeks. The lures had to be replaced with new ones by the end of August 1996. From Table 1 it is also evident that the lures set during August 1996 had to be replaced with fresh lures during the first week of December 1996. Similar to the batch-II, the chemical in batch-III also got almost exhausted after 12 weeks when, on average, there was 3.08 percent of the chemical intact. Thus, the two summer batches (batch-II and batch-III) exhausted the chemical in just over 12 weeks, and lures containing on average only 1.31 and 3.08 percent of the chemical, respectively, captured 66 and 95 weevils. A week after replacing the lures, in these two batches a total of 59 and 63 weevils were captured, respectively. This shows that even at a low quantity of less than five percent, the lures in all three batches were capable of capturing weevils, maintaining the efficiency of the trapping system.

The present study further aims to assess the influence of either exposing the trap to sunlight or setting it under shade, on the release of the pheromone from the sachet. From Table 1 it can be seen that during both winter and summer, traps exposed to direct sunlight exhausted the pheromone faster as compared to traps set in the shade. In batch-I, studied during the winter months, traps exposed to sunlight with F+ lures had 31.3 percent of the chemical intact after 15 weeks as compared with 59.92 percent of the pheromone remaining intact in sachets set in traps under shade. By the time the lures in batch-I were replaced with new stock, traps under shade contained more quantity of the chemical as compared to traps exposed to sunlight. This was also true for batch-II and batch-III studied during the summer months. Furthermore, the study revealed that under shade both Ferrolure and Ferrolure+ contained almost the same amount of the chemical after being in the field for the same period of time. This is seen in Table 1 (T2 and T4) where traps set in shade during winter had almost the same amount of chemical intact in both F and F+ after 24 weeks. This also holds good for the summer batches.

However, if traps have to be exposed to sunlight, then better field longevity could be obtained by using Ferrolure+ (Table 1). In batch-I at the 18th week, traps in sun with Ferrolure+ had 28.13 percent of the chemical as compared to only 12.5 percent of the chemical in traps with Ferrolure. Similar results were seen with respect to batch-II and batch-III.

Conclusions

The findings of this investigation showed that the male produced aggregation pheromone used for trapping red palm weevil on date palm in the Middle East exhausted the chemical much faster in summer as compared to winter. In addition, traps exposed to direct sunlight released the pheromone faster as compared to traps set under the shade. Finally, both Ferrolure and Ferrolure+ released the chemical at a uniform rate under shade, but when traps were exposed to sunlight, F+ lasted longer in the field as compared to F.

Depending upon the prevailing weather and trap exposure conditions in the field, pheromone lures, used on a large scale, have different field longevities which may vary for a few weeks. Furthermore, determining the status of each lure in a large scale trapping programme is difficult. Hence, using the present technique of grading lures for their longevity, observations on a small sample will help in predicting the average quantity of the intact pheromone in the sachets at a given time. Based on this prediction one can plan the replacement of pheromone lures. As discussed above, even at quantities of less than five percent of the chemical, the weevil capturing potential of the trapping system is not impaired. Hence, when the average quantity of the chemical is exhausted even further the lures can be replaced to maintain the continuity and efficiency of the trapping programme.

The grading index devised to assess the amount of pheromone present in the lure (dispenser) forms an efficient tool which enables the identification of exhausted lures and their replacement with new stocks. Also, the quality of the material procured in each batch can be closely monitored.

Acknowledgement

The authors are thankful to the Ministry of Agriculture and Water, Kingdom of Saudi Arabia, for granting permission to publish this article. We are also thankful to the Directorate of Agriculture and Water, Al-Hassa for providing all facilities to carry out the trial.

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