USE OF BIO-PESTICIDE -

NEW DIMENSION AND CHALLENGES FOR SUSTAINABLE DATE PALM PRODUCTION

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1. Larva in a date palm trunk

Abstract

According to the WHO, 1990 report, 25 million cases of acute occupational pesticides poisoning in developing countries each year. The environmental hazards resulting from half a century's intensive use of synthetic organic crop protection agents makes it imperative to consider alternative or complementary approaches to sustainable agricultural development and integrated pest management.

Date palm, Phoenix dactylifera L., is one of the oldest fruit trees in the world and is mentioned twenty times in the Qur'an and several times in Bible. The number of the date palms is about 100 million worldwide, of which 62 million palms can be found in the Arab world. The aim of this study was to identify and evaluate suitable and new plant extracts with eco-friendly activities against endoparasitic Larval Red Palm Weevil, Rhynchophorus ferrugineus Oliver found in Date Palm tree (Phoenix dactylifera L). These weevils are so effective that even a single pest if present destroys the tissues of the trunk of the tree, resulting therein the falling of the palm tree. Biopesticides of plant origin could be the key to the future. Biopesticides, as aware, are an important group of pesticides that can reduce pesticide risks having a narrow target range and a very specific mode of action it suppress, rather than eliminate, a pest population.

Biopesticides are inherently less harmful than conventional pesticides. Biopesticides are designed to affect only one specific pest or, in some cases, a few target organisms, in contrast to broad spectrum, conventional pesticides that may affect organisms as different as birds, insects, and mammals. Biopesticides often are effective in very small quantities and often decompose quickly, thereby resulting in lower exposures and largely avoiding the pollution problems caused by conventional pesticides. When used as a component of Integrated Pest Management (IPM) programs, biopesticides can greatly decrease the use of conventional pesticides, while crop yields remain high.

Biopesticides play an important role in providing pest management tools in areas where pesticide resistance and environmental concerns limit the use of chemical pesticide products. Keeping in view the above fact ZCHRTM worked on Biopesticide Management Program.

Keywords: Integrated pest management, Phoenix dactylifera, Cosmopolitan, Agricultural development, Arab world, Rhyncophorus ferrugineus Oliver.

Introduction

The date palm is believed to have originated in the lands around the Persian Gulf and in ancient times was especially abundant between the Nile and Euphrates rivers. The date has been traditionally a staple food in Algeria, Morocco, Tunisia, Egypt, the Sudan, Arabia and Iran. The founder of UAE attached a great importance to agricultural development in general, and to the date palm in particular. This attention is clearly evident in the fast growth in the number of palm trees in the continued increase in the size and variety of date products, in the extensive use of modern technologies, and in the important initiatives undertaken in the areas of manufacturing and marketing of date fruit. Over and above it is one of the 20 plants & vegetables discussed in Holy Qur'an. The plants mentioned in the Holy Qur'an have special significance not only because of their properties and uses but also on account of their relevance to the events and happenings associated with them.

Quranic Name : Al Nakhl; Al-Nakhil

Botanical Name : Phoenix dactylifera Linn. (Family Arecaceae)

Common Name : Date Palm

Quranic References

1. SURA II (Baqara the Heifer). V:266
2. SURA VI (Anam-cattle). V:99
3. SURA VI (Anam-cattle). V:141
4. SURA XIII (Raad-Thunder). V:4
5. SURA XVI (Nahl- The Bee). V:11
6. SURA XVI (Nahl- The Bee). V:67
7. SURA XVII (Bani Israel-The children of Israel) V:91
8. SURA XVIII (Kahf-the cave) V.32
9. SURA XIX (Maryam-Mary). V:23
10. SURA XIX (Maryam-Mary). V:25
11. SURA XX (Tatta-Mystic Letter, T.H) V:71
12. SURA XXIII (Mu-min-The Beleivers). V:19
13. SURA XXVI (Shu araa-The Poets). V:148
14. SURA XXXVI (Yasin- The abbreviated letters). V:10
15. SURA L (Qaf-Abbreviated letters). V:34
16. SURA LIV (Qamar-The Moon). V:20
17. SURA LV (Rahman- God most gracious) V:11
18. SURA LV (Rahman- God most gracious) V:68
19. SURA LXIX (Haqqa-The sure reality). V:7
20. SURA LXXX (Abasa-He frowned). V:29

2. Adult red palm weevil emerging from its cocoon

Medicinal uses

Besides its food value, the fruit, because of its tannin content, is used medicinally as a detersive and astringent in intestinal troubles. In the form of an infusion, decoction, syrup or paste, is administered as a treatment for sore throat, colds, bronchial catarrh. It is taken to relieve fever, cystitis, gonorrhea, edema, liver and abdominal troubles. And it is said to counteract alcohol intoxication. The seed powder is an ingredient in a paste given to relieve ague. A gum that exudes from the wounded trunk is employed in India for treating diarrhea and genito-urinary ailments. It is diuretic and demulcent. The roots are used against toothache.

Red Palm Weevil

The red palm weevil (RPW), Rhynchophorus ferrugineus Oliv., also called the Indian palm weevil, is well known in the Middle East where it causes severe damage on date palms (Table 1). The RPW was first noted in the Arabian Peninsula in the mid 1980's and in Egypt in 1992. The weevil was first observed in Ras El Khaima, United Arab Emirates in 1985. Approximately, 5 to 6 % of palms in the Middle East region are infested with the RPW with an annual rate of infection of about 1.9 (Table 2).

The rate of infestation is about 2.02 (1300 x5 = 44000) and about 1.70 (1000 x9 = 120,000) for the United

Arab Emirates (UAE) and the Kingdom of Saudi Arabia (KSA), respectively. The average rate of annual infestations could be 1.9. (Infestation year n = infestation year (n-1) × 1.9). The RPW was wrongly classified as a coconut pest. Indeed, as early as 1970, the RPW was found in India attacking date palms (Khawaja and Akmal, 1971). The first warning came from Dr. Djerbi (1983) who was the first to realize the danger and to invite date growing countries to conduct studies on the biology of this pest, and on appropriate control measures. According to Dr. Oehlschlager (1998), there are five species of palm weevils in the genus Rhynchophorus that are economically damaging to palms (Table 3). Up to December 1998, the following countries are officially declared as having the RPW infestation: Australia, Burma, China, Egypt, India, Indonesia, Iran, Iraq, Malaysia, Pakistan, Papua New Guinea, Philippines, Saudi Arabia, Sri Lanka, Taiwan, Thailand, Tanzania, UAE and Vietnam. According to Prof. Zaid (1999), three more countries are added to the above mentioned list (Jordan, Israel and Palestine): On April 21,1999, Prof. Zaid identified by e-mail scanning, the photo of the first red palm weevil found in Jericho (Palestine). On May 6, the weevil was found in Jordan (in Shunae), few kilometres north-east of Jericho. On May 14, another weevil was found in Israel, along the Jordanian border at Moshav Yafi t (15 km north of Jericho).

The red palm weevil is one of the most destructive and dangerous pests for date palm in Asia and the Middle East. It has caused mass destruction in palm-tree plantations in Egypt and the Gulf countries. It also attacks coconut trees, sugar cane, and various ornamental trees. The red palm weevils are large insects (greater than 25 mm long). They are found over a very wide geographical area involving different climates. This pest lays its eggs on the bark of the palm tree; the grubs eventually hatch, drill into the trunk and eat the entire inside of the tree. Under heavy attack, the tree weakens and inevitably dies. The weevils are attracted to dying or damaged parts of palms, but also attack undamaged palms. The damage is caused by the larvae that bore through the soft tissue such as the tree crown, the upper part of the trunk and at the base of the petioles. On average, females lay 260 eggs which take 3 days to hatch. The larval period takes two months and the pupal period, three weeks. These figures vary across different regions. The females use the rostrum to bore into the plant tissue to form a whole in which they lay their eggs. This occurs most frequently in crowns which have been damaged.

Normally, the Red Palm Weevil prefers to infest palms below the age of 20 years, where the stem of the young palm is soft, juicy and easily penetrated. The weevils are destructive pests to palms. The larvae are responsible for damaging the palm, and once they have gained access, the death of the palm generally ensures. The larva normally never comes to the surface, since it begins its life inside the palm. Therefore, neither the damage nor the larva can be seen. However, the trunk of the palm can be infested in any parts, including the crown. The damage caused by a few larvae of the weevil is astonishing. Even one larva may cause considerable damage, and, sometimes the death of the palm. It is difficult to assess the actual loss caused by this pest, but undoubtedly it affects the production of date palms.

Control

The challenge is to detect the presence of the weevil early enough so the tree can be saved. There are no external signs that would indicate that a tree has been infested; the leaves remain green up to the moment the tree falls over, its insides devoured. The thumb-sized grubs make so much noise eating that if you stand next to an infested tree you can actually hear them munching their way through the trunk. Another sign of infestation is a red gelatinous substance which has a putrid odor and which leaks out as the grubs feed. But by the time the smell can be detected by humans, it's too late for the tree: it must be cut down and burnt, otherwise the larvae will begin attacking nearby trees. In the Gulf region agriculture experts are testing a new method of fighting the red palm weevil using a harmless fungus: the Brazilian bioactive fungus which may be an effective deterrent because it has the ability to destroy the pest in the larval stage.

Another method involves pheromones which attract the red weevil, then an insecticide in a bucket attached to the trunk of the tree would kill it. But the problem is only partially solved because the larvae continue to thrive in the trunks of the palm trees and emerge as full-grown insects. Another strategy involves collecting mature weevils and injecting them with a poison which prevents them from reproducing and results in the death of any female they mate with. They are being implemented in UAE and Saudi Arabia. The Ministry of Agriculture and Fisheries of UAE has introduced Acecap capsules in its Integrated Pest Management (IPM) to fight the red palm weevil. The Acecap capsules are introduced in small holes in the trunk. The larvae are killed by the active components of the capsule that are absorbed through the trunk (each Acecap capsule contains 875 milligram of active Acephate). Each tree uses between seven to 10 capsules annually depending on the degree of infestation. A tree can be cured in two months and will stay healthy for a year. Acecap capsules are used in Saudi Arabia, Kuwait and Oman.

The Department of Agriculture and Fisheries of UAE set up a technical committee to help fight the red palm

weevil. Its directives include using nematodes to fight the larvae. The nematode is injected into the trunks of infected palm trees. Once inside, they remote-sense the weevils, penetrate into them and then release a deadly bacterium which kills them through blood poisoning within 72 hours. To concentrate the destructive weevils in one place and kill them, the project is using two naturally occurring substances known as aggregation pheromones and kairomones. Pheromones are chemical compounds produced in minute quantities by male weevils which cause them to gather in a hotspot. Kairomones are compounds emanating in tiny quantities from the fresh scars of trees that have been recently pruned. These two compounds are used to lure, trap and kill the weevils in mass quantities. But first the team has to locate the infected palm groves. By using satellite remote sensing and imaging technology they aim to build up a comprehensive picture of the weevils' geographical distribution across Saudi Arabia. Once a weevil infestation is located from the air through color changes, the priority is to eradicate the focus and prevent the pest from spreading to healthy plantations.

The environmental hazards resulting from half a century's intensive use of synthetic organic crop protection agents makes it imperative to consider alternative or complementary approaches to sustainable agricultural development and integrated pest management. Biopesticides of plant origin could be the key to the future. Indeed, in the past thirty years, advances in analytical chemistry and molecular biology have led to a better understanding of the interactions between plants and pests, and the communication mechanisms between organisms.

Biopesticides

Biopesticides are inherently less harmful than conventional pesticides.

Table 1. Distribution of red palm weevil in the Near East

Country	First Recorded	Area/Location Infested
Qatar	1985	Doha
UAE	1985	Ras El Khaima
Saudi Arabia	1987	Katiff
Egypt	1992	Salheya, El-Tal El Keber and El-Kassasin
Kuwait	1993	Throughout
Oman	1993	Buraimi, Mahadha, Masandam Governorate
(Source FAO, 1995)		

Table 2. Evolution of affected date palms

	Year		Year	
UAE	1990	1,300	1995	44,000
KSA	1987	Less than 1,000	1996	120,000

Table 3. Rhynchophorus species damaging palms

Species	Palm Hosts	Region
Rhynchophorus ferrugineus	Date	Middle East
Rhynchophorus vulneratus	Coconut	South East Asia
(Same species)	Oil	South East Asia
Rhynchophorus bilineatus	Coconut	Papua New Guinea
Rhynchophorus cruentatus	Sabal	Florida
Rhynchophorus phoenicis	Coconut Oil, Date	Tropical Africa
Rhynchophorus palmarum	Coconut Oil	Central and South America
Source: Oehlschlager, 1998		

Biopesticides are designed to affect only one specific pest or, in some cases, a few target organisms, in contrast to broad spectrum, conventional pesticides that may affect organisms as different as birds, insects, and mammals. Biopesticides often are effective in very small quantities and often decompose quickly, thereby resulting in lower exposures and largely avoiding the pollution problems caused by conventional pesticides.

When used as a component of Integrated Pest Management (IPM) programs, biopesticides can greatly decrease the use of conventional pesticides, while crop yields remain high. To use biopesticides effectively, however, users need to know a great deal about managing pests.

Generally, all biopesticides exhibit the following characteristics:

Narrow target range, highly specific mode of action, suppress pests, not eliminate, critical timing of application, limited field persistence, short residual effect, safer to environment and safer to people. Their use is best

as part of an Integrated Management Program (IPM).

Materials and Methods

Azadiracta indica; leaf extract, seed kernel extract

Annona squamosa; seed extract (Indian), seed extract (Australian)

Capsicum frutenscens; pod extract (pericarp and seeds)

The above parts of all the plants in their vegetative stage were collected from Abu Dhabi, UAE. The specimen of the materials, as specimen Nos.435-440/ ZCHRTM, are preserved in the herbarium of the Zayed Complex for Herbal Research Centre, UAE for record. These plant materials, dried under shade and processed using standard methods. The water and 70% alcoholic extracts were prepared using Rotaroy Evaporator – Buchi Rotavapor (R-153) fitted with a chiller. The powdered materials were used for fluorescence analysis and successive extraction using soxlet extractor. The quality control studies of the powdered aerial parts of all plants and their water &70% alcoholic extract were performed using standard procedures from different Pharmacopoeias. To develop the thin layer chromatograms, silica gel 60F254 precoated glass plates (Merck, Darmastadt) were used. The TLC plates were developed in solvent systems Benzene: Pyridine: Formic acid (36:9:5) and Toluene: Ethyl acetate (93:7), comparative studies were made using authentic samples .The TLC plate image was captured with the CAMAG Videostore 2 (Switzerland) under visible light. For IR fingerprints pellets, prepared by mixing the dried raw materials / extracts with KBr in 1:100 ratio, were scanned in Perkin Elmer Paragon 1000 FT-IR spectrometer in the scan range of 4000-400cm-1. The UV spectra were recorded on Spectronic Genesis 2 Spectrometer (Milton Roy, USA) fitted with a 8-position multi cell holder. Extraction was performed using Dionex ASE-200 Accelerated Solvent Extractor (USA). For HPLC studies Waters 600E analytical HPLC attached with UV / VIS detector and controlled by Millenium (ver. 2.15) software was used. 100 mg of 10% alcoholic extract was dissolved in 10 ml of distilled water and centrifuged for 10 minutes. The supernatant liquid was passed through a Sepak C18 cartridge equilibrated with 5 ml of methanol and 10 ml of water. The cartridge was eluted with two 15 ml portions of methanol. All the eluents were pooled together, dried and re-dissolved in 10 µl of methanol. 25 µl of this solution was injected in to the HPLC µBondapak C18 (3.9 x 300 mm 10 µm 1250A).

Quantitative analysis of the 70% alcoholic extract for different organic constituents were performed using modern methods. The ash of the powdered material was quantitatively analyzed for inorganic chemical constituents using atomic absorption spectrophotometer. For the centrifugal partition chromatography, Pharma-Tech CCC-1000 Instrument was used. Representative morphoanatomic characteristics were assigned by the help of Leica Microscope equipped with a JVC colour video camera connected to a computer and printer.

No	Plant extract	Conc.	Total no. of Larvae	Live
1	Azadiracta kernel + water	6%	4	2
2	Annona kernel + water	6%	4	2
3	Annona + Azadiracta + water	6%	4	0
4	Azadiracta leaf + water	6%	4	2
5	Annona + Capsicum + water	6%	4	3
6	Azadiracta kernel + Capsicum + water	6%	2	2
7	Azadiracta kernel + Annona + Capsicum + water	6%	4	0
8	Dichlervos + water	6%	4	0
9	Water only		4	4

Trials were conducted 'invitro' in the lab nine petridishes were taken and in each of the petridishes 4 large uniformly sized larval Red Palm Weevil were taken along with some plant fibers. Each petridish was numbered starting from 1 to 9. Each petridish was poured with mixture of plant extract and water in ratio of 3 gm of the plant extract to 50 ml water. The larvae were allowed to be in the petridishes filled with trial plant extract water for about 10 minutes.

Sample contents: Sampling in petridish

Azadiracta kernel + water

Annona squamosa kernel + water

Azadiracta leaf + water

Annona kernel + Capsicum + water

Azadiracta kernel + water

Azadiracta + Annona + Capsicum + water

Dichlorves 50% E.C + water (insecticide)

Water only (control)

Each of the above mentioned plant extract and insecticide is mixed with water at the concentration of 6% (that is 8 g in 50 ml water). If two extracts are mixed then they are mixed 4 g each in 50 ml of water. In the last petridish water alone was kept as a control.

Results and Discussion

Observation - Larvae were allowed to be in the mixture in the petridishes for about 10 minutes. Then the larvae were removed and were spread on bloating papers separately to wipe out excess plant extract / insect water from their bodies. Then they were observed for the effect of the test so on the larval mortality and the follow results were observed.

Inference - The mixture, viz. 3-, Annona + Azadiracta + water; 7- Azadiracta + Annona + Capsicum + water and 8- Dichlorvos + water gave 10 larval mortality while others gave mortality in varying degree

Result - Annona squamosa and Azadiracta indica extracts with or without Capsicum extract gave 100% mortality percentage which is also the case of the insecticide Dichlorvos which is a organophosphoric insecticide can be replaced and substituted with the botanical extracts.

Identified and evaluated suitable and new plant extracts with eco-friendly activities against endoparasitic Larval Red Palm Weevil, Rhynchophorus Ferrugineus oliver found in Date Palm tree (Phoenix dactylifera L). Biopesticides of plant origin could be the key to the future sustainable date palm production. The above two plant extracts have been found very effective to kill the aforesaid pest insects: Azadirachta indica (Neem) Seed and seed kernel and Annona sqamosa.

As the botanical extracts of Annona and Azadiracta have a promising results in the larval Red Palm Weevil i.e. the in vitro studies in the laboratory showed 100% mortality of these larvae. In vivo studies on infected live tree are under progress to reconfirm and is expected to give very encouraging results. Application of these biopesticides will not affect the taste and behavior of the date palm fruits as it is affected by the application of organophosphorous insecticide/ pesticides earlier. Further experiments are under progress. This programme has not only of national significance but if proved successful, would be applicable worldwide for the sustainable growth of date palm production.

Reference

Chapter XII. Disease and Pest of Date Palm. A. Zaid, P.F. De Wet, M. Djerbi and A. othabi and the references therein.