Review Article

The Rhinoceros Beetle *Oryctes agamemnon arabicus* in Tunisia: Current Challenge and Future Management Perspectives

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ABSTRACT

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Oryctes agamemnon arabicus was signaled in the oases of Southwest Tunisia in 1995, its only host-plant is date palm tree (*Phoenix dactylifera*). Favorable development sites are the standing alive palm tree with its different parts. Female laid about 27 eggs. Adults fly at night and during day they shelter in their development sites. They feed occasionally on the juice extracted from respiratory roots. Their roles are limited to reproduction and dispersion of the species on short distances. Larvae stand as the harmful stages of the species and none the adults. Larvae damages affect different levels of the tree: respiratory roots, superficial part of stem (fibrilium, stem bark and midrib) and the lower part of the crown, which are the breeding sites of the immature stages. The most severe damage is related to respiratory roots, basal support of the palm tree, and secondary to crown periphery. Management of the species is above all preventive targeting mainly the breeding sites to reduce population. Quarantine measures by the restriction of offshoots movement impede the spread of the pest to new zones, cultural techniques target the control and the destruction of development sites and traps of different type attract adults. All these methods reduce enormously the population inside plantations.

Keywords: Damages, date palm, distribution, life cycle, management, *Oryctes agamemnon arabicus*, Tunisia.

INTRODUCTION

Date palms, *Phoenix dactylifera*, are considered as one of the most economically important fruit trees in Arab world. These trees and their fruits are subject to depredation by several serious insect pests (17). Among these insects, the genus *Oryctes* (Coleoptera: Sacarabaeidae) was represented by several species in date palm orchards of many Arabian countries as *O. elegans*, *O. agamemnon* and *O. rhinoceros* (1); all of them known as rhinoceros beetle. In Arabian Peninsula, *O. agamemnon* is widespread in Gulf countries as Kingdom of Saudi Arabia, United Arab Emirates, Sultanate of Oman (1), and recently in Tunisia (6) where its mainly registered host is date palm tree.

Historically, *O. agmemnon arabicus* was accidentally introduced in Tunisia for the first time at the end of 70's decade from the oasis of United Arab Emirates (13) into the oases of Mrah Lahouar belonging to the governorate of Tozeur (6), and this as part of varietal exchange

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between both countries. Closely linked to palm tree, it stands as the only registered species of the genus *Oryctes* in some plantations of Southwest Tunisia (14).

However, from its introduction to the first report of its severe damage, expressed by the sudden collapse of many productive palm trees in 1995, *O. agamemnon arabicus* populations have considerably grown up and this species has become a major pest of date palm tree in this region. Few research studies are focused in this species which threat increases each year in infested oases: despite this danger; no serious control programs were set up against this beetle (14).

The aim of this paper is to develop a management strategy based on field studies conducted during the last fifteen years, to fight *O. agamemnon arabicus* in date palm plantations of Southwest Tunisia.

INSECT DESCRIPTION

Adult of *O. agamemnon arabicus* are stocky, stout, black or reddish black in color with shining aspect. They measure 30-57 mm in length and 14-21 mm in breadth. The male is characterized by a curved cephalic horn and a large depression on the pronotum (Fig. 1), both characters are rudimentary and sometimes absent on female. The pygidium is clothed by reddish brown hairs which are more densely in female than male (13).

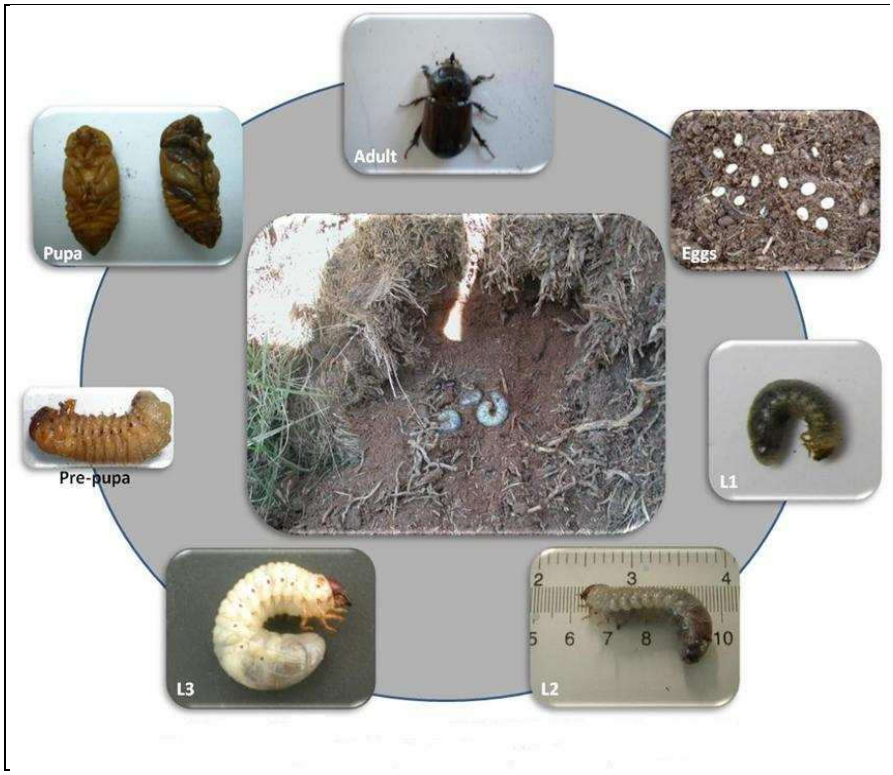

Fig. 1. Holometabolous life cycle of *Oryctes agamemnon arabicus* and an example of damage on the respiratory root parts of date palm tree (13).

After eggs hatching, life cycle completed through three distinguish larval stages and a pupal period. At full development, length of larva of third stage, which is the most destructive in the field, can exceed 90 mm (13).

Current distribution

Delimiting surveys performed in 2006 indicated that the infestation was restricted to some oases of extreme

Southwest, from Tozeur and Kebili governorates (Fig. 2), and permitted also to mark out the historical spread of the species in this zone. Based on the collected data, the historical spread of *O. agamemnon arabicus* was characterized by two distinguished periods (14).

Fig. 2. Geographical localization of the date palm oases in Southwest Tunisia (Djerid and Nefzaoua) (satellite photo, Google Earth).

Before 1987, the spread of this species was limited to Mrah Lahouar oases (387 ha) situated 5 Km in the West of Tozeur town just on the North edge of Chott El Djerid (F1 in Fig. 3). However, initially introduced in little numbers (15 larvae of third stage maximum), adult beetles of first generations secured by their reproductive activity, the growth of the population and then its continuity and perpetuation in this new environment. In addition, adults, the only mobile and observed stage out of the palm tree, assure the local and progressive spread of the pest between adjacent or bordered oases. Infestation reached the oasis of Dhraa El Janoubi located at 100 m in the West of Mrah Lahouar and which cover 200 ha. So, preliminary and based on this information, it is important to mention that flight activity can be considered as the most likely method of spread on short distance both within and between adjacent date palm plantations (14).

Fig. 3. Distribution of *O. agamemnon arabicus* in the oases of Djerid zone (Tozeur): F_1: Mrah Lahouar and Dhraa El Janoubi, F_2: Ibn Chabbat, F_3: Dhafria, F_4: El Oudia I et II (satellite photo, Google Earth).

After 1987, the lack of necessary primary plant material to achieve the plantation of Ibn Chabbat oases (F_2 in Fig. 3), located 5 Km in the North of Mrah Lahouar and in South of Chott El Gharsa, leaded to use offshoots originated from infested oases of Mrah Lahouar. This action permitted the spread of *O. agamemnon arabicus* between distant oases both in intra- and inter- regional level. In early 90's, the same case occurred in the five localities of Rjim Maatoug zone (1434.5 ha) located in the extreme Southwest of Kebili governorate and approximately 8 Km on the South edges of Chott El Djerid (F in Fig. 4), the lack of offshoots in Kebili oases imposed the use of offshoots originated from Ibn Chabbat oases (800 ha), both to continue the plantation process and to replace the lacks which favored more pest spread. During the 90's decade and from Ibn Chabbat oases, the major site of the spread, *O. agamemnon arabicus* reached the oases of El Oudia (40 ha) and El Dhafria (250 ha) both situated in the North of Tozeur governorate (F_3 and F_4 in Fig. 3). Thus, the most likely mode of spread between regions and distant plantations is with offshoots removed from infested plantations (14).

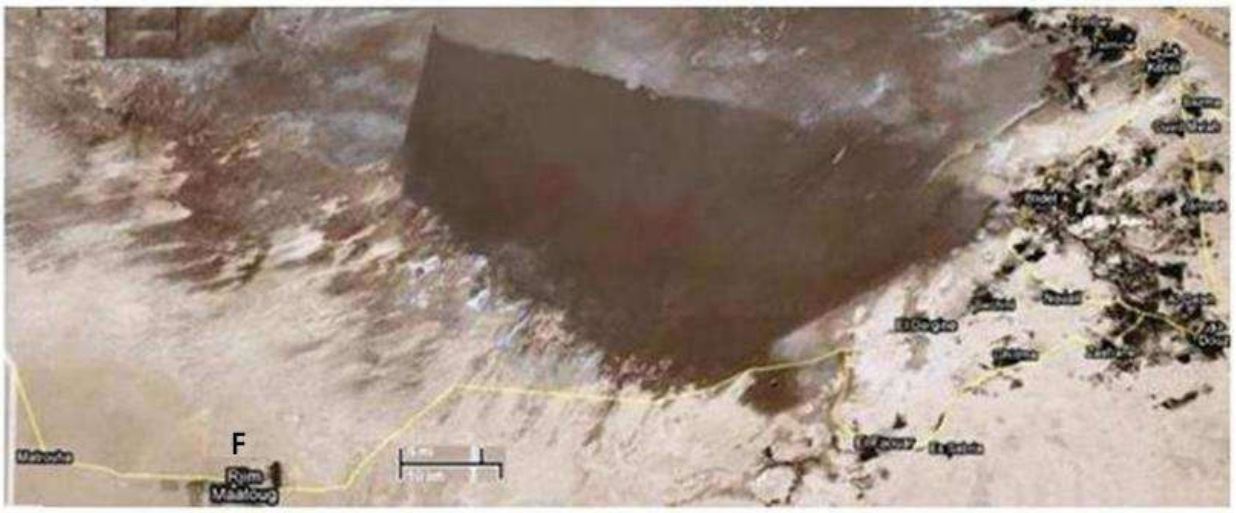

Fig. 4. Distribution of *O. agamemnon arabicus* in the oases of Nefzaoua (Kebili): Rjim Maatoug zone (F) constitute the only infested zone (satellite photo, Google Earth).

Many biotic and abiotic factors have contributed to the spread of *O. agamemnon arabicus*. In fact, during the 15 years elapsed between its introduction and its first report, favorable conditions expressed by adequate regional climate, abundance of food resources, absence of natural organisms (predators, parasitoids and micro-organisms) that regulate the population and time (years) allowing pest acclimatization to local conditions. Therefore, the pest reproduces rapidly and outbreaks of its populations occurred. The biotic potential of *O. agamemnon arabicus* may be considered as one of the major factors involved in its population explosion (14).

All these conditions were enforced by the ignorance of the species usually confused with other white grubs and this contributed mainly to its establishment and spread. As a result, it became a real threat to date palm trees. Actually, surveys estimated that the beetles affected about 3113.5 ha (Table 1) i.e., almost 10%, of the total area of palm trees in Tunisia (14).

Table 1. Distribution of *O. agamemnon arabicus* in the oases of Southwest Tunisia

Governorate of Tozeur		**Governorate of Kebili (Rjim Maatoug zone)**		
Locality	**Area (ha)**	**Locality**	**Area (ha)**	
Mrah Lahouar	389	Rjim Maatoug 1	300	
Edhraa El Janoubi	200	Ferdaous 1	360	
Ibn Chabbat	800	Ferdaous 2	349	
Ed Hafria	250	Nasr 1	281.5	
El Oudia	40	Nasr 2	144	**Total**
Total	**1679**	-	**1434.5**	**3113.5 ha**

DEVELOPMENT SITES

The availability of development or breeding sites and the knowledge of their nature and quality are determinant in the existence of any insect population in a given area. Indifferently of the infested oasis in Southwest Tunisia, it has been found that the breeding sites of *O. agamemnon arabicus* are the same both in the Djerid and Rjim Maatoug zones. All the stages develop in live standing palm trees. The large number of beetles, eggs and larvae were collected from respiratory roots both on the ground and in the aerial part, on the external dead wood through the stem as the matrixes of fibrilium, the bark of stem and basal part of dry petioles (13, 14, 15).

In Oman, *O. agamemnon arabicus* is considered as a fruit stalk borer which larvae are usually found inside the dead and weaken offshoots. In Saudi Arabia, larvae of *O. elegans* were found between the frond bases and trunks (1). However, the most favored breeding sites for *O. rhinoceros* in Pacific area are dead standing palms which die from old age, dead coconut trunks and stumps, and decaying cocoa pod humus (2, 16).

As with all beetles, larvae of *O. agamemnon arabicus* hatch from eggs and develop into nymphae, and these ultimately develop into adult beetles. Eggs are deposited directly on the area of future target. However, female burrows to lay the eggs singly 5 to 10 cm below the surface between fibrous of respiratory roots, through the stem eggs are laid between tough layers. In both cases and in new targeted place, female chewed and reduce the fibrous roots or the matrixes of fibrilium on small granules used to prepare chipboard of firm material where eggs are laid. However, when firm material exists, eggs are laid at intervals along the tunnel made in it. Each female lays at mean 27 eggs in single or several clutches (14).

Favored breeding sites are standing alive date palm trees in the good entertained oases, weakened palms are less attacked than vigorous ones. In the zone of Tozeur, where the species firstly appeared, targeted parts of standing vigorous palm trees are preferred to unhealthy and dead standing ones (13).

DAMAGES, THREAT AND ECONOMIC IMPORTANCE

In Southwest Tunisia, *O. agamemnon arabicus* was localized inside plantations of less than 30 years old and damage caused by this pest, are irreversible, particularly in respiratory roots part, and may result in one of the following symptoms, perceived through sight, depending upon the stage of infestation (14):

i) Occurrence of chewed plant tissues on the ground beside the attacked side and on the upper surface of tough layers,

ii) Weakened bases of fibrilium matrixes and dry petioles made them easy to pull up,

iii) Heavily attacks on offshoots linked to mother plant let them partially dry with wrinkled aspects of palms.

Damages are localized from the bottom to the top of the plant on the respiratory roots, external components of the stem and the basal levels of old green palms. Larvae of *O. agamemnon arabicus* constitute the mainly harmful stages (14) and not the adult beetle like for *O. rhinoceros* (2, 3, 12, 16) and *O. elegans* (1, 11). The concealed nature of the pest makes detection of infested palms a difficult task.

In respiratory roots, larvae move by cutting into fibrous roots. Through the stem, matrixes of fibrilium, frond midribs and stem bark are the interested part of attack and larvae are never seen inside the stem. Basal part of crown, represented by

the fourth oldest floor of green palms, was also infested by this pest but, green palms are not attacked and concerned parts are mainly matrixes of fibrilium and stem barks. Larvae move by feeding on the attacked tissues where they cut and dig tunnels. It is important to mention that indifferently from the level of attacks each larva dig its own tunnel (14).

The most important danger of damage appears on the attack of respiratory roots which represent the basal support of the palm. In this part and in late stage of infestation, after several subsequent years of attacks, larval galleries can overlap and interpenetrate. This leads to most severe damages: the formation of a hole of important dimensions in roots. Thus, the plant base becomes unbalanced by the weakening of its support, and, consequently, the risk of its sudden collapse increases even under moderate wind. Happily, palms can support pest attacks for several years yet for more than two decades depending on the two next linked parameters: the repetitive attacks and the yearly registered population of larvae. This slow damage expression constitutes a positive point in favor of palms which can be exploited to save/cure infested trees using several control methods if infestation was detected at early stage (14).

Attacks were also registered laterally between fibrous roots at 40 cm from the stem. However, risks from the species were increased when offshoots tufts developed at the base of the tree; this place constitutes the most preferential site to females' beetle for eggs deposition (13, 14, 15).

Stem is covered for several years with the bases of the old dry fronds (matrixes of fibrilium and midrib), making it rough, but with age these bases weather and the trunk becomes smoother with visible scars of the bases (17). Attacks through different parts of stem are not harmful to palm trees because larvae bore into dead parts without affecting the tree vital function. Eggs are laid between reduced parts of the matrixes of fibrilium located between the interior face of midrib and stem bark. Their number can not exceed five in maximum. After eggs hatching, larvae began their attack as follows: they destruct the tissues of fibrilium matrixes; after they attack superficially the stem bark and can penetrate inside midrib only in third larval instars where they continue their development until pupation. A frond midrib assures the development of only one larva of third stage (14, 15).

Crown attack interests the basal fourth oldest floor of green palms. New emerged adults, pupae and particularly larvae of third stage are collected from this part and never eggs and larvae of first and second stages. Invaded parts are mainly the matrixes of fibrilium and the bark of stem. Green palms petioles are superficially injured by mouthparts of larvae but never interiorly attacked because of the hardness of the wood which still alive and overloaded water (15, 14). However, existence of larvae on crown periphery level can be at the origin of indirect damage represented by harmful fungal diseases that are always related to stem invasion (6, 13, 14).

The pest does not affect the yearly harvest of date because attacks were never registered on the base of fruit bunches (14). Thus, this species was considered as secondary pest resulting in its late identification and lacking in related research studies.

Offshoots developed in tufts laterally on respiratory roots and all around the date palm tree (17). These unclean places are the best suited sites for adult beetles for egg deposition. It contributes to enhance the risks related to

respiratory root attack by raising the number of larvae in this part. Offshoots are superficially damaged by larvae and still alive as much as linked to mother plant. They are always deeply attacked by third larval stages. However, after plantation; attacked offshoots became autonomous and the drying process is installed. Obvious symptoms began by a partial drying located on the side of attacked part that can lead to a delayed or stopped development. At the end of this process, mortality is caused by the partial or total consumption of both the internal part and the sap conducting vessels. It is important to mention that each offshoot ensures the development of only one larva (14, 15).

In Oman, adults of *O. agamemnon arabicus* are responsible of damage, they bore into leaves and the surface of the fruit stalks which may break under heavy attacks. In Saudi Arabia, the adult beetle of *O. elegans* destroyed the surface of the rachises, fruit-stalks and frond bases (1).

CURRENT MANAGEMENT

Control of the Scarabaeidae, and especially of the *Oryctes* genus, is mainly preventive. It becomes very difficult when breeding places are not cleaned (11). *O. agamemnon arabicus* and as previously quoted was an invasive species in Tunisia introduced without its natural enemies. Additionally, no chemical treatments were applied against it. Consequently, the species represents now a potential danger and a real threat to palm trees within infested oases. To remedy to the lack in effective means of control, it will be necessary to exploit the multiple supporting conditions of this pest in order to decrease the existing population and its impact. However, although the lethal nature of *Oryctes* and the high value of the host crop, assumed actions to its control within oases are very low and few number of control measures were tested against this pest (14).

QUARANTINE MEASURES AND REGULATORY CONTROL

In Southwest Tunisia, the first infestation by the rhinoceros beetle, *O. agamemnon arabicus*, was detected in 1995 (6). The first step realized by the Plant Protection Services of Regional Commissariat of Agriculture Development (RCAD) consisted in the delimitation of infested zones by the revision of offshoots movement from the initial site (Mrah Lahouar oases) (14).

In Tunisia, almost 90.52% of the total area of date palm trees is still free from *Oryctes* infestation. In this case and in absence of any efficient means of control against this pest, stringent quarantine measures are requested and for avoiding spread and entry of such pest in new plantations and regions. Therefore, the key issue is to stop people carrying palms of any kinds (offshoots, young and old palm trees) from infested areas as eggs, larvae, pupae and beetles may be localized inside different plant parts (14).

Plant Protection Services of both RCAD of Tozeur and Kebili governorates helped by local police worked together to enforce this quarantine regulation by the establishment of checkpoints during the period of plantation and movement of offshoots from infested areas. This operation would stop the spread of the species using plant material with regard to inter-governorate movement.

However, under some exceptions the movement of host material (offshoots) can be authorized from the quarantined area, as when it lack, but in this case several steps may be adopted to ameliorate the quarantine measures. Indeed, in regions where planting material is imported from *Oryctes* infested areas, it is advisable to adopt

strict pre-departure period (3 months) and post-entry period (9 months) as a quarantine protocol. In fact, during the first period selected and pulled offshoots, originating from infested areas, must be set in nursery where they undergo a severe control by the continuous survey of the presence of any form of the pest (eggs, larva, pupa or adult) in conjunction with insecticides spraying until plantation. This method might be held as an efficient way to prevent the spread of *Oryctes* through planting material and must be considered as an important component of the *Oryctes*-management program that offers the much needed quarantine security against these pests. However, the second period interested autonomous offshoots during the first year after plantation. A simple method can be mentioned and which would avoid and restrict the spread of adults and the identification of suspicious material undetected by quarantine service. It stands in caging offshoots with a mesh net within plantations. This method could serve as a useful post-entry or post-plantation protocol. This, if done under supervision and proper certification, would play a major role in preventing spread of the pest to new plantations, regions and countries.

AGRONOMIC MEASURES

Agronomic methods which may be applied against *O. agamemnon arabicus* in the oasis of Southwest Tunisia are easy and not expensive but meticulous. Universally, major recommendations have been made for cautious phytosanitary steps inside and around plantations to destroy any life history stages found in all breeding sites. For farmers, sanitation constitutes the most simple and effective way of controlling the species. Its principle, based on several methods and techniques, is to unbalance the middle of life of the pest by maintaining the growing area in a clean condition. It mainly targeted breeding sites (13).

In the first part, the control targets oviposition and breeding sites at different levels of palm trees. It is important to mention that this control method has to be applied out of the season of reproduction, between November and late April. Major operations are (14):

• Eradication of suitable oviposition and breeding sites of the pest by the elimination of destroyed vegetal material previously transformed by larvae to small granules (firm material) where females laid their eggs and young larvae live and develop until new adult emergence. Moreover, this operation allows on one hand to expose these parts to ambient air and sun radiations making them dry, hard and unattractive to beetle, and on the other hand the handpicking (manual extraction) using a metallic wire of all encountered life history stages of the pest from feeding tunnels and their destruction.

• Throughout stem, farmers have to use a saw to prune on scale the dry petioles levels. This action destructs the oviposition sites of beetles by eliminating the matrixes of fibrilium with larvae and adults. However, it is far better to keep the last 4 to 6 levels of dry petioles located just under the crown as a trap to beetles in the goal to avoid the passage of invasion to the basal levels of the crown.

The second part is related to unclean palm trees which display too many offshoots at their base. These palms offer to beetles suitable sites for reproduction and eggs oviposition. Therefore, to break the pest cycle in this place, it is necessary to make it clean, exposed to sun light and air. Accordingly, farmers are encouraged to eliminate the excessive number of offshoots which can be either used to

replace lacks inside the same plantation after being treated with insecticides to kill larvae, developing in its basal part, or must be automatically eradicated.

However, sanitation is a careful work and a slow methodical process which can be hindered by the ability to detect infested material and the necessary time to execute this work. Approximately every five years, the Ministry of Agriculture launches a campaign of eradication of this pest by collecting and burning the various stages of the pest in infested oases. Despite the granting of financial incentives to make this work, the low involvement of the farmers in the campaign follow up has translated into a significant growth of the *O. agamemnon arabicus* population. Consequently, the lack of consciousness rising about the risks of this pest induce few farmers to apply these techniques within their plantations (14).

TRAINING AND EXTENSION

Extension constitutes a very important method to diffuse information between farmers. In Southwest Tunisia, few meeting and studies are organized on the subject of this pest. Thus, the solution consists in the organization of meeting conferences, field days, and workshops in collaboration between research institutions (researchers), agricultural organisms (engineers, technicians) and farmers are indispensable to the diffusion of important information about the relative pest danger. In addition, the pest is free of control by natural enemies on date palm oases of Tunisia which make worse this problem. Consequently, the goals of these meetings and training are to take farmers informed concerning mean of control of this pest. Farmers can also help to the diffusion of these techniques to other farmers.

CHEMICAL CONTROL

Presently, chemical control perfected against *O. agamemnon arabicus* is quiet ineffective. Subsequently, this pest management of both in old productive and young date palm oases scarcely relies on insecticide use that is almost absent. This is due in part to specific factors in relation with the biology and ecology of the species, and in other part to the morphology of the plant (problems of access to the crown of mature palms). However, insecticides can be used for both as preventive and curative applications as listed below (unpublished data).

Preventive treatment. Preventive treatments have to be applied during the whole period of adults' activities to be sure about their effectiveness in killing adults making possible the prevention of their entry in the reproduction and oviposition sites situated on different levels of the palm tree. Next applications can be useful:

- ✓ Stem and crown spraying/soaking.
- ✓ Protecting wounds and entry holes localized on the aerial part of the respiratory roots with insecticides.
- ✓ Use of repellent products on the crown of productive palms and in new plantations to drive away adults from the palm tree.

Curative treatment. Curative spraying intended for the immature stages located on the respiratory roots are ineffective, the pesticide emulsion can not reach the location of these stages well protected inside their shelter. However, if the spraying focus on the higher parts of mature palm trees, in this case and to be effective, specific treatment must be applied by spraying or soaking the whole stem and crown. The application of such

type of treatment, which requires higher dosages of chemical products, constitutes the only way to make possible the contact of pesticide with different developmental stages and then its effectiveness. However, although the efficiency application of this method, it is considered to be too expensive for general use within plantations compared to the low value per hectare of date production which severely limits expenditure on control measures. Moreover, other serious hazards involved in spraying tall palms by this way, due to the loss of products at the time of its application to higher palms make farmers highly exposed to the risks of toxicant spillage and inhalation. Thus, disadvantages of this application reside on the use of important quantities of chemicals per treatment endangered by repetitive treatments to ensure the remanence of the product and its efficiency and this was not safe both to environment and human.

However, chemical control was recommended and constitutes the widely advocated method of control (unpublished work):

- ✓ To sweep out the existing stages of the pest within offshoots, before being replanted offshoots bases are dipped within a barrel containing a solution of insecticide for 5 min, necessary time to penetration of the pesticide inside larval galleries. By this way, larvae were killed by the product in a short period. This method can ensure the safety of offshoots during the residual period, after that they constitute a new target to other invasion by adult beetles.
- ✓ To protect young palm replanting (< 5 years old), by soaking all the plant with pesticide during the period of adults' activity.
- ✓ Use of repellent products as naphthalene balls into the frond axils can be very effective in protecting young palms (17) and also in old palms by driving away adults before they cause damage.

ATTRACTANTS

Compost heaps. Traps of various types can be used. The simplest are on the form of breeding sites and play the role of a trap or attractant for adults such as compost of sheep manure and sawdust or heaps of decaying vegetable matter buried inside a pit on the ground within invaded plantations. Traps of compost must be put in place on the late spring early summer (late April to May) before the starting of the reproduction and oviposition periods (14).

These organic heaps operate as traps by attracting a large number of beetles, in particularly females, which lay down their eggs and subsequently largely contribute in the decline of the pest's populations inside plantations and of their impact on the palm trees (14).

Consequently, compost heaps stands as very favorable breeding sites for the *Oryctes* species and then can receive and produce large populations in one cycle. In this case, compost piles within plantations should be maintained properly. Its upkeep includes the destruction of all life stages of the pest and its treatment using insecticide or inoculums of the parasitic fungus like *Metarhizium anisopliae* which contaminated and killed the beetles' larvae of the similar species *O. rhinoceros* in the Pacific region (8, 9, 10).

Also, before its application as soil fertilizer, compost must be sieved to eliminate the remainder of larvae and adults (14).

Light traps. Adults are nocturnal and attracted to any source of light. Early experiences at trapping *Oryctes* in Mrah lahouar zone include the use of one light

trap by the Regional Research Center of Oasis Agriculture at Deguech (6). The use of only one light trap in the pilot station (3.5 ha) of Rjim Maatoug permitted to experiment the effectiveness of light trap for three years. However, more than 550 adults are trapped per season of activity, from June to mid-October. These good results and by the availability of several traps inside oasis and their exploitation for successive years during the period of activity of beetles can ensure important reduction of the pest population (14).

BIOLOGICAL CONTROL

O. agamemnon arabicus is an exotic species in Tunisia. Therefore, natural factors that keep the beetle under control in its native range are not present when introduced and this factor facilitates and makes easy its reproduction and local spread. Biological control via parasitoids, predators and entomo-pathogenic fungi are not yet identified and available against this pest in Tunisia due to its recent introduction and to the lack of deeper relative studies (14).

RECOMMENDATIONS

For raising awareness and capacity building, it is necessary to make farmers of the Southwest region understanding that *O. agamemnon arabicus* is not so much a national responsibility, but rather a regional responsibility. If it was already established in some oases of the region, it is highly likely that it will eventually spread to others (14). Next steps are needed both to limit its spread and its population increase within infested oases:

- Adoption and serious application of strict quarantine measures on the movement of offshoots from infested to healthy areas,
- Need of more attention to the pest from the authority and scientists due to its threat to palm trees,
- Distribution of the pest should be assessed by exploratory surveys in healthy regions,
- Adoption and application of phytosanitary steps in infested oases,
- Need to organize programs on *O. agamemnon arabicus* to get farmers informed about the real danger of the species and its threat on this economically important crop,
- Making available information on this pest in the regions concerned with date palm trees cultivation and including good photos of larvae, adults, symptoms and damages,
- Extension of information on control measures to concerned farmers,
- Extension of compost use within plantation to a significantly decrease both of the pest's impact on palm trees and of their populations.
- Support and implementation of IPM program
- Development of mass trapping using light traps and compost technique
- Establishment of research programs to tackle and develop mass trapping with aggregation pheromone
- Introduction of biological control relying on the use of the fungus *Metharizium anisopliae* and the antagonist *Oryctes* virus showing effective results in the Pacific coconuts' plantation (4, 5, 11).

CONCLUSION

In conclusion, *O. agamemnon arabicus* has became a major pest and a worrying threat to palm trees in infested oases of Southwest Tunisia where it has thriven unnoticed. Economically, it is considered as secondary pest without effect on production. This point made farmers and administration in charges of agriculture unaware of the hazard for two reasons: the unperceived damage and the

small number of yearly collapsed palm trees.

All means of its management still rudimentary and traditional relying mainly on hand collection of different stages. Then, farmers are encouraged to achieve a careful and intensive work every year to cleanse their plantations but, this repeated work is very hard and time consuming and farmers are unable to control all their palm trees. Consequently, they give up collecting the pest which population explode and became uncontrollable.

Facing to this situation and due to the ineffectiveness of chemical control and the lack of biological control, severe quarantine measures are the only way to prevent the spread of the pest out of unhealthy zones. Obviously, it is time to consider this species as a serious pest of palm trees in Tunisia. So, first steps have to target the control and to limit its populations; this can be possible by: i) informing farmers how to use the compost technique to bait adults, ii) studying the possibility of biological control by the introduction of natural enemies inside infested oases.

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RESUME

Soltani R. 2010. Le scarabée rhinocéros *Oryctes agamemnon arabicus* en Tunisie: situation actuelle et les futures perspectives de lutte. Tunisian Journal of Plant Protection 5: 179-193.

Oryctes agamemnon arabicus a été signalé dans certains oasis du sud ouest Tunisien en 1995. Les sites favorables à son développement sont les différentes parties du palmier dattier vivant. La femelle dépose environ 27 œufs. Les adultes sont nocturnes et passent le jour cachés dans leur abri, ils s'alimentent occasionnellement sur le jus extrait à partir des racines respiratoires. Leur rôle est limité à la reproduction et à la dispersion de l'espèce sur de courtes distances. Cependant, les larves représentent les stades nuisibles de l'espèce et non les adultes. Elles s'attaquent à différentes parties du palmier dattier, racines respiratoires, parties superficielles du stipe (fibrilium, écorce du stipe et pétiole sec) et la base de la couronne. Ces derniers représentent les sites de développement d'*Oryctes*. Le danger réel de cette espèce réside dans l'attaque de la zone respiratoire de la racine, support de base de la plante et secondairement à la périphérie de la couronne. La lutte contre cette espèce est avant tout préventive ciblant les sites d'élevage afin de réduire les populations. Les mesures de quarantaine par l'interdiction des mouvements des rejets bloquent la dispersion de l'espèce vers de nouvelles zones, les techniques culturales ciblent le contrôle et la destruction des sites de développement et les pièges de différents types attirent les adultes. Toutes ces méthodes contribuent à réduire considérablement les populations à l'intérieur des plantations.

Mots clés: Cycle de vie, dégâts, lutte, *Oryctes agamemnon arabicus*, palmier dattier, Tunisie.

ملخص

سلطاني، رسمي. 2010. الخنفساء وحيدة القرن ***Oryctes agamemnon arabicus*** في تونس: الوضع الراهن والآفاق المستقبلية لإدارتها. **Tunisian Journal of Plant Protection 5: 179-193**

تمت الإشارة إلى وجود حشرة الخنفساء وحيدة القرن (*Oryctes agamemnon arabicus*) في واحات الجنوب الغربي التونسي في 1995، يعدّ نخيل التمر المضيف الوحيد للحشرة. وتتمركز مواقع نمو كل أطوار هذه الآفة على مختلف

أجزاء النخيل الحي، حيث تضع الأنثى ما يقارب 27 بيضة. تعدّ هذه الآفة من الحشرات الليلية حيث تختبئ أثناء النهار في مواقع تطورها على النخلة وتنشط خلال الليل. وهي تتغذى عَرَضياً على العصارة المستخرجة من الجذور التنفسية للنخلة . ويقتصر دور البالغات على التزاوج والمساهمة في انتشار النوع لمسافات قصيرة. ولا يمكن اعتبار الحشرة الكاملة ضارة بالنخلة مقارنة بالأطوار اليرقية التي تلحق أضرارا بأجزاء مختلفة من النخلة: منطقة الجذور التنفسية والأجزاء الخارجية للساق والمنطقة السفلية من الجريد الأخضر حيث تمثل هذه الأهداف أهم مواقع نمو مختلف أطوار الحشرة. وتعدّ الأضرار المحدثة في منطقة الجذور، التي تمثل قاعدة ارتكاز النخلة، الأخطر على الإطلاق بينما تعتبر الأضرار الموجودة على محيط التاج ثانوية ودون خطر يذكر. أما فيما يخص طرق مكافحة هذه الحشرة فتعد وقائية قبل كل شيء وتستهدف أساسا مواقع تزاوج الحشرة للحد من كثافة أعدادها. أما تدابير الحجر الزراعي المتمثلة في تقييد تبادل الفسائل بين المناطق فتعتبر من أهم التدابير لمنع الحشرة إلى مناطق جديدة زيادة؛ بالإضافة إلى التقنيات الزراعية المتاحة التي تهدف أساسا إلى تدمير مواقع تطور الحشرة للحد من أعدادها وكذلك استعمال المصائد بمختلف أنواعها لجذب بالغات الحشرة. تسهم كل هذه الطرائق مساهمة كبيرة في الحد من أعداد الحشرة داخل الواحات.

كلمات مفتاحية: انتشار، أضرار، تونس، دورة حياة، مكافحة، نخيل التمر، *Oryctes agamemnon arabicus*

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