Biological Control of The White Cochineal
Parlatoria Blanchardi (Hemiptera - Diaspididae) by
Using Coccidiphagous Ladybirds and Biopesticides
in Palm Groves of The Region of Ouargla (South-
East Algeria)

Bennameur-Saggou Hayet1, Rekia Chennouf2, Gassou Insar3, Kirouane Noureddine1, Goui Khaoula1 and
Benbrahim Keltoum2

1 Phoeniculture Research Laboratory "Phoenix", Faculty of Natural and Life Sciences, University Kasdi-Merbah of Ouargla, Algeria.
2 Bioresources Laboratory, Faculty of Natural and Life Sciences, University Kasdi-Merbah of Ouargla, Algeria.
3 Email: dhiaoumeima gg@hotmail.fr

Abstract

The white cochineal of the date palm is a very serious pest in the palm groves of the Ouargla region (South-East Algeria). Our attempt at biological control of this pest was based on the use of two coccidiphagous ladybirds Pharoscymnus ovoideus and Pharoscymnus numidicus and aqueous extracts of two Saharan plants Solenostemma argel and Azadirachta indica with two doses in two palm groves in the Ouargla region. The results obtained are very encouraging. White cochineal infestation rates of treated plants decreased considerably especially for the high dose of two treatments. The infestation rate decreased from 52.54% to 35.49% with P.ovoideus (120 ladybirds/tree) and from 54.03% to 18.88% with Neem extract (dose 5%), to 11.01% with Argel extract (dose 7.5%). The two ladybirds and the two extracts used showed highly significant differences (P=0.000), as did the two doses used (P< 0.0001). Our control attempt also showed an efficiency that increased with the increase of the dose used. It is 0.119±0.20 with the low dose of P.ovoideus to reach an efficiency of 0.324±0.23. For the extract-based treatments, the highest efficacy was recorded with the high dose Argel (0.812±0.22). It should be noted that the low doses used for both treatments gave insignificant results compared to their controls with the high doses, which showed very high significant differences with P=0.000 for the ladybird releases and P<0.0001 for the high doses of the water extracts.

Keywords: White cochineal, Biological control, Ladybirds, Aqueous extract, Date palm.

1. Introduction

Algerian palm groves, especially those in the Ouargla region (south-east Algeria), have a fairly high varietal diversity. They include 53 cultivars, 22 of which are rare [1]. Our date palm and its production are attacked by a range of pests that affect the production and quality of dates. The main pests of the date palm currently causing considerable damage are the date moth Ectomyeloïs ceratoniae Zeller, the bouferoua Oligonychus afrasiaticus Mc. Gregor and the white cochineal Parlatoria blanchardi Targioni Tozzetti which is the most formidable pest of this patrimony, and which does not cease to cause important damage to our date production. It has become a serious handicap, especially the new development areas [2].

The various control methods, particularly chemical, applied in palm groves to combat the main date palm and date pests have not produced the expected results. On the contrary, the abusive use of pesticides (insecticides and acaricides) has caused perturbations at various levels. Several inconveniences have been noted after the use of these synthetic plant protection products [3]. Biological control remains a more appropriate alternative to insecticides which cause irreversible damage to the fragile and complex palm grove ecosystem.

Though the Algerian palm groves are located in a very difficult Saharan ecosystem under these climatic and edaphic conditions, they constitute a reservoir for various floristic species [4], and faunal species [5]. These species can be used as biological control agents against several date palm pests, in particular the white cochineal.

It is in the context of preserving our Algerian palm groves as well as for their sustainable development that we have opted for attempts at biological control of this pest through the use of two biological control agents. The first one is biopesticides from the use of aqueous extracts of two Saharan plants Argel Solenostemma argel and Neem Azadirachta indica presented biocidal
effects against other pests [6]. The second agents is tow natural endemic auxiliaries; namely two coccidiphagous ladybirds' *Pharoscymnus ovoideus* Sicard and *Pharoscymnus numidicus* Pic that natural predators and regulators of the white cochinial in Saharan areas [8-12].

2. Materials and Methods

2.1. Study sites

Our study was carried out at two sites with similar ecological conditions (varietal composition, floristic composition, maintenance, functional drains...). These were the palm grove of the University of Ouargla (31°40' N; 5°29' E) for the control by using plant extracts and the palm grove of Mekhadema (31°59' N; 5°20' E) for the release of ladybirds.

2.2. Biological materials

Our study is conducted on the Deglet-Nour date palm cultivar. This cultivar is the most abundant in Algeria and these dates have an important market value worldwide. The treatments and releases are carried out on 12 plants, each with the same white cochinial infestation score. The controls also had the same score. We have retained the note 3 (average population varying between 190 to 240 white cochinial / Cm2) according to the scale of [13]. The biological control was based on the use of two biological agents. These are the adults of two species of coccidiphagous ladybirds *Pharoscymnus ovoideus* and *Pharoscymnus numidicus* (Coleoptera-Coccinellidae), reared in the laboratory under controlled conditions (30°C temperature, relative humidity of 40±4.5%, a photoperiod of 16:08 hours, and permanent feeding). The two Saharan plant species used in the preparation of the aqueous extracts are, Neem *Azadirachta indica* (Meliaceae) harvested from the Ain Saleh region (central Algerian Sahara) and Argel *Solenostemma argel* (Apocynaceae) harvested from the region of Tamenrasset (South Algerian Sahara).

![Figure 1. Biological control agents for white scale (a: Pharoscymnus ovoideus, b: Pharoscymnus numidicus, c: Azadirachta indica, d: Solenostemma argel).](image)

2.3. Release of coccidiphagous ladybirds

The releases of the two coccidiphagous ladybirds were carried out with two different doses, namely 30 and 120 ladybirds/tree. The choice of the doses is according to the tests of voracity realized in the laboratory, where we have chosen the two extreme doses. Laboratory counts of white cochinial insects are carried out before the releases. We took leaflets from each crown of each tree treated with the control (24 leaflets per tree). Three square centimeters of each leaflet, corresponding to a low, medium and high concentration of scale insects, were selected for counting all individuals (mobile or fixed larvae of stages 1 and 2, male and female adults). We then obtained three values per leaflet and averaged them. The average number of living individuals was then calculated for each plant. One week later, we took another sample of leaflets to do the calculation in the same way. The treatment efficiency is then calculated by the Efficiency formula of [14]:

\[
\text{Efficiency} = \frac{\text{Infestation rate before treatment} - \text{Infestation rate after treatment}}{\text{Infestation rate before treatment}}
\]

2.4. Treatment with plant extracts

The aqueous extracts of the two plants studied, namely Neem and Argel, are prepared by the maceration method of Attia et al., 2010. After rinsing the leaves of both plant species to get rid of dust, one kg of plant was macerated in 10 liters of cold water for one week at a temperature of 12 °C or less. These macerates were filtered, and the filtrate obtained is considered as a 10% stock solution. Dilutions were prepared for each plant species to have two doses (low and high dose). The two doses...
used for Neem are 2.5% and 5%. For Argel, we used 2.5% and 7.5% in order to spray 3 feet of date palm for each treatment with a control without treatment. Spraying is carried out with 15 liters of product per foot using a LANDINI sprayer attached to a tractor. The flow rate used was 1.5 L/min.

After 48 hours another estimation of the white scale infestation rate of the treated and control plants was made to calculate the mortality rate from the formula of [15]:

\[
\text{Percentage mortality} = \frac{\text{Number of dead white cochineal individuals}}{\text{total number of individuals}} \times 100
\]

2.5. Statistical analyses

Our results are exploited by using analysis of variance ANOVA. Two-factor ANOVAs (ladybird species and treatment dose) are performed to test the effectiveness of the treatments. The significance of these releases as a function of treatment dose is addressed by a one-factor ANOVA (treatment dose). For the results of the extract-based treatments, ANOVAs are also used. The software use is XLSTAT 2021.3.1

3. Results and Discussions

3.1. Effect of coccidiphagous ladybird releases and aqueous extracts on white cochineal infestation rates

The releases carried out by the two species of ladybirds with two treatment doses (30 and 120 individuals/tree) on the cultivar Deglet-Nour showed that *P. ovoideus* and *P. numidicus* are all the more effective as they exert their predation more strongly at the time when the doses are high (120 individuals/tree) (Fig. 2). For the high dose *P. ovoideus* releases, infestation rates decreased from 52.54% to 35.49%. The ladybird *P. numidicus* at high dose also approved the decrease of white cochineal infestation rates but with lower averages (from 50.94% to 40.52%). Similarly, the plant extracts of Argel and Neem (2.5%, 5% and 7.5%) showed the same results. The mortality rates of the white cochineal insects increased with the increase of the dose of the extract used (Fig. 2).

![Figure 2](image-url)

*Figure 2. Infestation of Deglet-Nour cultivar by the white cochineal Parlatoria blanchardi before and after treatments (A: Release of Pharoscymnus ovoideus, B: Release of Pharoscymnus numidicus, C: Treatment with Neem extract, D: Treatment with Argel Extract).*
The low dose reduced infestation rates but only slightly compared to the high dose. In Argel, the 7.5% dose reduced the infestation rate to 11.01%, while in Neem; a 5% dose decreased the infestation by 54.03% to 18.88% after 48 hours of treatment (Fig. 2).

According to [16], Neem is a wonderful 100% natural insecticide, harmless to humans and animals, active against over 200 insects, mites, nematodes, fungi and bacteria. Similarly, argel is a plant known to have toxic and especially larvicidal effects [17].

Table 1. Two-factor ANOVA (species/plant extracts and treatment dose).

|                     | F-value | P-value |
|---------------------|---------|---------|
| Ladybird species    | 34.241*** | 0.000   |
| Treatment dose      | 153.352*** | < 0.0001 |
| Ladybird species* Treatment dose | 8.167* | 0.021   |
| Extracts plants     | 34.449*** | 0.000   |
| Treatment dose      | 1116.835*** | < 0.0001 |

*p < 0.05, **p < 0.01 and ***p < 0.001

The predation of both ladybird species as a function of dose was highly significant (P < 0.0001). However, Fisher's PLSD test at the 5% level indicates that there is no difference between the two species at low doses. Similarly, the interaction between species and release dose is significant at P = 0.021.

The analysis of variance shows that there is a very highly significant difference between the white cochineal mortalities from the two extracts used (P= 0.000). Thus, there is also a highly significant difference between the two doses used (P < 0.0001) (Table 1).

As for ladybird releases, Fisher's PLSD test at the 5% level for date palm extract treatments indicates that there is no difference between the two extracts at low doses. The interaction between the aqueous plant extracts and the treatment doses is significant with P = 0.030.

3.2. Efficiencies and significance of coccidiphagous ladybird releases

The releases of both species of ladybirds were effective at both doses (Table 2). However, a high efficiency is always recorded with the high dose (120 individuals/tree), it is 0.324±0.23 with *Pharoscymnus ovoideus* and 0.204±0.21 with *Pharoscymnus numidicus*.

Table 2. Efficiency and significance of releases of ladybirds *P. ovoideus* and *P. numidicus* on the cultivar Deglet-Nour.

| Releases of ladybirds | Efficiency | F   | Significance |
|-----------------------|------------|-----|--------------|
| *P.ovoideus* Control  | -0.074±0.17|     |              |
| Low dose              | 0.119±0.20*| 2.933| 0.162        |
| Control               | -0.049±0.10|     |              |
| High dose             | 0.324±0.23*| 67.815| 0.001        |
| Control               | -0.042±0.34|     |              |
| *P.numidicus* Low dose| 0.087±0.25*| 4.083| 0.113        |
| Control               | -0.054±0.11|     |              |
| High dose             | 0.204±0.21b| 117.918| 0.000       |

*p < 0.05, **p < 0.01 and ***p < 0.001 - a, b, c: Homogeneous groups at the 5% level of the Fischer PLSD test

The works of Maamri, 2012 and Benameur-Saggou, 2018 shows that *P. ovoideus* has a higher voracity than *P. numidicus* due to its more robust mouthparts.

The presence of the controls with an average number of white cochineals before treatment that was approximately the same as the plants intended for treatment confirmed the value of the releases. After one week, these controls showed an increase in infestation resulting in negative efficacy values for all controls (-0.074±0.17, -0.049±0.10, -0.042±0.34 and -0.054±0.11) (Table 2).

The significance of the releases is addressed by analyses of variance while comparing the doses used with the controls. It should be noted that the low doses gave non-significant results for both ladybird species (P= 0.162 and 0.113) and very high significance for the high treatment doses (P=0.001 and 0.000).
3.3. Efficiencies and significance of Aqueous extract treatments

The use of aqueous extracts of both plant species also showed remarkable efficacy especially with high doses, it is 0.812±0.22 with Argel and 0.650±0.20 with Neem. The effects of Neem have been observed in biting sucking Hemiptera such as some aphid species [18]. In southern Algeria, Argel is used to control soil nematodes [19].

Table 3. Efficacy and significance of aqueous extract treatments of Argel and Neem plants on the cultivar Deglet-Nour.

| Aqueous extract treatments | Efficiency F | Significance |
|----------------------------|--------------|--------------|
| Argel                      |              |              |
| Low dose                   | -0.008±0.12  | 2.865        |
| Control                    | -0.008±0.18  | 1.666        |
| High dose                  | 0.812±0.22   | 330.175      |
| Control                    | 0.009±0.11   | < 0.001      |
| Neem                       |              |              |
| Low dose                   | 0.688±0.43   | 25.551       |
| Control                    | -0.072±0.5   | 0.007        |
| High dose                  | 0.650±0.20   | 1468.303     |

*P < 0.05, **P < 0.01 and ***P < 0.001 - a, b, c: Homogeneous groups at the 5% level of the Fischer PLSD test

The treatment with Argel at low dose is not significant with P= 0.166, while for Neem is significant (P=0.007). The high doses gave very satisfactory and significant results with a very highly significant difference (P < 0.0001) compared to the controls.

As for the controls of the ladybird releases, the controls used for the treatments with aqueous extracts showed an increase in the rate of white scale infestation after 48 hours of treatment, which approves the effectiveness of the aqueous extracts used.

Conclusion

The attempt at biological control of the white cochinelle through the use of two coccidiphagous ladybirds endemic to our region and aqueous extracts of two Saharan plants with recognized biocidal power has given very encouraging results without affecting or creating imbalances in the palm grove ecosystem.

The use of these bioresources available in our Saharan ecosystems contributes to preserving them against the harmful effects of chemical pesticides that constantly pollute and degrade our environment.

References

[1] Achoura A. and Belhamara M., 2016. Possibilité de substitution des moyens chimiques par une lutte biologique contre la cochenille blanche du palmier dattier Parlatoria blanchardi Targ., 1868 (Homoptera, Diaspididae) dans les palmeraies de Biskra en Algérie. Journal of new sciences, Agriculture and Biotechnology, IABC (23), 1366-1373.
[2] Al-Dossary, N., Al-Nagem, A., Al-Munoor, N., Muhsen, H. 2008. Evaluate sufficiency of some plants oils to control on white scale insect Parlatoria blanchardi (coccocide: Homoptera) on date palm (Phoenix dactylifera L.). Basra Journal of Palm Dates Research. 8 (1): 48-61.
[3] Al-Mekhlafi F., Al-Mekhlafi A., Abutaha N., Farooq M. and Al-wadaan M., 2018. Insecticidal effect of Solenostemma argel extracts against Culex ppienis. Journal of the American Mosquito Control Association, 34(3):217–223, 2018
[4] Bennameur-Saggou H., 2009. La faune des palmeraies de Ouargla: Interactions entre les principaux écossystèmes. Thesis. Magister, Kasdi Merbah University, Ouargla, 155 p.
[5] Bennameur-Saggou H. 2018. Utilisation de Pharsoscyumus ovoides et Pharsoscyamus numidicus (Coleoptera-Coccinellidae) dans une tentative de lutte biologique contre Parlatoria blanchardi Targ.(Homoptera-Diaspididae) dans les palmeraies à Ouargla (Sud-est algérien). PhD thesis, University of Ouargla, 162 p.
[6] Benazzouz N. and Benabderahmane W., 2017. Etude de l’activité antioxydante des extraits de feuilles d’Aloe vera (L.) Burm et de Solenostemma argel (Delile) Hayne. Master thesis. Abdelhamid Ibn Badis University-Mostaganem, 62 p.
[7] Chehma A., 2005. Etude floristique et nutritive des parcours camelin du Sahara septentrional algérien. Cas des régions de Ouargla et Ghardaïa. Doctoral thesis. Badji Mokhtar University. Annaba, 178 p.
[8] Dalziel J. M., 1937. The useful plants of West Tropical Africa. The Crown Agents for the Colonies, London. pp. 52-560.
[9] Doumandji-Mitchie B., 2013- Historique de l’utilisation de la lutte biologique en algerie : quelques exemples. Séminaire international sur la protection phytosanitaire: Situation et perspectives, le 17, 18 et 19 novembre, Batna university, p 26.
[10] Idder M.A., 2011. Lutte biologique en palmeraies algériennes: cas de la cochenille blanche Parlatoria blanchardi, de la pyrale des dattes Ectomyelois ceratoniae et du boufaroua Oligonychus afrasiaticus. PhD thesis in Agronomic Sciences, ENSA, El-Harrach, Algiers. 152 p.
[11] Idder-Ighili H., 2015. Interaction entre les cultivars des dattes et la faune associée dans la région de Ouargla (Sud-est algérien). PhD thesis in Agronomic Sciences, Kasdi Merbah University, Ouargla, 151 p.
[12] Kehat M., 1968. The feeding behavior of Pharoscymnus numidicus (Coccinellidae), predator of the date palm scale Parlatoria blanchardi. Entomologia experimentalis et applicata, 11(1): 30-42. Doi: 10.1111/j.1570-7458.1968.tb00071.x
[13] Mohammed, M.A., Salman, S.R., Abdulridha, W.M., (2020), Structural, optical, electrical and gas sensor properties of zro2 thin films prepared by sol-gel technique, NeuroQuantology, 18(3), pp. 22–27.
[14] Maamri F., 2013. Contribution à l'étude de la bioécologie de deux coccinelles coccidiphages Pharoscymnus ovoideus et Pharoscymnus numidicus dans l'exploitation agricole de l'Université d'Ouargla. Thesis State Eng. Agro. Kasdi Merbah University., 98 p.
[15] Madkouri M., 1978. Etude bio-écologique de Parlatoria blanchardi Targ. (Homoptera- Coccoidae- Diaspididaes) et d’un prédateur Chilocorus cacti Scop. (Coleoptera- Coccinellidae) en vue de son éventuelles utilisation dans les palmeraies de Sud Marocain. Les cahiers de la recherche agronomique, n° 34, 148 p.
[16] Mouffok B., Raffy E., Uruty N. and Zicola J., 2008. Le neem, un insecticide biologique efficace. S2 tutorial project, Paul Sabatier University IUT, Biological Engineering Department, 15p.
[17] Ozenda P., 1983. Flore du Sahara. 2 nd Édition, Paris, 622 p.
[18] Saharaoui L., Biche M. and Hemptinne J.L., 2010. Dynamique des communautés des coccinelles et interaction avec leurs proies sur palmier dattier à Biskra. Bulletin de la société zoologique de France. 135 (3-4) : 265-280.
[19] Vallet C., 2006. Le Neem. Un «insecticide» naturel "petit guide pratique". HSF, France.8p.