

Review Article

Prickly Pear Cochineal *Dactylopius opuntiae*, in Morocco: Vigilance and Perspectives

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Abstract

The appearance in the Province of Sidi Bennour of a pest attacking the prickly pear was announced on 29-07-2015 by the National Office for Food Safety (ONSSA). In case of heavy infestation and in the absence of control measures, the insect can cause plant dieback. Since then, it has caused the death of the prickly pear in all Moroccan regions, resulting in heavy damage for small farmers. This plant is known for its use in animal, industrial, cosmetic, therapeutic and environmental food and whose fruit is appreciated internationally. The development of resistant varieties and new control methods with the establishment of a monitoring system is necessary given the importance of this sector. An inventory of the report, the probable causes and the countermeasures of Morocco and at the level of other regions of the world in the face of this problem, was carried out. The spread of the pest in Morocco has continued to grow since its discovery in 2014. A control and awareness program was launched by ONSSA in cooperation with the Food and Agriculture Organization of the United Nations (FAO). The Ministry of Agriculture has devoted 80 million Dirhams to the operation to fight against the cochineal with the establishment of a vigilance and surveillance committee to manage the plan for uprooting and burying diseased cacti. In addition, a selection program for resistant varieties and treatment products was launched and carried out by the services of the National Institute for Agronomic Research (INRA) in partnership with the various regional administrations of the Ministry of Agriculture. The Tunisian Ministry of Agriculture launched, on August 17, 2021 in social networks, a call for vigilance after the appearance of the insect in northern Algeria with the development of a three-year national strategy of control and to strictly apply agricultural quarantine to limit the spread of the insect.

Keywords

Vigilance Committee, Cochineal, FAO, INRA, Method of Combating

1. Introduction

The prickly pear, sometimes called “racket cactus”, is a succulent plant very widespread in Mediterranean and tropical regions, used as much for ornament as for its juicy fruits. [1].

This culture is very widespread in Mexico and North Africa.

The flesh is also transformed into beer called colonche in Mexico and other alcoholic drinks in Malta in particular. Nopal is made up of young *Opuntia* shoots that are eaten cut into thin strips in Mexican dishes. The prickly pear (*Opuntia ficus-indica*) is a shrub that can live a very long time and

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measures 3.50 m in all directions in its native area, sometimes up to 6 m high. [1]

The prickly pear is able to store water. Its extensive root system allows these undemanding cacti to absorb a lot of water soon after a dry spell. The plant stores its reserves in its shoots. With its fleshy, very green paddles and its juicy pulp, this cactus forms a striking contrast with its arid environment. [2]

The plant is said to have many healing and anti-aging properties. It is used in day cream, after-sun, anti-wrinkle, anti-stretch marks. Indeed, prickly pear oil is rich in vitamins and minerals, as well as active ingredients known for their antioxidant properties, thus acting against skin aging. The powers of this oil would exceed those of argan oil. Moisturizing, nourishing and softening, prickly pear oil has, among other things, 65% polyunsaturated fatty acids (against 33% for argan), as well as a level of vitamin E (antioxidant) greater than 100 mg /100 g, against 65 mg for argan 21). [3]

It is also used in industrial ways such as: Natural dyes are extracted from fruits and as vegetable leather, for clothing. [4]

In Morocco, the *Opuntia Ficus-indica* cactus is an integral part of the landscape. The cactus introduced to Morocco in 1770 by the Spanish colonies from Mexico, cactus fruits proliferate in the Rif, the center of the country and the Atlantic plateaus and plains. Due to the drought, the surface area of cactus has evolved considerably over the past 2 decades, increasing from 50,000 to more than 120,000 hectares (Ha) between 1998 and today. The region of Guelmim-Sidi Ifni represents more than 50% of this area followed by Haouz-El Kelaa de Sraghna with 30%, Khouribga in 3rd position and Doukkala in 4th. [5]

Morocco has several varieties of cactus, namely: Dellahia, Alhamra, Shoul, Majdoubia, Haddaouia, Rehmania 1 and 2, Akkouri, Mles, Dribina, Acherfi, Moussa and Aissa. The prickly pear is the fruit of the cactus. It is widely sold as a cooling snack mainly in the hot summer months. Traditionally used as a fence or as a base for animal feed, the cactus has seen its seed oil fetch very high prices in recent years. In 2011, a Protected Geographical Indication (PGI) was recognized with the aim of ensuring the legal protection of the two Moussa and Aissa ecotypes known in the Guelmim-Sidi Ifni region. [6]

Extending over an area of approximately 88,200 ha, the cactus plantations of the "Moussa" and "Aissa" varieties cover all the provinces of the region and produce no less than 400,000 tons of fruit annually. Part of this production is valued by approximately 45 groups (cooperatives and economic interest groups) for processing purposes (Cactus oil, Nopal, Soap, etc.). The sector has benefited from the creation of a significant recovery unit, which capacity is more than 10,000 T/year for the packaging of cactus fruit and 2,000 T/year for the extraction of cactus oil. [7]

In addition, many farms in North Africa (Morocco, Algeria, and Tunisia) grow cactus. For example, Brazil has more than 500,000 Ha of cactus plantations used as fodder. In Ethiopia,

180,000 Ha are covered by this plant. The cultivation of prickly pears is also gradually gaining ground in the face of the need to strengthen the resilience of populations faced with situations of drought, high temperatures or soil degradation. [5]

The first outbreak of the cactus *Dactylopius opuntiae* (Hemiptera: Dactylopiidae) (CDO) in Morocco was reported in 2014. [7]

The prickly pear cochineal *Dactylopius opuntiae* Cockerell (Hemiptera: Dactylopiidae) is a serious pest that causes severe damage to prickly pear cactus species of the genus *Opuntia*. [8]

Although this scale insect can be used for the production of the natural dye carmine, the damage it can cause is considerable. [9]

Although this flowering plant tolerates drought, since it only needs less than 200 mm of water per year to produce fruit, it is defenseless against this cochineal who's rapid and repeated attacks are devastating. So much so that in Australia and South Africa, this insect was introduced to eliminate the cactus, considered an invasive plant. [10]

Two years later, the exponential increase in the areas of prickly pear degraded by the pest led to the official launch of the emergency program to combat this scourge. At the time, the infestation was still limited to a few areas in Sidi Bennour and the Zemamra region. In 2017, the rate of spread of the scourge increased at the national level with the appearance of new outbreaks of infestation, in the Rhamna region in particular. Meanwhile, a mixed team of Moroccan researchers capitalized on the work of collecting ecotypes of prickly pears (led by the National Institute of Agronomic Research (INRA) since the 1980s) to try to identify resistant varieties, capable of saving a national sector. The fruit of this work came in the form of 8 varieties of cochineal-resistant prickly pear. Since then, a step has been taken to distribute these varieties to farmers and producers. [7]

This study aims to carry out a report of the state, the probable causes and the countermeasures of Morocco and at the level of other regions of the world to face this problem.

2. Materials and Methods

A census of the various actions and measures undertaken by Morocco through the National Food Safety Office (ONSSA), the National Institute of Agronomic Research (INRA) and the Moroccan Agriculture Ministry in terms of monitoring and controlling the spread of the cochineal and finding alternative measures to save this sector will be presented.

3. Results and Discussion

Since 2014, a sneaky pest has been gradually destroying cactus areas in several regions of the Moroccan Kingdom

known for their various varieties of prickly pear. The plantations and areas of this species native to Latin America have thus seriously deteriorated, like the infestations that have been recorded in several Mediterranean countries. A delicious fruit highly appreciated by Moroccans, whose harvest and sale allowed hundreds of families to generate valuable income, the prickly pear (Hendia in Darija) has become rare and its prices have reached record highs. For the past few days, several photos have been circulating on social networks showing cacti in remission, particularly in the region of Ait Ba âmrane. 'After many years of disease, the cacti are winning their war against the pest,' reads a comment attached to an image of a cactus racket that grew from a fig tree ravaged by cochineal. [7]

In view of its development potential and its exceptional resistance to climatic hazards, prickly pear cultivation has benefited from a privileged place during the implementation of the Green Morocco Plan (PMV). The forecasts for planted areas planned for 2020 were thus achieved in 2014 with the simultaneous development of several packaging and processing units for products from this sector. A momentum has been greatly disrupted since because of the ravages of the cochineal. Since its launch, the new national agricultural strategy "Generation Green" aims to restore and expand the areas destroyed by the cochineal thanks to new resistant varieties that have been selected from 400 ecotypes of this floral species. The objective for 2030 is to reach a cultivation area of 130,000 hectares. This re-establishment of the prickly pear sector will be achieved in particular thanks to the support of INRA, which intends to continue the multiplication of resistant varieties in order to produce nearly 1,630,000 seedlings and some 481,800 whole cladodes from the various platforms for a total of 2,112,000 seedlings. The combined efforts of the various stakeholders have thus made it possible to rehabilitate more than 7,800 hectares in 2022, and intend to reach 15,000 hectares in 2023, then 20,000 hectares in 2024. From the year 2025, 23,000 hectares will be added each year to the overall area occupied by this crop. In total, the Ministry of Agriculture has bet 80 million DH to save the culture which requires a capital importance in the solidarity pillar of the agricultural strategy. [11]

Covering an area of approximately 90,000 ha, cactus plantations cover almost all rural areas of the Kingdom. About 600,000 tons of fruit are produced annually. Part of this production is valued by cooperatives by transforming it into cactus oil and soap. An activity made possible by the increase (+15%) in the national area of cactus plantations between 2008 and 2019. But this increase could have been greater without the damage caused by an insect pest. The cactus is resistant to both drought and cold (-5 °). On the other hand, it is defenseless against the cochineal (*Dactylopius Opuntia*) who's rapid and repeated attacks are devastating. So much so that in Australia and South Africa, this insect was introduced to eliminate the cactus, considered an invasive plant. [5, 6, 11]

The prickly pear also plays an important role in the fight against desertification and the preservation of biological

diversity. It is used for the manufacture of therapeutic and cosmetic products for export. [7]

The "*Dactylopius opuntia*" seriously damages the prickly pear by absorbing the sap which causes the appearance of yellowish areas which gradually extend, until the affected plate falls and the trunk dies in the event of serious infection, according to the ministry. [7]

It should be noted that the consumption of fruit and the use of infected cactus rackets do not present a danger to human and animal health. Except that the parasite constitutes a serious threat insofar as it causes the dieback of plants. [10]

A first assessment of the various interventions mentions the chemical treatment of 1,700 km. While the operations to uproot and destroy infested plants have been carried out in 3 states since 2016. It is ultimately these operations, which are continuing, which have made it possible to stem the spread of the pest to other areas.

Despite these efforts, the ministry decreed the suspension of the new cactus planting program supported under the Green Morocco Plan. A decision that will only be lifted once the situation is under control. [12]

With the key to the valorization of the fruit and derivatives in the form of products with high added value: oil, jam, cosmetics, animal feed.... A vigilance committee has also been set up and a ministerial decree enacting the measures and procedures to be observed has been adopted.

The decree of the Ministry of Agriculture decreeing measures for the prevention and control of cactus cochineal (B.O 6610 of October 5, 2017) details the procedures to be observed. It appears that infested areas must deploy the following measures:

- 1) Uprooting and on-site destruction of cacti infected with cochineal (*Dactylopius opuntiae*).
- 2) Disinfection of the equipment used for uprooting.
- 3) Treatment of cactus plantations using phytosanitary products.
- 4) Prohibition of the movement of cactus plants or its parts within the infested zone and towards the exterior thereof. However, the fruits of the cactus can circulate within said zone.
- 5) The seizure of any cactus plant material coming from the said zone and circulating outside it and its destruction.
- 6) Any other measure whose implementation is necessary to contain the cactus mealybug. [12]

Since July 2019, ONSSA has adopted a strategy based on a participatory approach in the fight against the insect in the Guelmim-Oued Noun region. [13]

If the responsibility to fight against this scourge fell in the past to ONSSA and its partners in the Ministry of Agriculture, the involvement of the farmer in this effort is yielding good results today. [12, 13]

Field experience has proven the effectiveness of this approach, following the shrinkage or absence of scale insects in fields cultivated by local farmers. For this reason, ONSSA will publish a booklet that will be made available to farmers to

simplify the way they manage cactus fields.

The National Food Safety Office (ONSSA) and the Food and Agriculture Organization of the United Nations (FAO) jointly organized an awareness campaign on the cactus mealybug. The cochineal ravages Moroccan cacti and farmers are struggling to control this pest. The provinces of Chtouka A ħ Baha and Tiznit, in the Souss-Massa region, were particularly affected. The campaign led by the two organizations aimed to raise awareness among farmers and professional associations in Souss-Massa on the importance of fighting cochineal to preserve Moroccan heritage. [14]

The emergency assistance project for the eradication of the cactus mealybug developed by the two organizations focused on the establishment of an operational integrated control program and the development of an emergency plan for the monitoring and management of the CDO. This project enabled the safeguarding of the national collection of cactus ecotypes at the Melk Zher research station in Agadir through the installation of an "Insect proof" net greenhouse. [14]

In parallel with the chemical control which covered nearly 8,000 linear kilometers of plantations, the Ministry of Agriculture invested in the biological control of the pest. According to a source from the National Institute for Agronomic Research (INRA), the results are promising. Trials with a predatory ladybug have been encouraging. INRA researchers have also worked on the development of mealybug resistant varieties. And already 8 varieties of prickly pear have been listed in the official catalog by the research institute. This work was carried out on the basis of 249 varieties selected to choose those which are most resistant to cochineal. [15]

The eight resistant ecotypes have been registered in the national cactus catalogue and a parcel of mother plants with this identified plant material resistant to *D. opuntiae* was established. These resistant ecotypes will be the subject of later studies of resistance mechanisms (antibiosis and antixenosis) for the cochineal and also for research on genetic improvement of the cactus in Morocco. [15, 16]

The Tunisian Ministry of Agriculture, Water Resources and Maritime Fisheries calls for vigilance after the appearance of the insect "*Dactylopius opuntia*" in Tlemcen (northern Algeria). [17]

On his Facebook page, he calls on farmers in the different production areas to monitor the plantations of prickly pears and to inform them immediately, in the event of observation of one of the symptoms of this insect present in Morocco where it has already been spotted in 2014, and to inform the regional and central agricultural services, because of the danger that this insect represents for the prickly pear, a very popular fruit in Tunisia. [17]

The presence of this pest in Algeria on prickly pear was reported for the first time, in several localities of Msirda in the northwestern part of the country (Tlemcen, Algeria). The degree of infestation of this scale insect tends towards an alarming threshold which causes not only the deterioration of the fruits but also a total dieback of the attacked plants.

The Tunisian Ministry of Agriculture launched, on August 17, 2021 in these social networks, a call for vigilance after the appearance of the insect in northern Algeria with the development of a three-year national strategy. Control and fight and to strictly apply agricultural quarantine to limit the spread of the insect. [17]

4. Conclusion

Due to the important place occupied by prickly pear culture in Morocco and its various uses (nutritional, industrial, environmental and pharmaceutical), a surveillance and vigilance committee has been set up at the national level in order to monitor and follow up the execution of counter-attack measures against the prickly pear cochineal. This measure goes in parallel with the efforts of the department of agriculture deployed in its program of the awareness campaigns by the national office (ONSSA) and the FAO organization. In addition the selection program of resistant varieties and treatment products was indeed launched and carried out by the services of the national Institute of agronomic research (INRA) in partnership with the various regional administrations of the Ministry of Agriculture.

The fight against the cactus cochineal still continues despite the efforts made. Its impact on fruit availability has been remarkable since a shortage of fruit has been observed since the pest was first discovered. Awareness campaigns on methods of removing infested plants must be extended to reach all provinces of the country because it is the success key of new plantations. This scourge is requiring the joint efforts of all stakeholders.

The fight against this deadly pest requires the multiplication of the efforts of all the parties involved in this sector, at the head of which are the farmers who are the first to be affected and who suffer the damage and negative impacts of this situation.

Abbreviations

ONSSA	National Office for Food Safety
INRA	National Institute of Agronomic Research
FAO	Food and Agriculture Organization of the United Nations
Ha	Hectares
PGI	Protected Geographical Indication
CDO	<i>Dactylopius opuntiae</i> (Hemiptera Dactylopiidae)
PMV	Green Morocco Plan

Author Contributions

Madiha Bahouq: Conceptualization, Data curation, Formal Analysis, Investigation, Methodology, Resources, Software, Supervision, Validation, Visualization, Writing –

original draft, Writing – review & editing

Hanane Bahouq: Conceptualization, Formal Analysis, Methodology, Supervision, Validation, Visualization, Writing – original draft, Writing – review & editing

Abdelmajid Soulaymani: Conceptualization, Formal Analysis, Supervision, Validation, Visualization, Writing – review & editing

Conflicts of Interest

The authors declare no conflicts of interest.

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