# Impact of Pomegranate Cracked Fruit on *Ectomyelois ceratoniae* Oviposition and Behavior

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## Abstract

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The carob moth, *Ectomyelois ceratoniae* (Lepidoptera; Pyralidae) is a serious pest attacking pomegranate fruit among other fruit trees. Many practices were used to control this pest, such as cultural control by destroying rotten and mummified fruits. The late fruits are known to shelter this pest during the winter season. This study showed that *E. ceratoniae* adult females and larvae were attracted to cracked fruits, during the growing season, as the total number of eggs and larvae found in this kind of fruit was far more than that found in the un-cracked fruits. Larval migration towards cracked fruits was noticed with a positive correlation between the number of laid eggs and the number of cracked fruits. However, the number of non-cracked fruits present on trees at the peak of every generation had no positive effect on *E. ceratoniae* females' egg-laying activity. Thus, the present study showed the importance of avoiding having pomegranate cracked fruits, as they positively impact carob moth adult females' and larvae' behavior in pomegranate orchards.

**Keywords:** Pomegranate; cracked fruit, carob moth; oviposition; behavior; migration.

## Introduction

The pomegranate tree *Punica granatum* (Lythraceae) is one of the traditional crops that has been given attention for many years in Tunisia. In fact, this tree grows very well in arid and semi-arid regions, as it is highly tolerant to brackish water (Mars & Marrakchi, 1998) and to almost all types of soils. Thus, growing this species was extended to several regions in Tunisia. The revival of interest in pomegranate cultivation led to an increase in its production which rose from 37,000 tons in 1990 (Mars & Sayadi, 1992) to around 74,694 tons in 2018 (Agridata, 2018). This was accompanied by an increase in exports from 3989 tons in 2007 (Jeangille & Laif, 2020) to 8080 tons in 2019 (Agridata, 2019). However, despite this expansion, the quality of pomegranate fruit remained dependent on management techniques (irrigation rate, fertilization...) and especially on adopted phytosanitary measures. Indeed, pomegranate cultivation is facing major problems, including fruit cracking and rotting, in addition to damage caused by some insect pests, mainly the carob moth *Ectomyelois ceratoniae* Zeller (Lepidoptera: Pyralidae). This pest is still responsible for considerable damage, reaching up to 40% of pomegranate production (Ksantini, 2018), mainly in the south of the country compared with the northern part (Dhouibi & Jemmazi, 1993). Thus, effective control methods that would reduce the attacks of the carob moth to tolerable levels, such as the mass release of the egg parasitoids of the genus *Trichogramma* (Ksentini *et al.*, 2013), are being used. Beyond these methods, cultural control helps in the reduction of the prevalence of the carob moth. In fact, this pest is known to overwinter damaged and mummified fruits hanging on trees, since the latter offer shelter to caterpillars against bad weather (Dhouibi, 1982). Consequently, the removal and destruction of such fruits could reduce the infestation level in the following season. However, following the resumption of its activity during spring, many factors may regulate *E. ceratoniae* abundance in the orchards such as natural mortality following humidity decrease (Gothilf, 1969), temperature increase, and infections by micro-organisms, as well as predation and/or parasitism (Ksentini, 2010). Thus, good knowledge of *E. ceratoniae* bio-ecology and behavior can be very useful as it can help mitigate this pest's attack rates. In this context, this study aimed to investigate the impact of cracked pomegranate fruits on carob moth behavior and preferences.

## Material and Methods

### Biotopes investigated

Two pomegranate biotypes were monitored from the flowering period until harvest; the Zerkine biotype during the first two years and the Hzag biotype during the third year. Field visits were made every 10 days.

Zerkine biotope- The plot in which the study was conducted is part of an experimental field belonging to the Professional Training Centre of Agriculture in Zerkine (CFPA- Delegation of Mareth- Governorate of Gabes, Tunisia). This plot is planted with pomegranate trees at 5 × 5m spacing and irrigated by submersion every 10 days during the dry season. Weeding was not performed and the plot is protected by a cypress windbreak.

Hzag biotope- This biotope is located in Hzag (Delegation of Djebeniana, Governorate of Sfax, Tunisia), which is a public property rented to the private sector for 15 years. This field is surrounded by Acacia and Cypress trees, and weeding was done rather mechanically. This field included plots planted with olive, almond, and pomegranate trees at a spacing of 6×6 m and are irrigated by a dripping system.

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**Fruits collection and laboratory observations**

Fruits collection started from the beginning of the pomegranate fruit set and continued until harvest. The extent of the trees' initial load and final production were recorded, and the damaged fruit (rotten, cracked, dropped, and burned) throughout the period of maturation were removed and counted. Fruit sampling was carried out at a rate of one "apparently healthy-looking" fruit per tree/visit. In total, 45 pomegranate trees were followed in the first two years, and 20 trees in the third year. In the laboratory, every collected fruit (cracked and "apparently" healthy) was first tested under a binocular microscope, and observations were then systematically recorded.

**Data analysis**

The comparison between the number of hatched eggs and the number of larvae and pupae was performed using a dependent t-test at $P \leq 0.05$. A correlation equation ($y = aX + b$) was developed to assess the relation between the number of incubated eggs and the state of fruit on trees, with a coefficient $R^2$ being between -1 and +1.

## Results

**Comparison between "apparently" healthy and cracked fruits**

The total number of eggs found per 100 "apparently" healthy fruits was less important than the ones found per 100 cracked fruits during the second and the third year (Table 1). However, during the first year, the total number of eggs found in "apparently" healthy fruit was slightly higher than the ones counted in cracked fruits. Results obtained (Table 1) clearly showed that the number of larvae or pupae found per 100 cracked fruits was more important than the number found in 100 "apparently" healthy fruits, during the three years of study.

**Comparison between hatched eggs and larvae in "apparently" healthy fruits**

Except for the third year, in which the mean number of hatched eggs was almost three times equal to larval and pupal numbers, depending on the intended mean numbers (33.67 hatched eggs compared to 13.00 larvae and pupae), the mean number of hatched eggs was almost equal to that of larvae and pupae in the first year (36.30 hatched eggs compared to 34.01 larvae and pupae) and in the second year (14.51 hatched eggs compared to 16.24 larvae and pupae) (Figure 1). However, there was no significant difference between the mean number of hatched eggs and the mean number of larvae and pupae during the three years of study.

**Comparison between hatched eggs and larvae in cracked fruits**

Although only statistically significant during the first year ($F = 18.24477$; $df = 5$; $P = 0.005$), in cracked fruits, the number of hatched eggs was generally less than the number of larvae and pupae during the first, second, and third year of study (Figure 2).

**Relation between the number of eggs under incubation and the number of healthy-looking (un-cracked) fruits on pomegranate trees**

The possible impact of un-cracked pomegranate fruits on the oviposition of the carob moth females was investigated through the number of eggs under incubation laid on healthy looking fruits (un-cracked), and present on trees at the peak of every generation. The correlation obtained is presented in Figures 3a, 3b, and 3c.

The distribution of dots and the correlation coefficients ($R^2$) obtained showed a weak positive correlation for the three years of study.

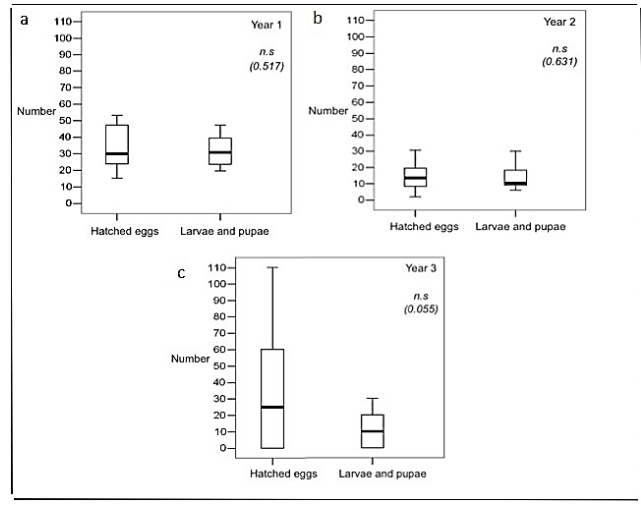


**Figure 1.** Comparison between the mean numbers of hatched eggs and number of larvae found in healthy-looking (un-cracked) fruits in two locations, during two years of study in Zerkine location (a, b) and one year in Hzag location (c), using t-test at $P \leq 0.05$.

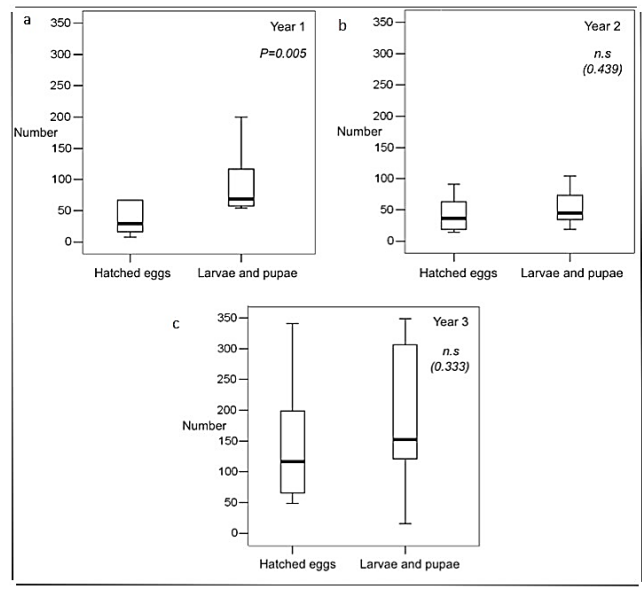


**Figure 2.** Comparison between the mean number of hatched eggs and of larvae found in cracked fruits at the two locations investigated; during two years of study in Zerkine location (a, b) and one year in Hzag location(c); using t-test at $P \leq 0.05$.

**Table 1.** Eggs and larval-nymphal densities/100 "apparently" healthy or cracked pomegranate fruits in two locations; during two years of study in Zerkine and one year in Hzag.

| Location | Period | Number of eggs per 100 fruits | | Number of larval-nymphal stages per 100 fruits | |
|---|---|---|---|---|---|
| | | Healthy-looking fruit | Cracked fruit | Healthy-looking fruit | Cracked fruit |
| Zerkine | Year 1 | 135.89 | 133.98 | 21.8 | 54.85 |
| | Year 2 | 35.42 | 105.92 | 14.5 | 75.39 |
| Hzag | Year 3 | 102.70 | 608.87 | 12.6 | 142.66 |

**Correlation between the number of eggs under incubation and the number of cracked fruits on pomegranate trees**

A strong positive correlation ($R^2$ close to 1) between the number of eggs under incubation and the number of cracked fruits present (at the peak of every generation) on pomegranate trees for three years was observed (Figure 4).

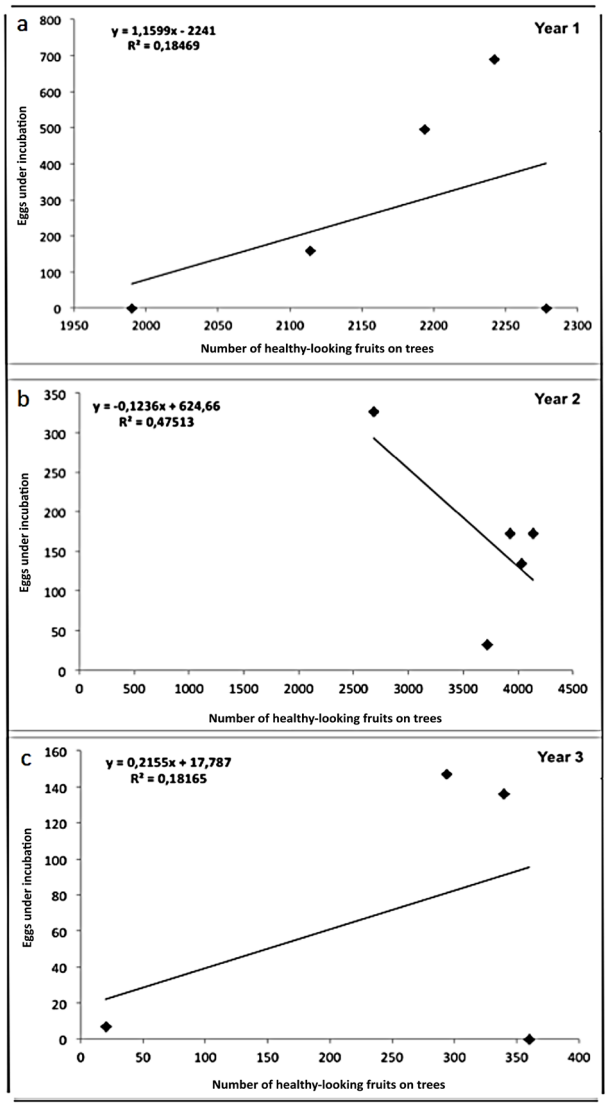


**Figure 3.** Correlation between the number of eggs under incubation and the number of healthy-looking (un-cracked) fruits present on pomegranate trees at two locations; during two years of study in Zerkine location (a, b) and one year in Hzag location (c), with $R^2$ being between 0.0 and 0.5.

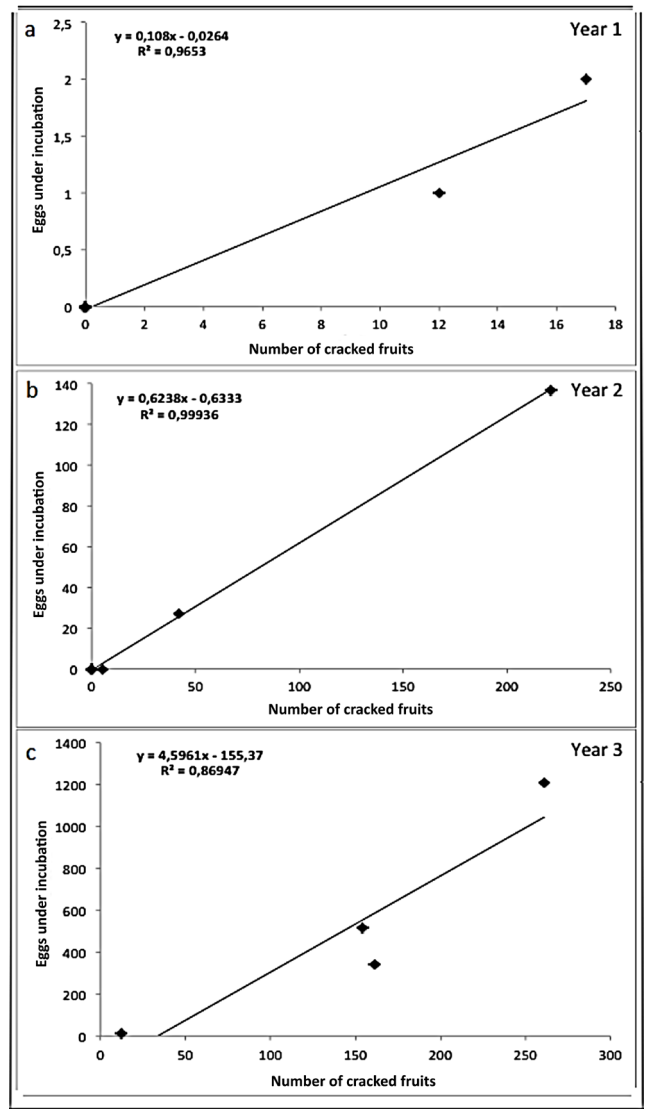


**Figure 4.** Correlation between the number of eggs under incubation and the number of cracked fruits present on pomegranate trees in two localities; during two years of study in Zerkine location (a, b) and one year in Hzag location, with $R^2$ being close to 1.

## Discussion

*Ectomyelois ceratoniae* is a pest that has 4 to 5 generations per year on pomegranate trees in Tunisia (Ksentini, 2010). Its cycle begins in the third decade of April (Dhouibi, 1985). Previous research has shown that *E. ceratoniae* females select the calyx as a preferred place for egg-laying, with 53.70% of the eggs being laid in it, whereas 32.40, 8.51 and

5.37% of the eggs are laid on the fruits, leaves and peduncle, respectively (Dhouibi, 1982), and sometimes on mummified fruits (personal observation). According to Jerraya (2003), the newly hatched larvae will gather and eventually end up on the calyx, regardless of the egg-laying site. These observations suggest that young, hatched larvae of *E. ceratoniae* migrate toward pomegranate calyxes, and consequently the number of hatched eggs found in the calyx might be far below the number of larvae. However, this is not in agreement with the results obtained from this study, since the number of hatched eggs was found equal to or even more than the number of larvae and pupae found in the calyx of "apparently healthy" fruits, suggesting the possible migration from calyxes toward more available food sources, such as cracked pomegranate fruits. In fact, in this study, the number of larvae and pupae found in cracked fruits was generally higher than the number of hatched eggs, suggesting movement from "un-cracked" fruits and/or leaves towards nearby cracked fruits. Furthermore, it was noticed that the total number of larvae and pupae found in cracked fruits was more than their numbers in the "apparently" healthy fruits, thus confirming that *E. ceratoniae* larvae have a preference for cracked fruits.

It should be mentioned, however, that the behavior described above was not limited to larvae, since the number of eggs under incubation was more in cracked fruits compared with healthy-looking fruits, suggesting that *E. ceratoniae* females prefer cracked fruits as an egg-laying site, and supporting the hypothesis that female insects select the resources that maximize the survival of their offspring (Gripenberg *et al.*, 2007). As a matter of fact, a strong positive correlation was found between the number of eggs under incubation and the number of cracked fruits. However, no correlation was found between the number of eggs under incubation and the number of healthy-looking fruits existing on trees during the three years of this study at the peak of every generation, suggesting strong preference of *E. ceratoniae* females for cracked fruits compared with healthy-looking fruits.

Findings of this study were not in agreement with Al-Izzi & Maliky (1996), who claimed that the calyx appeared to be the most preferred site for egg-laying, especially in open fields (Dhouibi, 1982; Jerraya, 2003). Nonetheless, based on our findings, we confirmed that by depositing eggs on cracked fruits, *Ectomyelois ceratoniae* females will increase their offspring's chances of survival, hence the need to minimize the availability of cracked fruits by collecting and destroying them. It should be noted, however, that these cracked fruits can become a breeding ground for the species, which will soon attack other healthy pomegranate fruits, as well as other neighboring fruit crops, since *Ectomyelois ceratoniae* is a polyphagous species.

It can be concluded from this study that all *E. ceratoniae* stages were attracted to cracked pomegranate fruits. Not only *E. ceratoniae* adult females sought to lay their eggs there, but also larvae sought to immigrate to such fruits. Thus, avoiding as far as possible the presence of cracked fruits in an orchard by properly managing the amount of irrigation, and removing any damaged fruits from the trees will be an appropriate practice to reduce the population of this pest in pomegranate orchards.

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## الملخص

**القسنطيني، إيناس، الطيب جردق ونجيبة الزغل. 2026. تأثير ثمار الرمان المتشققة في وضع البيض لحشرة عثّة الخروب وسلوكها. مجلة وقاية النبات العربية، 44(2):142–146.** https://doi.org/10.22268/AJPP-001397

تعدّ عثّة الخروب (*Ectomyelois ceratoniae*) (Lepidoptera: Pyralidae) من أخطر الآفات التي تتغذّى على ثمار الرمان وغيرها من أشجار الفاكهة. تستخدم العديد من الوسائل لمكافحتها مثل بعض الممارسات الزراعية الجيدة كجمع وتدمير الثمار المتشققة والمتعفنة والمحنطة. من المعروف أن هذه النوعيّة من الثمار توفر المأوى لهذه الآفة خلال فصل الشتاء. ومع ذلك، أظهرت هذه الدراسة انجذاب الإناث البالغة وبرقات النوع *E. ceratoniae* إلى الثمار المتشققة، أثناء موسم نمو الرمّان، حيث كان العدد الإجمالي للبيض واليرقات الموجودة في هذا النوع من الفاكهة أكبر بكثير من العدد الموجود في الثمار السليمة (غير المتشققة). في الواقع، لوحظت هجرة اليرقات بطريقةٍ ما نحو الثمار المتشققة بالإضافة إلى وجود ارتباط إيجابي بين عدد البيض الموضوع وعدد الثمار المتشققة خلال السنوات الثلاثة التي نفذت فيها التجربة. كما تبيّن أنّ عدد الثمار غير المتشققة الموجودة على الأشجار في ذروة كل جيل لم يكن ذو تأثير إيجابي على نشاط وضع إناث عثّة الخروب (*E. ceratoniae*) للبيض. بناءً عليه، أظهرت الدراسة الحالية أهمية تجنب وجود ثمار الرمان المتشققة، حيث أنها تؤثر بشكل إيجابي في سلوك الإناث البالغة وبرقات عثّة الخروب في حقول الرمان.

**كلمات مفتاحية:** رمان، تشقّق الثمار، عثّة الخروب، وضع البيض، سلوك الحشرة، هجرة.

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## References


**Al-Izzi, M.A.J. and S.K. Al-Maliky.** 1996. Action of tannic acid on consumption and utilization of food by *Ectomyelois ceratoniae* Zeller (Lepidoptera: Pyralidae). Journal of Stored Products Research, 32(3):195-199. https://doi.org/10.1016/S0022-474X(96)00025-2

**Agridata.** 2018. Tunisian Ministry of Agriculture data. Onagri. Available at Agridata Tunisia. Accessed 9 August 2024.

**Agridata.** 2019. Tunisian Ministry of Agriculture data. Onagri. Available at Agridata Tunisia. Accessed 9 August 2024.

**Dhouibi, M.H.** 1982. Bio-écologie d'*Ectomyelois ceratoniae* (Lepidoptera: Pyralidae) dans les zones présahariennes de la Tunisie. PhD dissertation, University of Paris VI, France. 145 pp.

**Dhouibi, M.H.** 1985. *Essai de traitement sur Ectomyelois ceratoniae* Zell. vivant sur dattes. Document Technique INRAT No. 85. Institut National de la Recherche Agronomique de Tunisie, Tunisia. 9 pp.

**Dhouibi, M.H. and A. Jemmazi.** 1993. Lutte biologique contre la pyrale des caroubes *Ectomyelois ceratoniae* (Lepidoptera: Pyralidae) par *Habrobracon hebetor* (Hymenoptera: Braconidae) en vergers de grenadier. Mededelingen van de Faculteit Landbouwwetenschappen, Rijksuniversiteit Gent, 58:427-436.

**Gothilf, S.** 1969. Biology of the carob moth *Ectomyelois ceratoniae* (Zell.) in Israel: effect of food, temperature and humidity on development. Israel Journal of Entomology, 4:107-116.

**Gripenberg, S., E. Morrien, A. Cudmore, J.-P. Salminen and T. Roslin.** 2007. Resource selection by female moths in a heterogeneous environment: what is a poor girl to do? Journal of Animal Ecology, 76(5):854-865. https://doi.org/10.1111/j.1365-2656.2007.01261.x

**Jeangille, M.P. and M.H. Laajef.** 2020. Chaîne de valeur grenade dans le gouvernorat de Gabès: cartographie et plan d'action à court et à moyen terme. EuropeAid/139091/IH/SER/TN, Programme IRADA, Tunisia. 151 pp.

**Jerraya, A.** 2003. Principaux nuisibles des plantes cultivées et des denrées stockées en Afrique du Nord: leur biologie, leurs ennemis naturels, leurs dégâts et leur contrôle. Climat Pub, Tunisia. 251 pp.

**Ksantini, M.** 2018. Mass-releases of the egg parasitoids (*Trichogramma*) for organic protection of pomegranate fields in Gabes and Kairouan governorates from *Ectomyelois ceratoniae* attacks during the 2018 campaign. Report, Tunisian Ministry of Agriculture, Tunisia. 5 pp.

**Ksentini, I.** 2010. Contribution to the study of the bio-ecology of the carob moth *Ectomyelois ceratoniae* (Lepidoptera: Pyralidae) and other pests in pomegranate orchards: importance of damage and biological control essays using the oophagous parasitoid of the genus *Trichogramma* (Hymenoptera: Trichogrammatidae). PhD dissertation, University of Sfax, Tunisia. 347 pp.

**Ksentini, I., T. Jardak and N. Zeghal.** 2013. A laboratory comparison of four *Trichogramma* species (Hymenoptera: Trichogrammatidae) as potential biocontrol agents for the carob moth, *Ectomyelois ceratoniae* (Lepidoptera: Pyralidae). Biocontrol Science and Technology, 23(4):465-469. https://doi.org/10.1080/09583157.2012.763088

**Mars, M. and S. Sayadi.** 1992. Étude comparative de la qualité des fruits de cinq variétés de grenadier (*Punica granatum* L.). Revue des Régions Arides, 3:45-57.

**Mars, M. and M. Marrakchi.** 1998. Conservation et valorisation des ressources génétiques du grenadier (*Punica granatum* L.) en Tunisie. Plant Genetic Resources Newsletter, 114:35-39.



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