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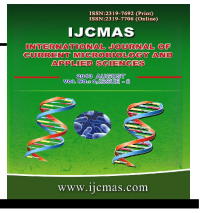


**Original Research Article**

# Biological activity of essential oils leaves from one Sahara plant: *Peganum harmala* L. (*Zygophyllaceae*) on the desert locust

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**K e y w o r d s**

*S. gregaria*, toxicity; *P. harmala*; Sahara; lethal time; essential oils.

**A B S T R A C T**

The biological activity of crude leaf essential oil of *Peganum harmala* L. collected from Oued M'Zab in Ghardaïa region (Algerian Septentrional Sahara), on the larvae $L_5$ and adult individuals of desert locust, showed a toxic effect in the desert locust. After treatment, the fifth stage larvae and imagos of *S. gregaria*, by crude extracts of *P. harmala* leaf essential oils, problems of imbalances and convulsive movements are observed. These are the same symptoms noted, in insects treated with insecticides. The lethal time 50 ($LT_{50}$) measured immediately after treatment, are of the order of 06 mn 12 ' of $L_5$ larvae and for 19 mn 21' for imagos of this insect. The fifth stage larvae of the desert locust seem more sensitive to the action of essential oils as imagos.

## Introduction

Looking for new techniques to protect crops against pests in order to increase agricultural production for a growing world population while preserving the environment, organizations and research institutions are moving towards biological control (Appert and Deus 1982; Anthelme *et al*., 2006). The possibility of using plant secondary metabolite against insect pests in general and against the desert locust in particular has generated a lot of work. The most recent are those of Abbassi *et al.*, (2003a, 2003b, 2004, 2005), Ould El Hadj *et al*., (2006), Zouiten *et al.*, (2006), Idriss and Hermes (2008), and Doumandji-Mitiche Doumandji (2008), and Ammar N'cir (2008) and Kemassi *et al.*, (2010).

The Sahara has a unique plant biodiversity, is about 480 species (Mair, 1933), of which there are 162 endemic species in the Northern Sahara and one which is added a centuries-old tradition of traditional medicines. Several species are known for their remarkable healing properties (Quezel, 1963). The wild plants of arid region are considered one of the plant genetic resources that are of agronomic, economic and ecological as well as strategic (UNESCO, 1960). Given

this fact, and to better characterize the potential of the Saharan flora, this study research from *Peganum harmala* L. (Zygophyllaceae), a wild plant of septentrional Sahara of Algeria, untouched by the desert locust, its acridicides characteristics.

## Materials and Methods

### Biological Material

The biological material is made up of fifth stage larvae ($L_5$) and imagos of locusts and leaves of *Peganum harmala L*., harvested from Oued M'Zab (region of Ghardaïa, Algerian septentrional Sahara).

The fifth stage larvae and imagos of locusts experienced result from a mass breeding maintained in protection ecosystems in arid and semi-arid areas laboratory, University Kasdi Merbah-Ouargla.

### Plant Material

*Peganum harmala* L. is a perennial herb of the family Zygophyllaceae, usually little branched stems, 30 to 90 cm high, with rather short internodes. It has elongated leaves and irregularly divided into multiple strips very thin, dirty white flowers with large sepals unequal persistent beyond the corolla and petals cream washed pink-orange-yellow ribbed, oblong subsymétriques (Photo 1). This plant grows in Southern Europe and Austro-eastern Asia Minor, Tibet, Iran, Turkestan, Syria, Arabia, Egypt and North Africa. In Algeria, *P. harmala* is common to the highlands, northern and southern Sahara, and the mountains of the central Sahara (Maire, 1933; Ozenda, 1991; UICN 2001). It is used by local people as a fumigant for treating seizures in children in decoction and ointment for the treatment of fevers in frictions for rheumatism. *P. harmala* has properties anthelmintic, antimalarial, antispasmodic, sudorific and intoxicating. This plant is not grazed by animals (Ozenda, 1991; UICN, 2001).

### Extraction of essential oils

The leaves of *P. harmala* subjected to extraction are taken from seedling stage plants, harvested from their natural habitat of existence far places by man. With the help of a simple hydrodistillation assembly, the fresh leaves of *P. harmala* are brought to a boil for 6 hours, decanting is then performed. The resulting product was dried using anhydrous sodium sulphate to remove the little water that may have been retained in the organic phase. The resulting product is a pure essential oil, used for the treatment of insects.

### Study of the toxicity

With the help of a micro-spray (Ultra Low Volume), pure essential oils are sprayed directly on the fifth stage juveniles and adults of *S. gregaria* to their action studied by contact. It was noted after treatment motor activity and the rate and time of death. The experiment is followed until the death of all individuals in the treated groups. To this end, four lots of insects for 60 individuals including 30 males and 30 females per lot are made, making a total of 240 individuals. Two lots are fifth stage larvae including one for the control and the other for the treatment and the other two consist of imagos which one for the control and the other for treatment.

### Determination of lethal time 50 ($LT_{50}$)

The median lethal time 50 ($LT_{50}$), is the time required for 50% of individuals of a

population die from treatment with any substance. It is calculated from the probit regression line corresponding to the percentage of mortality adjusted for log processing time. It is used Schneider formula and the probits table.

**Schneider formula:**

MC = [M2-M1/100-M1] x 100
MC: corrected mortality (%); M2: mortality in the treated population (%); M1: mortality in the control population (%).

## Results and Discussion

### Effect of essential oil of *Peganum harmala* on the mortality of larvae $L_5$ and adults of *Schistocerca gregaria*

Showed the results of Figures 1 and 2, it appears that the essential oils of *P. harmala* have a lethal effect on larvae $L_5$ as well as the adult of desert locust. The fifth stage larvae seem more sensitive than adults; they die first, $L_5$ larvae, mortality was recorded from the third minute, after treatment and 100% mortality was reached after 08 mn 30', while it is in 30 mn 18' in adults. But the early deaths are visible from the twenty-second minute at the beginning of treatment in adults. However, no deaths were recorded in individuals of control groups and that all larvae $L_5$ have completed fledge after 7±1 days.

Furthermore, it is important to note that males either their stages of development, larvae $L_5$ or adults seem more sensitive, they also die sooner than females. In addition, balance disorders, convulsive movements, intense defecation loss of the ability to perch with a support following the inability to join tarsique, trembling of appendages and increased respiratory rate are observed. These events demonstrate the neurotoxic action and organohalogen effects of *P. harmala* essential oils on locust is probably the consequence of the effect of its extracts on the nervous system of desert locust. The neurotoxic action of crude *P. harmala* essential oils on the fifth stage larvae and adults of the desert locust stems probably from the effect of different chemical compounds that are particularly alkaloids on the nervous system of the desert locust (Abbassi *et al.,* 2005). Similar events are observed in locusts treated with insecticides organohalogens used, for fight against locusts swarm (Chauvin, 1956; Moreteau, 1991). An examination of dead locusts treated under a dissecting microscope, revealed the absence of lesions in the cuticle, for that, the essential oils of the plant exert little effect on the cuticle and inhalation action may be considered because of the volatile character of its plant species. ISMANS (2000) and Chiasson and Beloin (2007), studying the biological activity of essential oils of many plants, including oregano, basil, marjoram, thyme, sage, bay leaf, rosemary, lavender and others on many insects that thrips, aphids the Coleoptera and Hymenoptera whiteflies, note that essential oils act directly on the cuticle of insects and mites, soft-bodied as thrips, aphids, whiteflies and some mites. By cons, they have been less effective on insect cuticle lasts such as Coleoptera and Hymenoptera adults and some predatory mites. However, it should also be noted that individuals either male developmental stage larvae or adults die before females, this is probably related to the difference in weight between males and females of the locust. Usually in locusts sexual dimorphism is apparent, the males weigh less compared to females. Meanwhile, it is recognized that resistance to toxic differs from one species to another, and for the

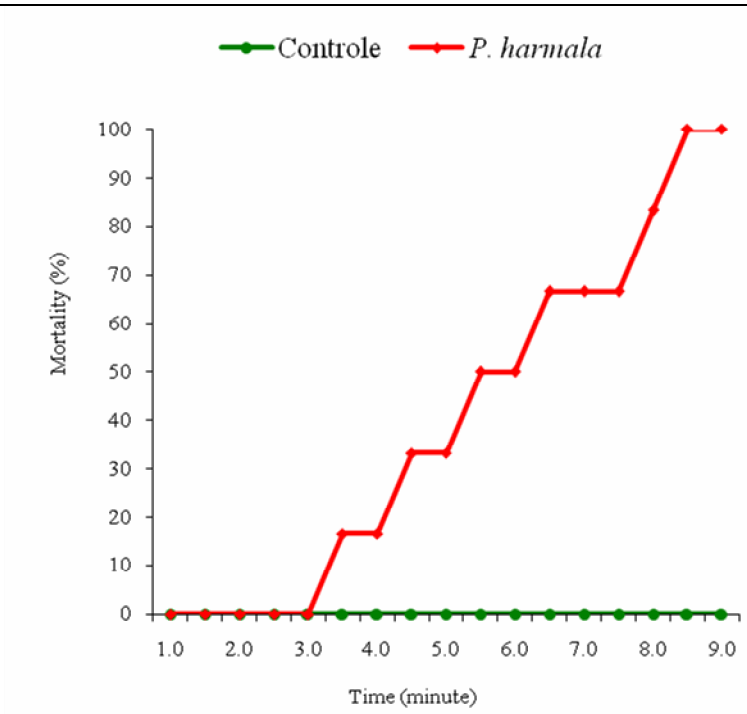



**Figure.1** Kinetics of the cumulative mortality of *S. gregaria* larvae $L_5$ control and treated with essential oils of *Peganum harmala*

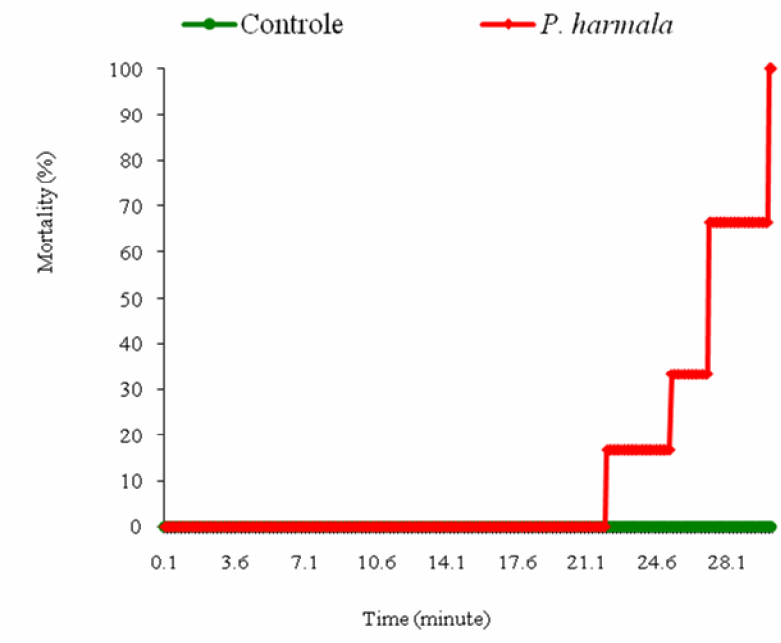
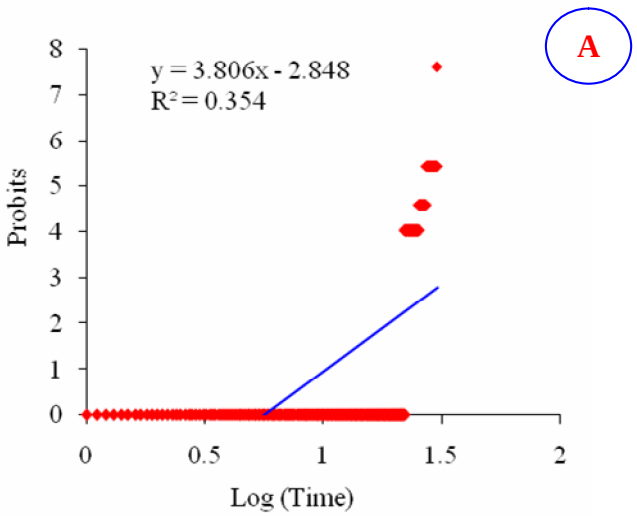
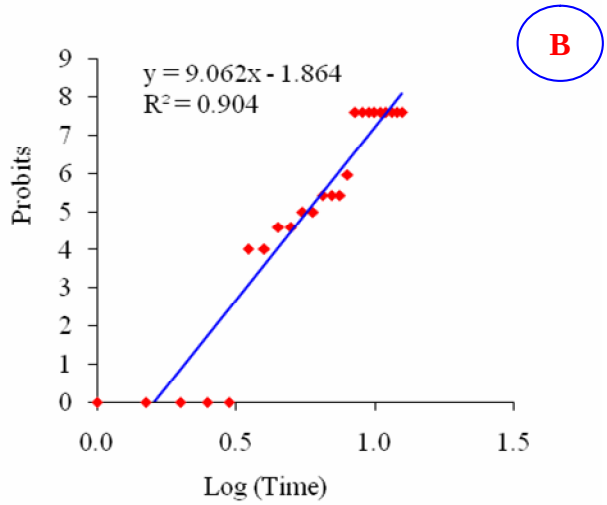



**Figure.2** Kinetics of the cumulative mortality of adult *S. gregaria* witnesses and processed by the essential oils of *Peganum harmala*




Essential oils of *P. harmala* in time for adults of *S. gregaria*




Essential oils of *P. harmala* time of $L_5$ larvae of *S. gregaria*

**Figure.3(A, B)** Action of *Peganum harmala* essential oils on the fifth stage larvae and adult of *Schistocerca gregaria* in time.

**Table.1** Regression equation, regression coefficient and $TL_{50}$ and $TL_{90}$ calculated for the essential oil of *Peganum harmala*

| Stage | Regression equation | Regression Coefficient ($R^2$) | Lethal time 50 ($TL_{50}$) (minute) | Lethal time 90 ($TL_{90}$) (minute) |
|---|---|---|---|---|
| **Larvae $L_5$** | y = 9,0624x – 1,8647 | 0,9042 | 06 min 12’ | 07 min. 56’ |
| **Adults** | y = 3,8067x – 2,8485 | 0,3542 | 19 min 21’ | 41min. 43’ |

same species, it is relative to several factors whose weight is critical.

### III-2- Lethal time 50 ($LT_{50}$) of *Peganum harmala* essential oils of on larvae $L_5$ and adults *Schistocerca gregaria*

Table 1 and Figure 3 (A, B) group the regression equations and, regression coefficients and values of $TL_{50}$ and $TL_{90}$ evaluated for essential oils of this Saharan plant on the $L_5$ larvae and imagos of desert locusts.

Evaluation of lethal time 50 ($LT_{50}$) and 90 ($TL_{90}$) for *P. harmala* essential oils on $L_5$ larvae and adults of *S. gregaria*, has to confirm the speed of action of these extracts on $L_5$ larvae compared to adults. The $LT_{50}$ reported for the fifth stage larvae being shorter, it is of the order of 06 min 12', as for the assessment for adults is the 19 min 21'. As for the lethal time 90 ($TL_{90}$) evaluated, they are 07 min. 56' and 41min 43'for the fifth stage larvae and adults respectively. This confirms the sensitivity of larvae per intake for adults. Moreover, it is commonly accepted that insect resistance to toxins increases depending on the stage of development, and that adults are generally more resistant than larvae (Chauvin, 1956).

The study of the toxicity of essential oils of *Peganum harmala* on the fifth stage larvae and adults of *Schistocerca gregaria* demonstrate their power to put insecticide on the desert locust. The fifth stage larvae are more susceptible to the biocidal action of essential oils compared to adults, lethal time 50 ($LT_{50}$) estimated for $L_5$ larvae are shorter to those reported for adults of *S. gregaria*. The neurotoxicity symptoms were reported, then disorders and convulsive movements, inability to perch in the support is also noted in the larvae and adults exposed to essential oils of *P.harmala,* this reflect the neurotoxic effect of its crops extrqcts on desert locus. From this perspective, the use of *P. harmala* essential oils against the locusts could be considered. These natural compounds could be a building block for the synthesis of new molecules with particular effectiveness of locusts and without risk of environmental poisoning. However, in advance, it is appropriate to refine knowledge of the chemical composition of the essence plant of the functional properties and to determine the terms and possible applications without harming the ecosystem and in compliance with health human.

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