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OSYRIS (*OSYRIS ALBA* L.) UPDATES, THE ILLUSTRATED THREATENING PARASITE TO FRUIT AND FORESTRY TREES IN JORDAN

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Abstract

Field trips carried out in different parts of Jordan showed that *Osyris alba* L. is parasitizing certain fruit and forestry species of different plant families. The parasite was found attached to the root system of olive, grape, almond, figs and plum, and on forestry trees of cypress, orange wattle, Aleppo pine, Palestine buckthorn and wild pistachio. In addition, different common wild shrubs including the widely spread thorny burnet and spiny broom were severely attacked. The parasite growth mass was different on different hosts. Cypress, olive, almond and grapes were heavily attacked while Aleppo pine showed low infestation. *O. alba* may exhibit host preference, since it caused death to several fruit and forest species including olive in certain sites. Farmers indicated that birds and mainly the yellow vented bulbul, commonly found in different places, is the main dispersing agent of parasite seeds since it feeds on the abundantly produced berry fruits. The infected hosts and the parasite were photographed and illustrated. In conclusion, the parasite is spreading on economic fruit and forestry species and has the potential to spread into other geographical regions. The heavily attacked thorny burnet and spiny broom may be regarded as a source of parasite infestation since common in different regions. The parasite may be considered as a serious threat to important tree species in the country.

Key words: *Osyris alba*, Parasitic weeds, Fruit trees, Forestry species.

Introduction

Osyris (*Osyris alba* L.) is a shrub or sub-shrub 0.2 - 2 m height, depending on the attacked host species, food supply and ecological factors. It is of 40-100 cm hairless and green, very branched, twigs erect, tapered, spindly and angular. The parasite has woody, erect or sometimes creeping dark green or brown stem and turns out constituted from ram celli black and thin on which they dull alternate of dark green color and sessile long narrow leaves 3-8 cm (http://www.science.siu.edu/parasitic-plants/ santalaceae/des-cription.htm.). *O. alba* is a dioecious hemiparasite, takes an advantage of the roots of other plant species and also exhibits self-parasitism (Planchon, 1858; Aronne *et al*., 1993). It belongs to the Santalaceae family which includes almost 30 genera all of which are believed facultative parasites. These parasites obtain their food and water through absorptive organs (haustoria) attached to the root system of host plants. It is widely spread in southern Europe, North Africa, and southwest Asia mainly Mediterranean region (Aronne *et al*., 1993; Herbarium records: (http://www.science.siu.edu/parasitic-plants/ Santalaceae/description.htm; http://www.naturescene.net/ plants/ Osyris %20alba.html) and has been reported as a temperate to tropical, cosmopolitan, except in cold regions (Watson & Dallwitz, 1992). The parasite is frost sensitive and prefers sandy soils. Flowers are yellow, with three petals and flowering scented in spring during May-July.

Pollination is a prerequisite for fruit and seed development. The single seed, containing a small embryo and a large, rich endosperm, enclosed in a red color fleshy bird-dispersed berry or drupe fruit. On maturity seeds become dark brown. Drupes are non-edible.

O. alba has been mentioned in old literature as parasitizing different perennial plant species of both herbaceous or woody plants of different families of dicotyledons including *Ailanthus, Rhus coriaria, Ulmus campestris, Jasminum fruticans, Pinus halepensis, Rosa canina, Silene italica, Lychnis dioica* and *Rubia peregrina* (Planchon, 1858), later on other host species have been mentioned as being attacked by this parasite including *Hedera helix* (Benharrat *et al*., 987), *Amygdalus*, *Quericus* and *Cupressus* (Joel *et al*., 1991) and found also growing on the edges of *Pyrus communis* and *Vitis vinifera* (Nickrent, 2002; Nickrent & Musselman, 2004). However, in a more recent study Qasem (2006a) recorded 23 host species 5 of which the parasite attachment on their roots was not possible to confirm but was growing in their vicinity.

While different chemicals were isolated and identified from the parasite many of which have medicinal uses for different ailments (Mamoucha & Christodoulakis, 2016) and including pyrrolizidine alkaloid, flavonoids, phytochemicals and some organic acids (Hamdan & Afifi, 2008, Tsukasa *et al*., 2008, Al-Jaber *et al*., 2010), the more importantly is the presence of two classes of alkaloids; quinolizidine and pyrrolizidine that enable the parasite defend itself against herbivores (Woldemichael & Wink, 2002).

The aim of the present study was to confirm *O. alba* presence in certain parts of Jordan and document its hosts in the country. Familiarize local farmers and agriculturist with the threat that parasite exerts on agriculture in the country, and draw their attention to the necessity of taking control measures and manage its threat to other fruit and forestry species and new regions in the country, update and quantify the significant changes in the distribution and hosts of the parasite and correlate that with certain ecological factors, and finally, document the role that certain wild species play in hosting and spreading the range of the parasite to more economic crops.

Materials and Methods

This study forms a part of the ongoing field survey to document parasitic weeds and their hosts in Jordan. The survey involves field trips that are conducted to update information and evaluate parasitic weed problems and the extent of their distribution and spread in the country. The effect of these parasites on cultivated crops and wild growing plants and forestry species are quantified. *O. alba* was identified and recorded on its hosts in different bio-geographical regions. Host species were recorded, photographed, visually evaluated and information and notes on the host and parasite growth and performance were taken. Visual estimation was considered to quantify the severity and intensity of parasite infestation on different hosts and on spread of the parasite in certain parts of the country. The present work represents a continuity of a previous work done (Qasem, 2006a) but host and parasite association were photographed and presented. This allows interested researchers and farmers to better recognize the parasite and visualize its damage on different hosts. In addition, illustrations of the parasite at flowering and fruiting stages showed the high potential of the parasite to expand into different regions by birds and the massive growth it attained on different hosts and host preference can be visually evaluated and recognized. A photo of the bulbul indicated by farmers as a main agent among other birds in dispersing the parasite fruits was also included.

Results

The present survey revealed that *O. alba* is present in different geographical regions in the country including the sub-tropical and Mediterranean in the central and north parts of Jordan. The parasite was found attacking different hosts belong to different plant families varied in their growth and stature and included wild shrubs and fruit and forest trees (Table 1). Severity of infestation was clearly different on different hosts (Figs.1, 2 and 3), the parasite developed a massive growth and longest shoots, huge number of flowers and heavy fruit yield on cypress and olive, but its vegetative growth and productivity on other species was obviously lower. Among fruit trees, almond (wild and cultivated) and plum suffered death in certain places and grape and olive were heavily attacked and died in certain sites (Fig. 2). Among forest trees cypress of both varieties (*pyramidal* and *horizental*), Palaestine pistachio, and Palestine buckthorn were severely affected and some trees died or turned yellowing while infestation on Aleppo pine was low and plants of this species were least affected and either appeared normal or showed death on some branches (Fig. 3). The parasite attacked almond (Fig. 4) in different places and the effect ranged from slight to death depending on the intensity of infestation (Fig 2).

Compared with parasite growth and yield on cypress, it produced short shoots with no flowers or fruits observed when parasitized Aleppo pine although both hosts were found growing together in the same place. Parasite infestation on small woody shrubs or trees including thorny burnet, spiny broom, and Palestine buckthorn resulted in death of these species (Figs. 1 and 3). It seems that the parasite prefers species of the Rosaceae and Leguminosae (Fabaceae) families but more to the first since it caused death to almond and plum trees and widely spread on the commonly spread thorny burnet in mountainous area in different parts of the country. Local farmers are not familiar with the parasite or aware with its problem on their trees although they used to remove parasite shoots from the crown area of their trees using the hoe or by cutting. However, farmers indicated that birds including the yellow vented bulbul (*Pycnonotus xanthopygos* Hemprich and Ehrenberg) (Fig. 5), commonly found at home gardens in different places, usually feed on the fruits of this parasite.

Table 1. Fruit and forest plant species commonly parasitized by *O. alba* in Jordan.

Scientific name	English name	Family name	Importance	Status of infected plants	Parasite growth mass
Acacia cyanophylla Lindl.	Orange wattle, Blue-leaved wattle	Leguminosae	Ornamental & forest	Weak growth	Low
Amygdalus communis L. (wild and cultivated)	Almond	Rosaceae	Fruit	Death or severely attacked	High
Anagyris foetida L.	Stinking bean trefoil	Leguminosae	Forest	Partial death	High
Calycotome villosa (Poir) Link.	Spiny broom, Thorny broom	Leguminosae	Ornamental & forest	Death	Low
Clematis cirrhosa L.	Fern-leaved clematis	Ranunculaceae	Forest, climber	Partial death	Moderate
Cupressus sempervirens L.	Cypress	Cupressaceae	Forest	Severely attacked, yellowing, weakened	High
Olea europaea L.	Olive	Oleaceae	Forest	Death, severely attacked	High
Ficus cariaca L.	Figs	Moraceae	Fruit	Yellowing	Moderate
Pinus halepensis Mill.	Aleppo pine	Pinaceae	Forest	No symptoms	Low
Pistacia palaestina Boiss	Wild pistachio	Anacardiaceae	Forest	Death	Moderate
Prunus domestica L.	Plum	Rosaceae	Fruit	Death	Moderate
Quercus coccifera L.	Oak	Anacardiaceae	Forest	Yellowing, severely weakened	Moderate
Retama raetam (Forskal) Webb & Berth	White weeping broom	Leguminosae	Forest	Moderate growth loss	Moderate
Rhamnus palaestina Boiss	Palestine buckthorn	Rhamnaceae	Forest	Death	Moderate
Sarcpoterium spinosum (L.) Spach	Thorny burnet	Rosaceae	Mountainous, forage, fuel, and medicinal	Death in many cases	Moderate
Vitis vinifera L.	Grape	Vitaceae	Fruit	Yellowing, weakening, not yielding	High

O. alba on thorny burnet

O. alba on spiny broom

O. alba Fern-leaved clematis

O. alba on stinking bean trefoil

Fig, 1. *O. alba* parasitizing certain species of forest shrubs in Jordan.

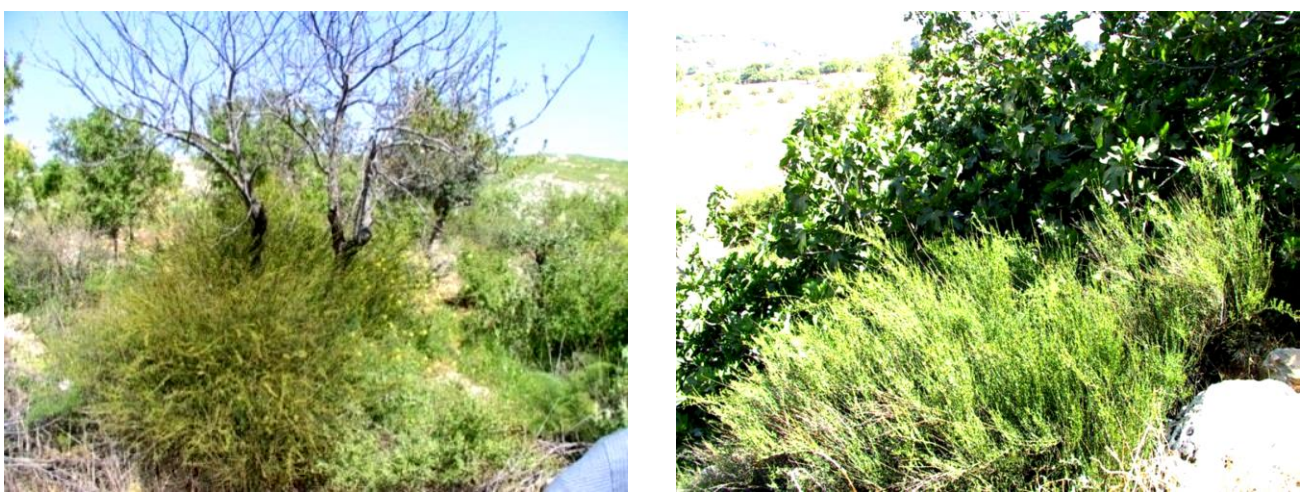
Discussion

O. alba is a hemi-parasite, contain chlorophyll pigments and thus can perform photosynthesis and produce its own food. In spite of that, the parasite tends to attack suitable host species mainly from woody shrubs and trees in its vicinity taking an advantage in absorbing food and may be other growth materials (Qasem, 2006a and b). Literature on parasite germination and growth and requirements, differences in growth and biology when grown separately or parasitizing other species, chemical constituents, parasitic habit and fruit production, physiology, dispersing agents, hosts range, economic importance and parasite control are generally limited worldwide. However, few host species of the parasite have been reported (Qasem, 2006a) and some other species were suspected to be attacked since was found growing close to or in their surroundings (Joel *et al*., 1991). Parasitic habit of the hemi-parasites including *Osyris* spp. is difficult to understand and justify, but may occur because of insufficient food produced by these parasites through photosynthesis. However, *O. alba* was found growing separately in certain parts of the study area and also parasitizing other plant species and at different extents (Figs. 1, 2 and 3). This indicates that this parasite has a host preference habit accompanied with high physiological tolerance since species of different plant families were found parasitized. Other workers however, reported *O.alba* as unspecialized hemi-parasite producing haustoria on the host roots through which can absorb water and nutrients from host plants (Aronne *et al*., 1993) and thus its seed germination may not require host stimulants.

In the present work, it has been observed that certain fruit (e.g. *Pistacia vera* L.and *Punica garanatum* L., *Prunus armeniaca* L., *Malus demostica* L. and *Morus alba* L.) and forestry (e.g. *Eucalyptus camaldulensis* Deh.) species not attacked by the parasite while others were heavily infested although all were found growing in the same field. The heavily parasitized fruit trees were almonds (cultivated and wild grown) and plum while olives and grapes were second. The parasite caused death to the first (Fig. 2) and seriously weakened the second group. Of the forestry species, cypress (both varieties) was severely attacked in different places in the Amman area and the parasite produced high and massive growth and fruit yield. In contrast, growth of the parasite on Aleppo pine trees was low and seems that these trees although attacked but were not preferred in presence of other more attractive species. However, the simultaneous presence of two classes of alkaloids, quinolizidine and pyrrolizidine, in *O. alba*, indicate that the parasite must have tapped more than one host plant concomitantly. Since both alkaloids do not occur in the same host plant (Woldemichael and Wink, 2002).

O. alba killed wild almond | *O. alba* on cultivated almond | *O. alba* killed almond

O. alba on grape | *O. alba* on olive | *O. alba* grow below and over olive tree



O. alba on plum | *O. alba* on figs

Fig. 2. *O. alba* parasitizing certain species of fruit trees in Jordan.

The parasite was found widely spread on woody shrubs in mountains in different regions indicating the possible importance of these in the parasite multiplication and spread. While spiny broom suffered death in different places, the parasite was found widely spread on thorny burnet in subtropical and Mediterranean regions in Amman, Sweileh, Nau'ur and al-Salt areas. These results confirmed that species of the Rosaceae family may be preferable hosts for the parasite since thorny burnet is of the same family. The parasite shoots may grow 3-4 m long, elongated, tapped and laid over foliage of cypress and olive trees. It appeared climbing the pyramidal variety of cypress trees but was confound to the crown area on Aleppo pine. However, on these professed hosts the parasite produces a massive vegetative growth, flowers and heavy fruit yield. However, the horizontally grown cypress trees that were attacked exhibited yellowing on foliage parts which may indicate that the parasite absorbed high amounts of the photosynthate materials from host plants, interfered in photosynthesis or in the partitioning of growth materials (including photosythates and nutrients) between shoots and roots. Other possibility that the parasite may interfere with nitrogen translocation to shoots in these plants since was growing in the crown area and not reached their vegetative parts (Fig. 3). On vertically grown cypress (var. *pyramidal*) the parasite can also prevent light interception by these plants and olive trees since grow on their vegetative parts in addition to its parasitic effects.

O. alba on cypress var. *horizontalis*

O. alba on cypress var. *pyramidalis*

O. alba on Aleppo pine

O. alba on white weeping broom

O. alba on Palestine buckthorn

O. alba on oak

O. alba on Palestine pistachio

O. alba killed Palestine pistachio

O. alba on orange wattle

Fig. 3. *O. alba* parasitizing certain species of forest trees in Jordan.

Fig. 4. *O. alba* shoots attached on almond roots.

Fig. 5. The Yellow vented bulbul.

Although control measures of the parasite practiced by local farmers are primitive but recommended and practiced measures for parasite control are mainly through cutting or the use of contact herbicides (Qasem, 2006a). However, these must be frequently followed. If control was not achieved then translocated herbicides can be applied using a Rope-whip applicator in a directed spray. However, when translocated herbicides are used to control the haustoria inserted in host tissues this require these chemicals to be used at very low rates. In all cases, control must be applied before the parasite starts fruiting. *Orgyia trigotephras* was reported as a biocontrol agent for the parasite (bio/life/warp/food-plants-o.htm) but the parasite has been mentioned to contain quinolizidine and pyrrolizidine alkaloids that serve as defense compounds against herbivores, the simultaneous acquisition of the two types of alkaloids by a single plant could provide a novel mode of defense of hemiparasites against herbivores (Woldemichael & Wink, 2002) which may hinder their biological control.

Conclusions

It seems that the parasite has a wide host range of both wild and cultivated woody plant species that differ in growth habit, habitat and genetics. These ranged from shrubs, to fruit and forest trees of both gymnosperms and angiosperms. The parasite appears exhibits a wide range of ecological and physiological tolerance. Severity of infestation on different hosts varied, indicating incompatibility, presence of chemical, physiological or mechanical differences. Almond, cypress, olives, grapes, and thorny burnet are heavily infested. The parasite is destructive to spiny broom, almond and Palestine pistachio while stinking bean trefoil and Aleppo pine were less infected. Necessary measures should be taken to prevent parasite spread and invasion into other regions. Studying the physiological effects of the parasite on different hosts appeared important in understanding their interrelationships. The parasite dispersing birds and mainly the yellow vented bulbul, while similar studies are required on its method of control before taking over a wide area grown by fruit and forestry species in the country.

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