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ORIGINAL ARTICLE

# The seedcorn maggot *Delia platura* (Diptera: Anthomyiidae): An emerging pest of garlic crops in Tunisia

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**Abstract**

During routine phytosanitary inspections performed in February 2021 on vegetable crops in the region of Sidi Bouzid, Central Tunisia, unusual severe and generalized damage on young garlic, *Allium sativum* L., crops were observed. The causal agent was later identified as the seedcorn maggot *Delia platura* Meigen (1826) (Diptera: Anthomyiidae) using morphological and DNA-based approaches. Symptoms on garlic are described and brief notes on diagnostic features of both adult and juvenile instars are presented. Possible phytosanitary risks and control measures are discussed.

**La mouche de l'oignon *Delia platura* (Diptera : Anthomyiidae) : organisme nuisible émergent sur cultures d'ail en Tunisie**

Au cours d'inspections phytosanitaires de routine réalisées en février 2021 sur des cultures maraîchères dans la région de Sidi Bouzid, située au centre de la Tunisie, des dégâts inhabituels, graves et généralisés, ont été observés sur de jeunes plants d'ail, *Allium sativum* L. L'agent causal a été identifié ultérieurement, sur la base de critères morphologiques et moléculaires, comme étant la mouche de l'oignon *Delia platura* Meigen (1826) (Diptera : Anthomyiidae). Les symptômes sur l'ail sont décrits et les caractéristiques de diagnostic des stades adultes et juvéniles sont brièvement présentés. Les risques phytosanitaires éventuels et mesures de lutte envisagées sont également traités dans cet article.

**Луковая муха *Delia platura* (Diptera: Anthomyiidae): новый вредный организм чесночных культур в Тунисе**

В ходе плановых фитосанитарных обследований, проведенных в феврале 2021 года на овощных культурах в регионе Сиди Бузид, Центральный Тунис, были отмечены необычные случаи серьезного и массового повреждения молодых посевов чеснока (*Allium sativum* L.). Позднее с использованием морфологических и ДНК-методов, возбудитель был идентифицирован как луковая муха *Delia platura* Meigen (1826) (Diptera: Anthomyiidae). Описаны симптомы на чесноке и представлены краткие сведения о диагностических признаках взрослых особей и преимагинальных возрастов. Обсуждаются возможные фитосанитарные риски и меры борьбы.

  

## 1 | INTRODUCTION

Garlic, *Allium sativum* L., is an economically important crop which is cultivated and consumed worldwide, with China and India being the largest producing countries (FAOSTAT, 2021). This vegetable is an important component of diets and is known as a source of various compounds which provide potential health benefits, including antithrombosis and antimicrobial activities. Garlic is also an important source of vitamin C and flavonoids known for their antioxidant activity (Shang et al., 2019).

There are several pests associated with garlic and related species, such as thrips, mites, nematodes and flies. Among the latter, the anthomyiid flies *Delia antiqua* (Meigen) and *Delia platura* (Meigen) (Diptera: Anthomyiidae) are considered as important insect pests of garlic. Additionally, other related plants such as *A. ascalonicum*, *A. porrum* and *A. cepa*, and non-related hosts (listed below for *D. platura*) are also hosts of these insects (Ning et al., 2017).

Some species belonging to the Anthomyiidae family are specialized on certain hosts, such as the cabbage maggot *D. radicum* and the onion maggot *D. antiqua*. Some other species in the genus have a much larger host range and are polyphagous pests, such as the seedcorn fly *D. platura*.

According to CABI (2019), *D. platura* originated from Europe and has a global distribution as it occurs in nearly all continents and climatic zones. The larva of this fly is phytophagous and saprophagous as it feeds not only on germinating seeds belonging to a wide variety of cultivated plants, but also on decaying organic matter. This species was reported as pest of many crops, including vegetable crops, fruit crops, legumes and cereals such as Brassicaceae, Cucurbitaceae, *Oryza sativa*, *Phaseolus vulgaris* and *Zea mays* (Boquel et al., 2018). Damage occurs during the larval stage. When feeding on germinating seeds, young seedlings or even root systems, larvae can cause significant losses, especially in cold and humid climatic conditions (Boquel et al., 2018), which causes dieback of aerial parts of host plants. Yield losses in Fabaceae, cereals, tubers and tobacco seedlings of 10–30%, and in some extreme cases up to 75%, have been reported (Gouinguené & Städler, 2006).

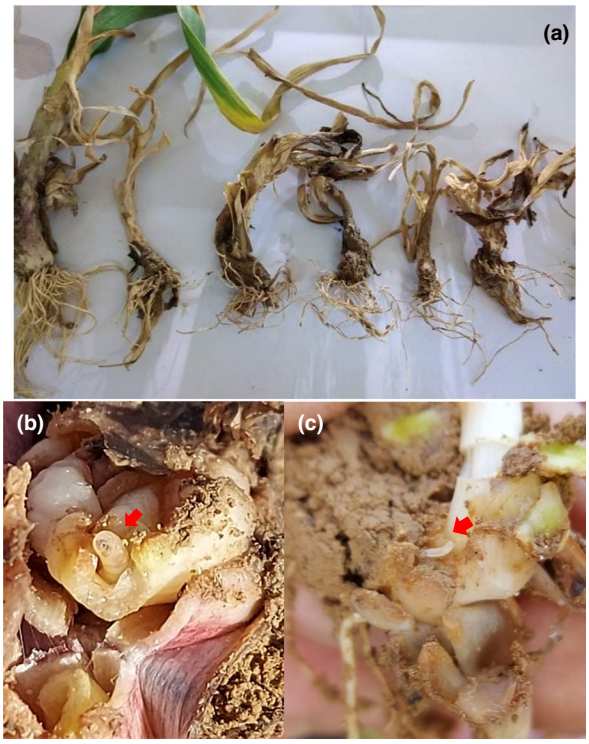


**FIGURE 1** Infestation symptoms of *Delia platura* on garlic. (a) External symptoms and evolution of the infestation on young garlic bulbs starting from wilt of leaves until the death of the plant. (b and c) Infested young garlic bulbs showing larvae inside their tissues (red arrows)

## 2 | OBSERVATIONS IN TUNISIA

### 2.1 | Field detection and morphological identification

During routine phytosanitary inspections in garlic crops, performed by the fourth and last authors, in the region of Sidi Bouzid, Tunisia during February 2021, unusual symptoms of witling on young garlic plants presenting rotten bulbs were observed in many fields. Some areas of the visited garlic fields showed a high number of dead plants (Figure 2). Samples consisting of whole plants exhibiting symptoms were taken to the Laboratory of Entomology of the High Agronomic Institute of Chott-Mariem (ISA-CM), Sousse, Tunisia for further investigation.

In the laboratory, collected plant material was examined and some of the sampled young bulbs showed decaying tissues while some others were hollow and completely dry (Figure 1a). Garlic bulbs were dissected and examined under a binocular microscope (4–8 times magnification) and maggots (Figure 1b–c, red arrows) were observed. Infested materiel was then placed in mesh framed cages (25 × 25 × 25 cm) on a thin layer of fine sterilised sand and incubated in a climatic cabinet (Scimmit, Shanghai Scimmit Technology, China) under controlled conditions (25°C temperature, 70% relative humidity and 16:8 (L:D) photoperiod). Pupae were collected and incubated in the same climatic conditions until the emergence of the adult flies. Emerged flies were collected using a mouth aspirator and conserved in 70% and 90% alcohol. Specimens of adults and juvenile instars of the fly were sent to Dr Marc DeMeyer and Kenny Meganck, Department of Biology, Royal Museum for

Central Africa, Belgium for morphological and molecular identification.

## 2.2 | Diagnostic features

### 2.2.1 | Adult

The adult of *D. platura* (Figure 3a,b) is greenish grey, measuring approximately 6 mm long and marked with longitudinal dark strips on the thorax. The legs are black and the wings are colourless with black veins (Figure 3c).

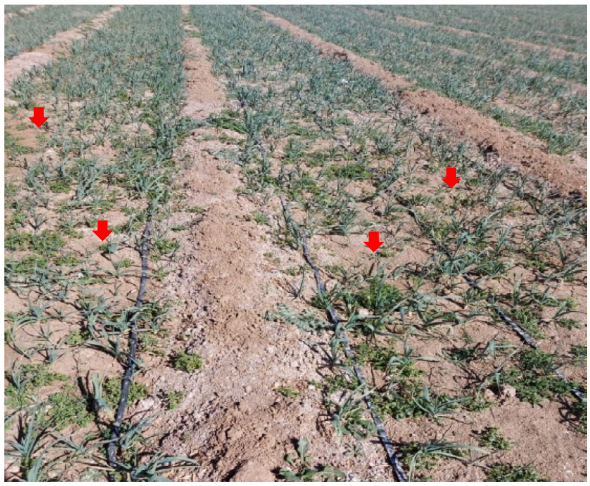

**FIGURE 2** Symptoms of infestation by the seedcorn maggot in the field. Note the empty areas (red arrows) where garlic plants were destroyed by larvae developing inside their bulbs

### 2.2.2 | Larva

Larvae are whitish, measuring up to 6–7 mm depending on the stage (there are three larval stages) (Figure 3d). The posterior spiracles, a useful taxonomic character, do not become visible until the second instar and bear six to eight protruding structures (Figure 3e).

### 2.2.3 | Pupa

Mature larvae (third instar) form a puparium in the soil. Puparium colour varies from yellow-brown to dark-brown or almost black. The puparium measures 4–5 mm long (Figure 3f).

## 2.3 | Molecular identification

The individual DNA of two specimens morphologically identified as *D. platura* (extraction of DNA from one leg in the first case and of a whole adult in the second case) was extracted following the protocol provided by the NucleoSpin®Tissue DNA extraction kit (Macherey-Nagel, Düren, Germany), except for elution volume, which was set to 70 µL. The COI target gene was amplified. The PCR conditions used are those described by Hebert et al. (2003) using the universal primers LCO1490 (5'-GGTC AACAAATCATAAAGATATTGG-3') and HCO2198 (5'-TAAACTTCAGGGTGACCAAAAAATCA-3') (Folmer et al., 1994). PCR results were confirmed through a 1.2% agarose gel electrophoresis (Midori$^{Green}$ Direct) visualized

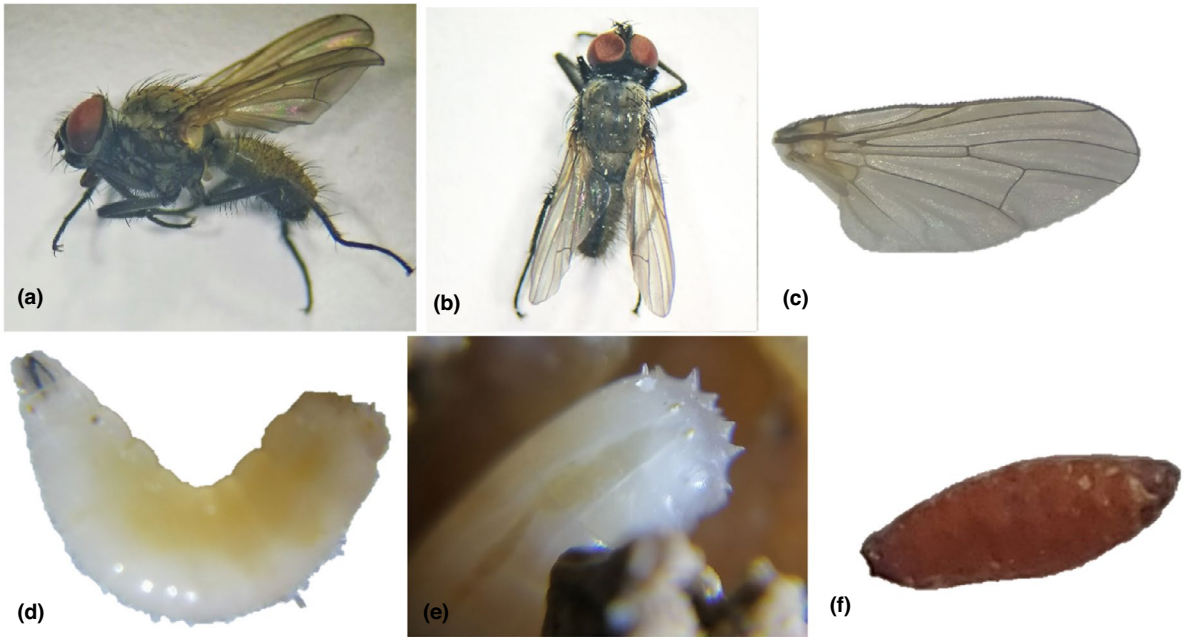


**FIGURE 3** Development stages of the seedcorn fly *Delia platura* collected from infested garlic bulbs from the region of Sidi Bouzid, Tunisia: (a) female, lateral view; (b) female dorsal view; (c) details of wing venation; (d) larva; (e) posterior part of the larva showing protruding lobes (range 6–8); (f) pupa

under a UV transilluminator. The PCR products were then purified according to the *ExoSAP* protocol and finally sequenced bidirectionally with the same primers by Macrogen$^{Inc}$ (Amsterdam, the Netherlands). The quality of the sequences was controlled using the Geneious Prime® 2.3 (Biomatters Ltd, Auckland, New Zealand) software. The ends of lesser qualities were trimmed and the sequences were aligned to obtain a single consensus sequence. The identity of the sequenced specimens was confirmed by BLAST search in GenBank (National Centre for Biotechnology) and querying on the Barcode of Life Data (BOLD) identification engine (https://blast.ncbi.nlm.nih.gov/Blast.cgi).

The fly had previously been morphologically identified as *Delia platura* Meigen (1826). This was confirmed by DNA barcoding (BOLD: 100% similarity with more than 100 vouchers; GenBank: 99.7% similarity). The percentage of similarity drops to 95.4% for the next closest match, which is the species *D. antiqua*. Voucher specimens of the fly were deposited at the insect collection of the High Agronomic Institute of Chott-Mariem (ISA-CM).

## 2.4 | Assessment of damage in the field

In March 2021, to assess the infestation rate of *D. platura*, two garlic plantations each of 1 ha located in the region of Sidi Bouzid were visited and sampled. The sampling protocol consisted of uprooting all garlic plants in a randomly delimited area of 4 $m^2$ replicated 10 times for each field (40 $m^2$ for each plot). Data on sampled crops, the total number of sampled plants, the number of infested and uninfested plants as well as the infestation rates are presented in Table 1. We found that the average infestation rate was 25.4% in the first plot and 37.6% in the second plot.

## 2.5 | Possible phytosanitary risks and control measures

Although *D. platura* is reported as present in Tunisia, associated damage on garlic crops was not common until the last few years. Losses on garlic reported in this paper in the region of Sidi Bouzid suggest that it can potentially become an economic pest of this crop in Tunisia.

**TABLE 1** Infestation rates of garlic plant caused by the seedcorn fly *Delia antiqua* estimated on 10 randomly chosen samples of 4 $m^2$ of planted area each in two onion plantations located in Sidi Bouzid in March 2021

| Plots | Sample | Total number of sampled plants | Number of infested plants | Infestation rate (%) |
|---|---|---|---|---|
| Plot no 1<br>Plantation date: 15 August 2020<br>Variety: Glibi | 1 | 201 | 77 | 38.4 |
| | 2 | 176 | 56 | 31.8 |
| | 3 | 198 | 51 | 25.8 |
| | 4 | 165 | 33 | 20.0 |
| | 5 | 204 | 38 | 18.6 |
| | 6 | 186 | 47 | 25.3 |
| | 7 | 176 | 52 | 29.5 |
| | 8 | 219 | 48 | 21.9 |
| | 9 | 149 | 39 | 26.2 |
| | 10 | 256 | 42 | 16.4 |
| | | | | **25.38** |
| Plot no 2<br>Plantation date: 20 October 2020<br>Variety: Glibi | 1 | 165 | 80 | 48.5 |
| | 2 | 165 | 70 | 42.4 |
| | 3 | 190 | 69 | 36.3 |
| | 4 | 208 | 77 | 37.0 |
| | 5 | 189 | 56 | 29.6 |
| | 6 | 198 | 61 | 30.8 |
| | 7 | 192 | 87 | 45.3 |
| | 8 | 212 | 77 | 36.3 |
| | 9 | 197 | 64 | 32.5 |
| | 10 | 218 | 82 | 37.6 |
| | | | | **37.64** |

The average infestation rate in each plot is given in bold.

Garlic growers in the investigated area have highlighted that attacks became more frequent and significant in the last 3 years. The same situation was recently described elsewhere in the EPPO region by Erdogan (2019), who reported significant presence and attacks of this pest on garlic cultivations in Kastamonu Province, Turkey. After monitoring the pest in garlic crops for two years (2015 and 2017), the same author concluded that *D. platura* should be considered as a major pest of garlic in Turkey.

In the case of Tunisia, garlic and some related species of the genus *Allium*, as well as other vegetables and cereal crops which can also serve as host plants of the fly, are widely cultivated in the region of Sidi Bouzid throughout the year. The production is commercialized all over the country for local consumption, which may potentially facilitate the dissemination of this pest to other garlic growing areas. The emergence of *D. platura* as a pest of Tunisian garlic crops may force growers to use more insecticides to cope with this new pest. In addition, the potential absence of efficient natural enemies can contribute to outbreaks of this fly. This may cause a rise of insecticide applications, especially as the management of this pest is problematic due to its cryptic life cycle and its ability to develop on the decomposing remains of crops in the field. Additionally, irrigated crops and humid soils in the region of Sidi Bouzid offer suitable conditions for outbreaks of this pest, which was reported to develop two to four overlapping generations per year depending on environmental conditions (Légaré & Moisan-De Serres, 2015). Therefore, this pest should be closely monitored by trapping to avoid its dispersion in the country. Monitoring can also be used to decide the timing of insecticide applications, which should target adults. In this context, yellow sticky traps were reported to be efficient for monitoring purposes as adults are attracted to the yellow colour. These traps should be installed in the field soon after seedling emergence as young garlic plants are the most susceptible to this pest. The efficiency of yellow sticky traps can be enhanced using pheromone lures, which are commercially available and are attractive to both *D. platura* and *D. antiqua*. Seedling treatment with spinosad or cyantraniliprole gave good results in onion crops (Fortier, 2016). Likewise, onion seedlings treated with the entomopathogenic fungus *Beauveria bassiana* (strain ANT-03) based insecticides were less attacked by the pest (Fortier, 2016). Mass trapping, which gives satisfactory results against many fruit fly species, should be also considered and developed as a possible alternative control method against *D. platura* due to its environmental benefits compared to chemical insecticides.

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