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Drosophila suzukii, a species to monitor

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Drosophila suzukii has recently arrived in Northern Hemisphere vineyards and has caused damage to grape, particularly in Europe. Damage to the grapes has been observed, as well as the development of sour rot linked to its presence. Other species of drosophila are also present in the vineyards. This insect has now clearly established itself in the vineyard, requiring the attention of the viticultural and wine industry.

Damage to vines

Drosophila suzukii is a damaging pest during the cluster ripening phase leading to negative effects on grape quality. The insect is a precursor and accelerator of the development of other drosophila species associated with grape sour rot epidemics[1] (Figure 1D). This species is the only one of the Drosophilidae that can bore through the thick skin of grape berries[1], with or without laying an egg (Figures 1A and 1B). The direct impact of *D. suzukii* (Matsumura) (Diptera: Drosophilidae) on grape is ambiguous due to the low number of emergences observed per cluster[2]. The potential impact of *D. suzukii* on different cultivars has been tested as a function of the physiological characteristics of grape berries, such as degree Brix, pH and skin penetration force. In particular, the highest number of eggs was found during the ripening period when the pH increases and berry firmness decreases, whereas sugar content increases, black grape varieties being more affected than white ones[2]. The variation in susceptibility of grape varieties is mainly explained by the resistance of the berry skin and the chemical properties of the epicuticular waxes in the choice of oviposition[2]. Other parameters, such as previous damage (Figure 1C), climate, environment and sanitary protection, can have an influence on the intensity of the attack. The direct impact of this pest is therefore limited, with population levels rarely high and also rarely able to generate bunch destruction[3]. These alterations rarely lead to non-harvesting of the plot. The risk of this disease can increase in years of high susceptibility linked to abiotic favorable conditions and damage resulting from mechanical injury or primary pests[3].

How to recognise this drosophila?

➡Adult: General shape of a Drosophilidae, slightly larger in size than *Drosophila melanogaster* (2.3 to 4 mm). The eyes are red and the body is bright yellow or brown. Each abdominal segment has a continuous black stripe on its posterior side (Figure 2A). The female is larger than the male and has a robust ovipositor with sharp black teeth (Figure 2B). The male can be recognised by the presence of a black spot on the tip of each wing (Figure 2C) and by the two sex combs of 3 to 6 bristles on the first and second tarsi of its forelegs (Figure 2D).
➡Egg: Elongated, translucent to milky-white, shiny, less than 1 mm long. It has a pair of long subapical respiratory tubes. The eggs are laid in the pulp of the fruit, with the 2 filaments emerging from the fruit (Figure 1B and 1C).

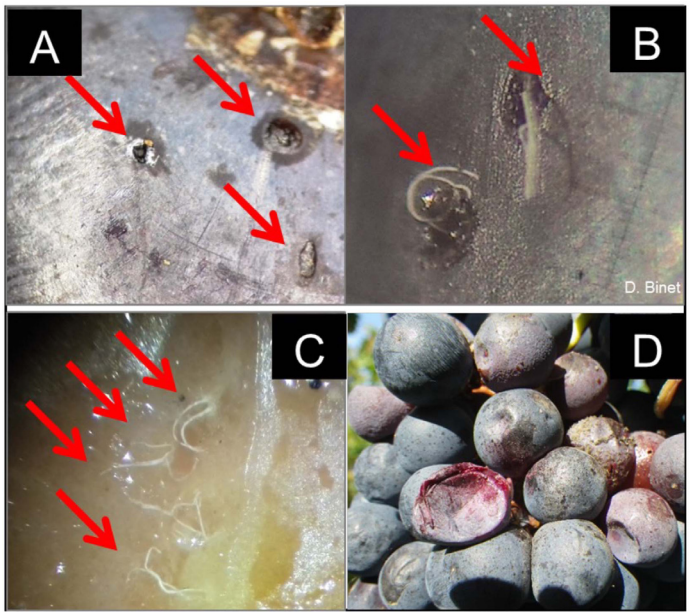

FIGURE 1. *Drosophila suzukii* damage: A) Perforations without eggs; B) Perforations with eggs; C) Eggs deposited in an injury; D) Development of sour rot (credit: D. Binet & L. Delbac).

➡Larva: Typical of the larvae of the genus *Drosophila*, milky white in colour, cylindrical in shape, with black mouthparts and conspicuous spiracles at the rear end of the body. There are 3 larval stages, the larva in the last of which measuring 4 mm.
➡Pupa: Cream to brown in colour with two characteristic star-shaped breathing tubes on the anterior part. Metamorphosis occurs inside the fruit or in the soil, with the anterior part clearly visible.

Geographical distribution

Drosophila suzukii is widely distributed throughout temperate and subtropical Asia[4]. In the 1980s, it was accidentally introduced to Asia Pacific and then to the North American continent in 2008, when red berries were damaged in California. The pest spread rapidly throughout the West Coast states. Concurrently, *D. suzukii* joined the drosophila community in Europe. Its presence on the European continent was detected in 2008[4]. Its extremely rapid geographical expansion is linked to the fruits trade and to the adaptation of this

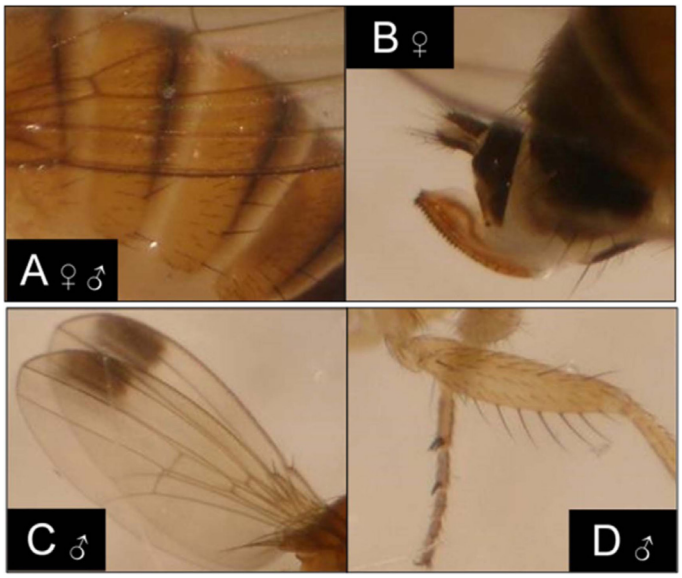

FIGURE 2. Identification of *Drosophila suzukii*: A) Abdominal segments; B) Hardened, saw-like ovipositor with strong, dark teeths; C) Wings with dark spot; D) Foreleg with two sex combs (credit: R. Rouzes & L. Delbac).

species to the temperate climate, which is particularly similar to the one of its area of origin. This invasive species has been observed to spread rapidly in European vineyards[5], often with damage to the grape harvest[1, 2, 3, 6].

Roles of host plants and link to the landscape

Drosophila suzukii is a polyphagous[4] and mobile[6] insect that develops well in complex habitats, where it finds food resources that allow it to move from one host plant to another during the growing season. In vineyards, the link between the phenology of *D. suzukii* and the proportion of semi-natural habitats around the plots has been clearly demonstrated[7]. Monitoring has shown that at least five plant species (Figure 3) present within a vineyard landscape can serve as host plants for this insect, ensuring temporal continuity of resources during its life cycle[3]. The role of the *Rubus* genus is crucial for the seasonal activity of the insect. Areas covered with these blackberry plants create a very favourable environment for its development for several months. The insect also disperses rapidly from cultivated plots to wild habitats to seek shelter from pesticide treatments or to protect itself from unfavourable weather conditions[6]. Hence, areas of vegetation surrounding the vineyard plays a key role in the epidemiology of drosophila; such spots can be used as a reservoir or possibly as an infestation hot-spot.

Control methods

The are different strategies for managing this pest, which depend on the grape variety being cultivated, the winegrower, type of vineyard and the region. A pest management strategy is based on a combination of preventive methods, supplemented by other methods if necessary[6]. Prophylactic methods such as leaf removal, weed mowing or shredding, yield limitation and grape sorting are recommended. Monitoring infestations is also a very frequent measure. Indeed, infestation levels depend on the year[3] and also vary according to the grape variety[2]. The detected infestations can be

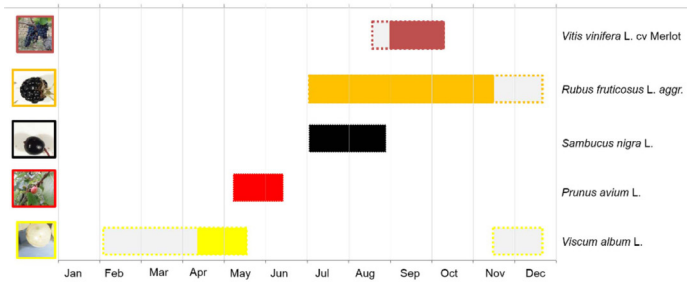

FIGURE 3. Chronological susceptibility of different host plants for the development of *Drosophila suzukii* in the vineyard. (Sampling = dotted rectangles; Emergences = solid rectangles) (From: Delbac *et al* 2020, Entomologia Generalis).

controlled by applying insecticides (neurotoxics) or insect repellents (kaolin)[6]. Other methods can be used for small isolated areas, such as mass trapping. With the approach of maturity, the harvest date is sometimes brought forward as a preventive measure, especially for late-maturing varieties, as climatic conditions can favour sour rot or drosophila epidemiology. However, this strategy depends directly on the income obtained from the final product. In addition to these methods, it is necessary to ensure the correct management of harvest waste and compost, which are resources for insect reproduction at the end of the season[6].■

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