Data Sheets on Quarantine Pests

# *Diabrotica barberi* and *Diabrotica virgifera*

## IDENTITY

- ***Diabrotica barberi***
  **Name**: *Diabrotica barberi* Smith & Lawrence
  **Synonyms**: *Diabrotica longicornis barberi* Smith & Lawrence
  **Taxonomic position**: Insecta: Coleoptera: Chrysomelidae
  **Common names**: Northern corn rootworm (English)
  **Notes on taxonomy and nomenclature**: *D. barberi* and *D. virgifera* are two closely related species (McDonald, 1989), mainly found on maize. *D. virgifera* has two subspecies: *virgifera* and *zeae* Krysan & Smith. There are other North American *Diabrotica* spp. with a wider host range, whose larvae feed on roots of many species (including maize) and whose adults feed especially on flowers of Cucurbitaceae, e.g. *Diabrotica balteata* LeConte (banded cucumber beetle) and *Diabrotica undecimpunctata* Mann. (spotted cucumber beetle), whose subspecies *howardi* is also known as the southern corn rootworm.
  **Bayer computer code**: DIABLO
  **EPPO A1 list**: No. 210
- ***Diabrotica virgifera***
  **Name**: *Diabrotica virgifera* LeConte
  **Taxonomic position**: Insecta: Coleoptera: Chrysomelidae
  **Common names**: Western corn rootworm, Colorado corn rootworm (subsp. *virgifera*), Mexican corn rootworm (subsp. *zeae*) (English)
  Chrysomèle des racines du maïs (French)
  Gusano de la raíz del maíz (Spanish)
  **Bayer computer code**: DIABVI
  **EPPO A2 list**: No. 199

## HOSTS

Both species attack mainly maize (*Zea mays*), the larvae feeding on the roots and the adults feeding on the leaves and silks. Other Poaceae may occasionally serve as host plants for the larvae, while the adults may also feed on other Poaceae, Asteraceae, Fabaceae and Cucurbitaceae.

## GEOGRAPHICAL DISTRIBUTION

As its common name suggests, *D. barberi* mainly occurs in the north-central states of the USA. *D. virgifera* subsp. *virgifera* was until 1955 confined to the western part of this area. Since 1955, it has spread considerably eastwards into the main distribution area of *D. barberi*, and also to scattered locations in western states. *D. virgifera* subsp. *zeae* mainly occurs in Mexico and Central America. It has recently spread to the southern USA. It may be noted that the other North American *Diabrotica* spp. also have a more southern distribution, extending to Central and South America.

- ***Diabrotica barberi***
  **EPPO region**: Absent.
  **North America**: Canada (Ontario), USA (widespread in Illinois, Indiana, Iowa, Kansas, Kentucky, Michigan, Minnesota, Missouri, Nebraska, Ohio, South Dakota, Wisconsin; also present in Alabama, Arkansas, Arizona, Colorado, Connecticut, Georgia, Maryland, New Mexico, New York, North Dakota, Oklahoma, Pennsylvania, South Carolina, Tennessee, Texas).
  **EU**: Absent.
- ***Diabrotica virgifera***
  **EPPO region**: Croatia (first record in 1995), Hungary (single record in 1995), Yugoslavia (Federal Republic), introduced into the area of Belgrade airport, northern Serbia, in 1993 (Baca, 1994); Sivcev *et al*. (1994) provide a map of the local distribution. These records all concern subsp. *virgifera*.
  **North America**: Mexico (subsp. *zeae*), USA (mainly subsp. *virgifera*; until 1955 practically confined to Colorado, Kansas (also subsp. *zeae*) and Nebraska; by 1970 it was widespread also in Illinois, Iowa, Minnesota, Missouri, South Dakota, Wisconsin, reaching furthest east in Indiana; also present in Arizona, Michigan, Montana, New Mexico, North Dakota, Oklahoma (also subsp. *zeae*), Texas (also subsp. *zeae*), Utah, Wyoming).
  **Central America and Caribbean**: Subsp. *zeae* is present (no details on national distribution).
  **EU**: Absent.

## BIOLOGY

The bionomics of the two species has been reviewed in detail by Chiang (1973). Eggs are laid in the top 15 cm of soil, at the base of maize plants; they are the overwintering stage. They hatch over a prolonged period. The larvae develop in and on the roots, the young larvae feeding on fine rootlets and the older ones invading the root core. Pupation takes place in the soil. The emerging adults move to the maize plant, feeding on the leaves and silks.

Eggs normally require a cold-induced diapause period before they will hatch, although a proportion of the population may hatch during a warm prolonged autumn. Under laboratory conditions, 4-5°C was found to be more suitable for diapause than 0°C or lower. Hatching is 50% reduced by exposure to -10°C for 1 week and reduced to zero by 4 weeks at that temperature or 1 week at -15°C. The threshold temperature for development of *D. barberi* is 11.1 and that of *D. virgifera* is 12.8°C, the thermal requirements for hatching lying in the range 300 to 400 degree-days over the threshold according to different reports. Larval development of *D. virgifera* took 71, 38 and 27 days at 15, 22 and 29°C respectively, and of *D. barberi* 65 days at 20°C. The pupal stage is short-lived. Adults are most active at dawn and dusk. Evening temperatures of about 18°C are optimal for oviposition. The population dynamics of *D. virgifera* has been modelled by Elliott & Hein (1991). Since maize has been alternated with break crops in the USA, there has apparently been a selection for longer diapause in larvae of *D. barberi* and *D. virgifera* (Tollefson, 1988; Levine *et al.*, 1992).

The two species occur in the same area over a large part of their range. Since their biology and behaviour is very similar, many field studies treat the two species together, without specifying which is involved. They are also interfertile (at least under laboratory conditions), so hybrids may occur. General bibliographies of the two species have been provided by Luckmann *et al.* (1974) and Levine & Chang (1990).

## DETECTION AND IDENTIFICATION

### Symptoms

Larval feeding on the roots causes root pruning. As a result the force needed to pull the plant from the soil decreases (this can serve as an index of damage), and the plants have a greater tendency to lodge. The older larvae burrow in the cortical parenchyma of the roots, and then dig channels in the central vascular tissue. Tunnels in maize roots are thus a characteristic symptom, though they may be due to other species. Adult feeding does not cause any particularly characteristic symptom.

### Morphology

**Larva**

Small, wrinkled, yellowish-white, with a brown head capsule, reaching 10-18 mm in length (Hill, 1984).

**Adult**

Small beetles, 5-6 mm long, with a basic pale greenish-yellow body coloration. Longitudinal striae are present on the elytra of some forms. *D. barberi* has femora which are green, flavous or testaceous (never piceous or marked with piceous), while *D. virgifera* has femora entirely piceous or pale with outer edge lined with piceous. Krysan *et al.* (1980) describe the differences between subspecies *virgifera* and *zeae*. Other North American species have more distinct spots or bands on the elytra.

## MEANS OF MOVEMENT AND DISPERSAL

While the larvae move relatively little, the adults fly to maize fields and can migrate over short and longer distances, moving with weather features such as cold fronts (Grant & Seevers, 1989). The spread of *D. virgifera* in Canada and USA over the last 40 years is a clear indication of the species' potential. There is no very obvious means of intercontinental dispersal by trade, since the insects would not normally be expected to be carried by consignments of seeds or grain. This is perhaps why *Diabrotica* spp. did not appear earlier in Europe or cause concern there. Within Europe, *D. virgifera* can progressively spread by adult flight, and has in this way extended its range to 200 000 ha by 1994. It is also possible that it could be carried by consignments of maize cobs or of green maize.

## PEST SIGNIFICANCE

### Economic impact

The two species of corn rootworm are the "most serious insect pests of dent corn in the major corn-producing states of the north-central United States and Canada" (Levine & Oloumi-Sadeghi, 1991). The cost of soil insecticides to control larval damage to roots, and of aerial sprays to reduce adult damage to silks, when combined with crop losses, can approach 1000 million USD annually (Krysan & Miller, 1986).

### Control

The control of *Diabrotica* spp. in maize in North America is a major problem for this crop. Generally, granular soil insecticides such as terbufos or isofenphos are applied at planting (Sutter *et al*., 1990). Levine & Oloumi-Sadeghi (1991) refer to the following approaches in their detailed review of IPM in relation to these pests: crop rotation, tillage and soil environment, planting and harvesting dates, host-plant resistance, biological control, control of larvae with insecticides, controlling adults with insecticides. Present IPM tactics depend on monitoring pest populations, use of economic thresholds and integration of the different control methods. Monitoring adults in one season gives a reasonably good forecast of damage in the following season (Levine & Gray, 1994). Many different types of

traps are available (Hesler & Sutter, 1993). In a recently infested area in Canada, a rotation strategy was effective (Nelson *et al*., 1994).

### Phytosanitary risk

EPPO is the only regional plant protection organization which has placed these pests on its quarantine lists: *Diabrotica barberi* on the A1 list and *D. virgifera* on the A2 list. The latter species is much more immediately threatening for the EPPO region, since there is still no obvious pathway for *D. barberi* to be carried from North America to Europe, while *D. virgifera* is actively spreading in Europe. All maize-growing areas in the EPPO region are at risk, particularly those in the more continental areas of Central Europe, where conditions most resemble those of mid-western USA. Baufeld *et al*. (1996) recently evaluated the establishment potential of *D. virgifera* in Germany, and concluded that the species could very probably establish although it was not certain that it would cause serious damage. The fact that *D. virgifera* spreads relatively slowly by natural means offers some prospect of its containment and/or suppression, although the rate of spread is still such as to pose a serious threat to countries surrounding Serbia.

## PHYTOSANITARY MEASURES

The capacity for natural spread of *D. virgifera* is such that it is difficult to propose measures to prevent spread in Europe. At the present time, it is essential to monitor the behaviour of the pest and its rate of local spread. Methods for local eradication should be investigated, and their potential for future application assessed. Changes in maize-growing practices may have to be considered. The main aim at present must be to contain *D. virgifera* and to delay its impact as much as possible. Specific measures against the possible introduction of *D. barberi* from North America seem of secondary importance, though evidently increased vigilance is called for. A committee organized by the International Working Group on *Ostrinia* (IWGO) of IOBC (International Organization for Biological Control) is studying the outbreak in Central Europe, with the cooperation of a newly established EPPO *ad hoc* Panel (OEPP/EPPO, 1995). In particular, the countries of that area have put in place a monitoring network, with traps, to follow closely any further spread, and are examining the various possibilities for control.

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