# *Diabrotica virgifera virgifera*

**(Western Corn Rootworm )**

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## Information Taken From

Kriticos, D.J., Reynaud, P., Baker, R.H.A., and Eyre, D. (2012). Estimating the global area of potential establishment for the western corn rootworm (*Diabrotica virgifera virgifera*) under rain-fed and irrigated agriculture. *Bulletin OEPP/EPPO* Bulletin 42(1): 56–64.

## Background Information

**Common Names:**
Western corn rootworm, WCR

**Scientific Name:**
*Diabrotica virgifera virgifera* LeConte

**Taxonomy:**
Kingdom: Animalia; Phylum: Arthropoda;
Class: Insecta; Order: Coleoptera;
Family: Chrysomelidae

**Crop Hosts:**
Maize (*Zea mays*)

**Figure 1.** Adult western corn rootworm, *Diabrotica virgifera virgifera* LeConte. Photograph from http://extension.entm.purdue.edu.

## Introduction

*Diabrotica virgifera virgifera* is a devastating pest of maize in the USA and in Europe. Its distribution overlaps with that of the northern corn rootworm, *Diabrotica barberi*. Both the larvae and the adult beetles cause damage to maize crops, by interfering with the growth, reproduction and sometimes harvesting of plants.

## Known Distribution

*Diabrotica virgifera virgifera* occurs from the Mid-Western to Eastern and South-Eastern USA and northward into Ontario (Canada). *Diabrotica virgifera virgifera* is thought to be native to the high elevation regions of tropical or sub-tropical Mexico (Branson and Krysan 1981; Krysan 1982), with subsequent colonization of North America following the expansion of agricultural maize production into the USA and Canada in the mid-20th century. It was first detected in Serbia (Yugoslavia) in 1992 near Belgrade airport, the presumed path of entry (Kiss et al. 2005). It has since become a pest of major concern to Europe, where it has been the subject of several local eradication attempts (EPPO 2004).

## Description and Biology

*Diabrotica virgifera virgifera* adults are about 0.5 cm long, and are yellow with three black stripes on their forewings (Figure 1). The stripes on female wing covers are distinct, with one on the outside of each wing cover and the third one along the middle, where the wing covers meet. The stripes on male wing covers tend to merge across the wing covers. The eggs are very small and white. Mature larvae are around 1.25 cm long, slender, and white with brown head capsules and a dark plate on the top side of the last segment. Pupae are white, but otherwise similar to adult beetles.

*Diabrotica virgifera virgifera* eggs are found in the soil; larvae are found in, and on roots, and the soil around them; and pupae are found in the soil (Chiang 1973). *Diabrotica virgifera virgifera* is univoltine, and eggs undergo an obligate winter diapause (Krysan 1986). Winter dormancy consists of two phases: an initial obligate diapause, followed by facultative quiescence governed by environmental conditions (Krysan 1978).

Emerging larvae feed on maize roots, directly affecting plant growth, reproduction and yield (Levine and Oloumi-Sadeghi 1991; Krysan and Millar 1986). Where roots are severely attacked, plants may lodge, creating harvesting difficulties. Adult beetles consume leaf tissue, silks, tender kernels, and pollen; thus maize yield is affected by all stages of this species. It is a significant economic insect pest of maize in America and is becoming increasingly so in Europe (Gray et al. 2009).

## Host Crops and Other Plants

Although *D. v. virgifera* may complete its life cycle on a few other grass species (Branson and Ortman 1967; Breitenbach et al. 2005), maize is its most suitable crop host.

## Potential Distribution

Kriticos et al. (2012) fitted a model of *D. v. virgifera* to the USA and Europe, considering different agricultural irrigation practices for maize in the two continents. In North America, all sites where *D. v. virgifera* occurs on maize that is grown without irrigation are projected to be suitable by their theoretical model under rain-fed conditions. With an irrigation scenario, this model captures all but 3 sites where *D. v. virgifera* occurs on maize grown with irrigation (Figure 2). The model suggests that these three sites are too cold for growth and/or for diapause to be terminated.

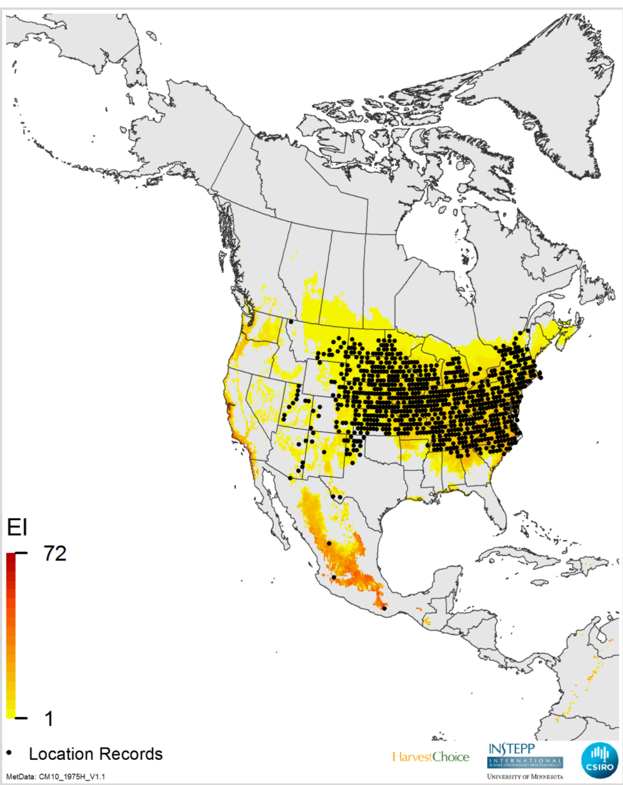


**Figure 2.** Modelled climate suitability of North America for *Diabrotica virgifera virgifera* as a composite of natural rainfall and irrigation based on the irrigation areas identified in Siebert et al. (2005). Location records come from the Entomology Department at Purdue University (http://extension.entm.purdue.edu/wcr/).

**Table 1**. CLIMEX Parameter Values for *Diabrotica virgifera virgifera*

| Parameter | Description | Value |
|---|---|---|
| **Moisture** | | |
| SM0 | lower soil moisture threshold | 0.1 |
| SM1 | lower optimum soil moisture | 0.3 |
| SM2 | upper optimum soil moisture | 1 |
| SM3 | upper soil moisture threshold | 2 |
| **Temperature** | | |
| DV0 | lower threshold | 9 °C |
| DV1 | lower optimum temperature | 18 °C |
| DV2 | upper optimum temperature | 24 °C |
| DV3 | upper threshold | 31 °C |
| **Diapause Index** | | |
| DPD0 | diapause induction daylength | 14 hours |
| DPT0 | diapause induction temperature | 7.5 °C |
| DPT1 | diapause termination temperature | 7.0 °C |
| DPD | diapause development days | 60 days |
| DPSW | diapause summer/winter switch | 0 |
| **Cold Stress** | | |
| DTCS | degree-day threshold (stress accumulates if the number of degree-days above DV0 is below this value) | 8 °C days |
| DHCS | degree-day stress accumulation rate | -0.00028 week-1 |
| **Heat Stress** | | |
| TTHS | heat stress temperature threshold | 31°C |
| THHS | temperature threshold stress accumulation rate | 0.009 week$^{-1}$ |
| **Dry Stress** | | |
| SMDS | soil moisture dry stress threshold | 0.1 |
| HDS | stress accumulation rate | -0.005 week$^{-1}$ |
| **Threshold Annual Heat Sum** | | |
| PDD | number of degree-days above DV0 needed to complete one generation | 666 °C days |
| **Irrigation Scenario** | | |
| | 2.5 mm day$^{-1}$ as top-up throughout the year | |

Here, we have created a composite rain-fed and irrigated risk model, by applying the Kriticos et al. (2012) theoretical model (Table 1) to the distribution of irrigated areas reported by Siebert et al. (2005). We applied an irrigation scenario of 2.5 mm day-1 as top up throughout the year. This composite irrigation risk model indicates that *D. v. virgifera* is well suited to substantial areas throughout Eurasia. Much of New Zealand and southern and eastern and also Australia appear climatically suitable. In Africa, most countries southwards of Angola and Zambia have areas with a suitable climate, and there are small pockets of suitable climate in the highlands of Kenya and Ethiopia. The bulk of suitable climatic conditions in South America are in central Chile, Argentina and Uruguay, although there are small areas of suitable climate in other countries (Figure 3).

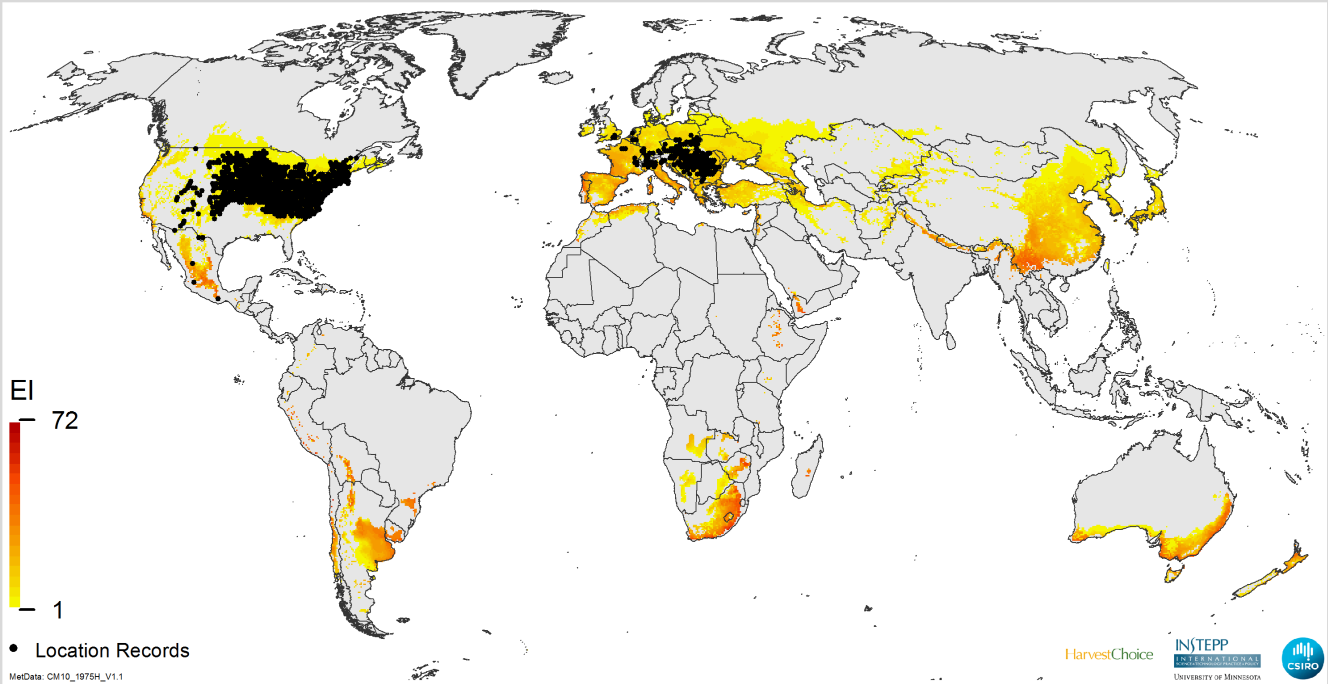


**Figure 3.** Modelled global climate suitability for *Diabrotica virgifera virgifera* as a composite of natural rainfall and irrigation based on the irrigation areas identified in Siebert et al. (2005).

## Potential Impact in Africa

The composite model indicates that parts of Africa are climatically suitable for *D. v. virgifera*. Small pockets of suitable climate occur in the highlands of Kenya and Ethiopia, and substantial regions of southern Africa (South Africa, Lesotho, Swaziland, Namibia, Botswana, Zimbabwe, Angola, and Zambia) are also suitable (Figure 4). Apart from Namibia, where not much maize is grown, all of these climatically suitable areas coincide with maize production areas.

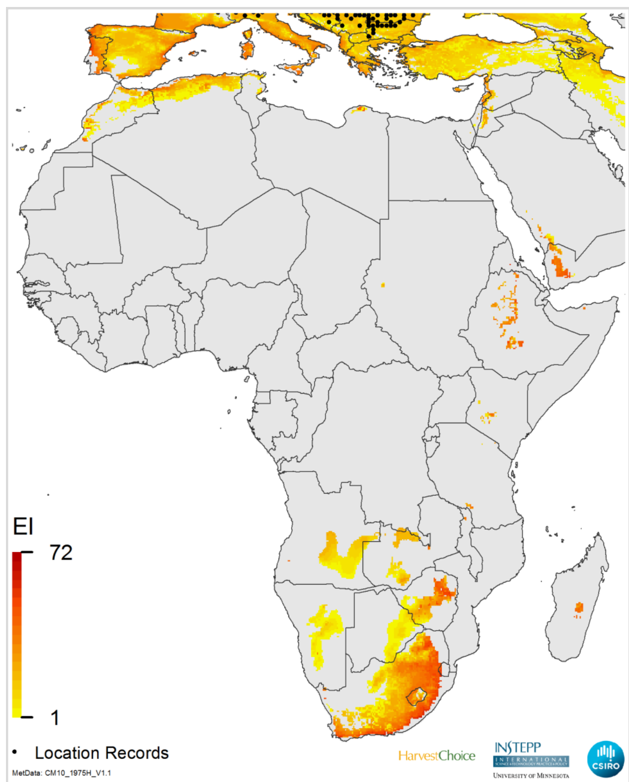


**Figure 4.** Modelled climate suitability of Africa for *Diabrotica virgifera virgifera* as a composite of natural rainfall and irrigation based on the irrigation areas identified in Siebert et al. (2005).

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### ACKNOWLEDGEMENTS

HarvestChoice would like to acknowledge Noboru Ota for spatial data analysis and the production of all maps. This brief was prepared with support from the Bill and Melinda Gates Foundation by way of the HarvestChoice project with additional support from the Commonwealth Scientific and Industrial Research Organisation (CSIRO) and The International Science and Technology Practice and Policy Center (InSTePP), University of Minnesota.

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