EPPO Secretariat Report on the IWGO International Workshop on Diabrotica

Graz, AT, 1995-03-20/21

This Workshop on *Diabrotica* has been organized by the International Working Group on Maize Pests (IWGO) of IOBC. The President of this Working Group, Dr Berger, recalled that IWGO has been created in 1978, in particular to gather scientists working in the field of maize resistance maize against the European corn borer (*Ostrinia nubilalis*). But with the recent introduction of a new maize pest in Serbia, it was felt useful to call an international meeting on this subject for information exchange on its biology and possible means of control. Approximately 30 participants from Austria, Bulgaria, Croatia, Germany, Greece, Hungary, Italy, Romania, Slovak Republic, Slovenia, USA and the EPPO Secretariat attended this meeting.

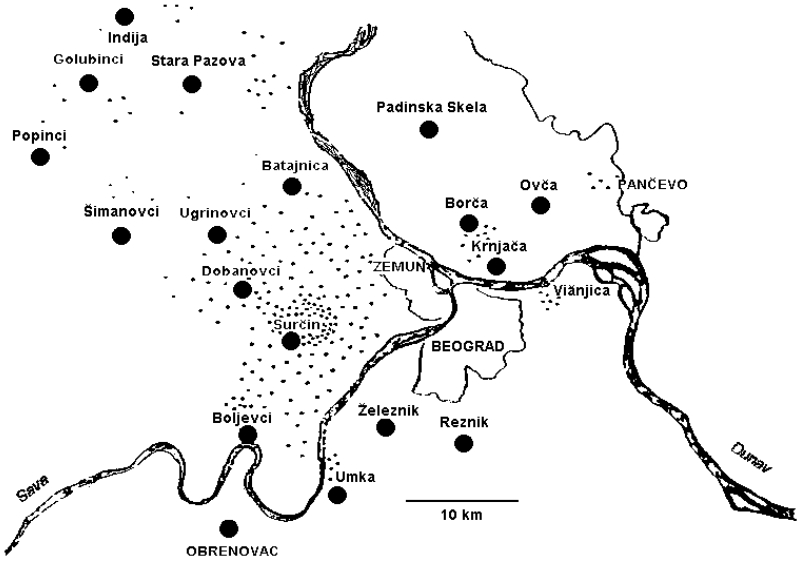
- **Situation of *Diabrotica virgifera* in Serbia**

Dr Edwards (US) read the report from Dr Baca (YU) who could not come to the meeting. In mid-July 1992, unusual symptoms of maize destruction were observed in the vicinity of Surcin airport, near Belgrade, on a small plot (0,5 ha). The pest was identified as *Diabrotica virgifera* by a US expert. In 1993, maize fields were infested, on the territory of Srem, in the zone of Boljevci-Popinci-Golubinci-Indija to the confluence of the river Sava with the Danube, then south of the Danube at Visnijicka Banja and east of the Danube at Borca. Highest levels of populations were recorded in the immediate vicinity of Surcin airport. In some fields, losses were extremely severe (up to 80 % plant mortality): these maize fields had been infested in 1992, and maize was cultivated again in 1993. The numbers of adults observed were considerably less in the localities in the direction of Boljevci, Dobanovci, Ugrinovci, Batajnica and Zemun. During this period, the spread of the pest was 40-70 km to the north, 40 km to the east, 40 km to the south. The main direction of the spread is towards the north-west (in general, the main movement of the populations follows the prevailing winds). On the basis of three years of observations it was found that adults quickly covered huge distances. Respectively, 110.000 ha of maize were found infested in 1993, and 200.000 ha in 1994. Up till now, the pest has crossed the rivers Sava in Sumadija, Danube and Tamis in Banat, but has not reached Backa yet. The air distances to the Romanian and Hungarian borders are respectively 50 km and 100 km. It is thought that the pest was introduced in 1990, by air transport, from North America.

The pest life cycle observed in Serbia is similar to that in USA. The pest has one generation per year and overwinters in soil (diapausing eggs). In Serbia, hatching takes place from mid-May to the end of June, and three larval stages are observed before pupation. Beetles have been observed from June 24 to October 15, with a maximum number per plant during maize flowering from July 28 to August 10 in 1993 (July 15 to July 20 in 1994).The peak of oviposition has been recorded in August.

The main damage is caused by larvae which bore and feed on the roots. Attacked plants then usually show stem deformation, bent stems ("goose necking") and may lodge. Adults feed on leaves, pollen and later on silk. However, when populations of adults are high (over 30 imagoes have been found on severely damaged ears), feeding damage on maize leaves and especially on corn silk (leading to reduction of kernel numbers) has been observed. In 1994, damage was in general less serious than in 1993 which was a dry year. In 1994, large amounts of rainfall in the first half of the growing season resulted in a better recovery of attacked plants which were able to produce new roots. It has been noted that wide areas of maize, high plant density, high amount of rainfall, maize irrigation, continuous cropping of maize are factors favourable to the multiplication of *D. virgifera*.

The main method of control against this pest is crop rotation (in Serbia: maize/wheat). Trials have been set up to evaluate the efficacy of several chemical compounds, in 1994, in the vicinity of Surcin. The first results indicate that the best control of larvae was achieved by applying terbufos, chlormefos and phorate as a soil treatment at sowing.



Distribution of *Diabrotica virgifera* in Serbia
(map published by Sivcev, I.; Manojlovic, Krnjajic, S.; Dimic, N.; Draganic, M.; Baca, F.; Kaitovic, Z.; Sekulic, R.; Keresi, T. (1994) [Distribution and harmful effect of *Diabrotica virgifera* Leconte (Coleoptera, Chrysomelidae), a new maize pest in Yugoslavia.]
Zastita bilja, 45(1), 207, 19-26.

- ***D. virgifera* in USA**

Dr Edwards (US) gave many details on the biology, damage, distribution, control of *D. virgifera* in USA, and especially in Indiana, and he tried to outline the possible scenarios for Europe. In USA, several species are present: *D. virgifera virgifera* (Western corn rootworm) - predominant species, *D. barberi* (northern corn rootworm), *D. virgifera zea* (Mexican corn rootworm) and *D. undecimpunctata* (Southern corn rootworm). The last does not cause serious damage. In the Mid West, the main rotation is maize and soybean (possibly wheat, lucerne and orchards). He stressed that maize grain has been shipped all over the world for many years, and no introduction has resulted from this trade. He felt that the introduction in Serbia was not associated with grain shipment, and might be due even to the introduction by aeroplane of a single gravid female, 10-15 years ago.

(Map presented by Dr Edwards)

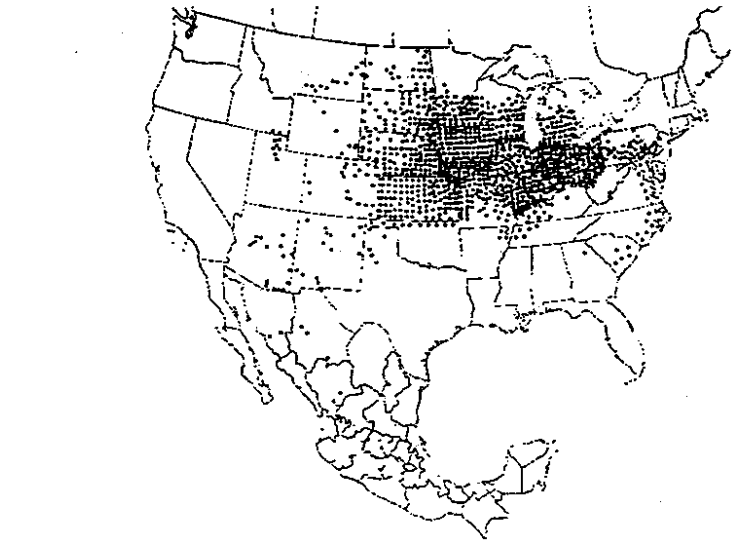


Figure 1 Distribution of western corn rootworm, Diabrotica virgifera virgifera LeConte, in North America (updated from Krysan and Miller, Methods for the study of Pest Diabrotica, 1986).

Life cycle (data for Indiana): The pest is univoltine. First instar larvae appear between May 15 to June 10 (it mainly depends on soil temperature). In Indiana, maize is planted in early April. In fact, maize is planted earlier and earlier in order to reduce as much as possible the interval between chemical treatments applied at planting and the beginning of the hatching period. Then, the pest will pass through three larval instars. Newly hatched larvae feed primarily on root hairs and outer root tissue; as they grow they tunnel through root tips to the plant base, and feed on larger roots to the plant stalk (main damage). Pupation takes place and males emerge first. Females follow within a few days and eggs are produced approximately after 10 days. Adults feed on pollen (they are primarily searching for pollen), but also on silk and leaves. By clipping the silk before pollination they can damage the ear (missing kernels). By damaging the roots, the water and nutrient uptake is reduced and this may lead to yield reduction and increased sensitivity to soil compaction, water and/or fertility stress. Roots are weakened and plants may lodge or grow in a "gooseneck shape", which renders harvest more

difficult and contributes to yield losses. *D. virgifera* has virtually no other host than maize, little feeding has very occasionally been observed on sorghum, and the insect has been observed on several grasses.

Assessment methods. Dr Edwards presented the various assessment methods which are used in USA to evaluate the population levels of adults and larvae.
Counting beetles: adults counts are useful to determine silk damage (aerial treatments can be applied to control adult populations in order to prevent silk damage, but this is not generally necessary) and to determine the potential for larval problems in the following season. Thresholds have been developed in US, in order to trigger the application of soil insecticides against larvae during the next season. In order to monitor the beetle populations, yellow sticky traps can be wrapped around maize ears to attract beetles, but the best attractant is cucurbit bitters (feeding stimulant) which is placed with a sticky substance and an insecticide in small containers.
Counting larvae: sample plants must be uprooted. They are examined for the presence of larvae (a scale of damage can also be used), alternatively roots can be washed and floating larvae are observed. Plants must be sampled during the period when it is still possible to apply soil treatments against larvae.

Control methods. The best method is crop rotation. In addition, it is important to remove volunteer maize plants in the succeeding crop by using herbicides. Soil insecticides will not provide 100 % efficacy (but 60 - 80 % in most cases). Usually, soil insecticides are applied in bands (or furrows, depending on the active ingredient), at planting time. It is recommended not to use the same compound every year (at least no more than 2-3 consecutive years) to avoid development of resistance. Several compounds are registered in USA against *D. virgifera* (organophosphates: chlorpyrifos, ethoprop + phorate, fonofos, phorate, terbufos and pyrethroids: tefluthrin). Apparently, no resistance has been recorded. Control and eradication of this pest on a large area would probably be very costly and difficult, and should be based on a strict monitoring of the populations, followed by a systematic chemical/cultural control over many years.

- **Biology, rearing techniques of *D. virgifera* with special emphasis on host plant resistance**

Dr French (US) presented the biological characteristics of *D. virgifera* observed in the laboratory. *D. virgifera* can be reared in the laboratory, though this is a very difficult and laborious task. Adults are collected from the field or come from the laboratory, they are placed in cages on artificial food diet and maize shoots, and they lay eggs in dishes loosely covered with aluminium foils. Larvae will develop in dishes containing mats of maize roots which are for the later stages placed vertically over a container with soil. Larvae will fall, pupate in the soil and adults will then emerge. Eggs can be collected from the soil by washing or flotation. Low pH (<5) in soil is not favourable to survival of the insect. USDA and seed industry are trying to develop resistant plants. Several techniques have been developed to try to evaluate this resistance, and so far adult host plant resistance evaluation have been limited to leaf and silk feeding. Host plant resistance has been very difficult to evaluate with the underground feeding habits of this pest. Therefore, no resistant cultivars are available for the moment.

- **Preliminary trials carried out in Serbia**

Dr Stankovic (AT) presented the results of two trials conducted in Yugoslavia on the efficacy of several insecticides, by Dr Baca, Dr Sivcev and Dr Sekulic. Two trials have been organized near the airport where the pest appeared for the first time. Different products have been applied (granulars, liquid formulations applied in band), at different times (before sowing, with sowing, 10 days after sowing). At present, he could recommend to use liquid formulations in band application at sowing of carbofuran, carbosulfan and bifenthrin; granules at sowing with higher rates (≈ 3 kg/ha). But further trials are necessary.

- **Biological control of *D. virgifera***

Dr Chandler (US) stressed the need for IPM programmes: cost of chemical treatments, exposure to highly toxic chemicals, problems of persistence of the compounds in the soil. A part of the strategy would be to reduce as much as possible adult populations before oviposition and try to apply biological control against larvae. New semiochemical-based insecticide baits have been developed (cucurbitacins are used as feeding stimulant and attractant in mixture with insecticides). For biological control, few agents are available. The entomopathogenic fungi *Beauveria bassiana*, new isolates of *Bacillus thuringiensis*, the dipteran parasite *Celatoria diabroticae* are being studied. Presently, entomopathogenic nematodes (e.g. *Steirnonema* spp.) offer the best opportunity for controlling *D. virgifera*.

- **Preliminary analysis of the establishment potential and possible damage of *D. virgifera* in Croatia**

Dr Igrc-Barcic (HR) explained that due to the first occurrence of *D. virgifera* in Serbia, near the border of Croatia, it was important to evaluate the consequences of possible introduction into Croatia. In Croatia, maize is grown on 500,000 ha (10 % as a monoculture), most of it in small private farms (<20 ha). The main regions at risk are near Vukovar and Osijek. The pest has not been seen in Croatia, but it is felt that it is a very serious threat. The activities carried out in Croatia have been 1) to collect and study publications from USA dealing with *D. virgifera*, 2) to estimate the significance of this pest for Croatia, 3) to find legal support for extensive monitoring of *D. virgifera* in Croatia by organising meetings between plant protection experts.

The climatic conditions prevailing in Croatia are very similar to those in the areas where the pest is present in the USA. In eastern Croatia, minimum soil temperatures (at 10 cm depth) are never lower than -3,8 °C. In North-west Croatia in some localities, the soil temperature rarely reach - 8°C. It can be recalled that -10 °C is a critical temperature, as hatching is 50 % reduced by exposure to -10 °C for one week. Based on biological data obtained in US publications, Croatian experts have calculated that the first larvae will hatch between May 14 and June 15 (average 29-30 May). Hatching of 50 % of the larvae will occur between May 25 and June 25 (average June 8-10). She felt that this type of studies should be carried out in all countries to try to predict the development of populations.

Possible effects of agricultural practice on *D. virgifera* have been evaluated in Croatia. It is felt that the deep pre-winter ploughing will perhaps negatively influence the development of

the pest. Concerning possibilities of adult feeding on pollen of weeds, a good control of weeds is applied in state farms but not always in small private farms. Dr Igrc-Barcic stressed that the susceptibility/tolerance of maize cultivars grown in Croatia is not known

In conclusion, Dr Igrc-Barcic noted that available information indicates that *D. virgifera* will behave in Europe in a similar way as in USA, and perhaps will cause even more serious damage in its new region of introduction.

- **Draft EU project concerning *D. virgifera***

Dr Baufeld (DE) explained that a proposal for a 3-year project on PRA and elaboration of measures to prevent further spread of *D. virgifera* will soon be submitted to EU. Four countries, Germany, Hungary, Austria and Greece will be involved and will be responsible for studies on possibilities of transmission and potential host plants (as pathways of introduction remain unclear), monitoring measures, chemical control measures, cultural control measures. If agreed this project will start in May 1996.

- **Presentation of some chemical compounds which can be used against *D. virgifera***

Dr Doel (FMC, AT) presented Furadan® which can be used as a post-emergence treatment (granular or liquid formulation) against *D. virgifera*.

Dr Foltin (Zeneca, AT) presented Force® (tefluthrine) which can be used as a furrow application of granules during maize planting or as a liquid formulation (pre-planting).

At the end of this meeting, it was decided that IWGO with the help of Dr Edwards, will coordinate a monitoring programme in countries neighbouring Serbia. Traps (containing adult attractant) will be sent by Dr Edwards to Dr Berger who will then give them to the countries concerned so that they can be placed in maize fields at the beginning of the season. Dr Edwards will also send pinned specimen in order to facilitate identification of the adults.