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Data Sheets on Quarantine Pests

Leptinotarsa decemlineata

IDENTITY

Name*: Leptinotarsa decemlineata Say*
Synonyms: *Chrysomela decemlineata* Say
Doryphora decemlineata Rogers
Polygramma (Chev.) *decemlineata* Mels.
Taxonomic position: Insecta: Coleoptera: Chrysomelidae
Common names: Colorado beetle (English)
Doryphore de la pomme de terre (French)
Kartoffelkäfer (German)
Escarabajo de la patata (Spanish)
Koloradskii kartofel'nyi zhuk (Russian)
Bayer computer code: LEPTDE
EPPO A2 list: No. 113
EU Annex designation: I/B

HOSTS

L. decemlineata attacks potatoes and various other cultivated and wild solanaceous plants. Resistance exists, to varying degrees, among *Solanum* spp.; for example, *S. berthaultii*, *S. chacoense*, *S. pinnatisectum* and *S. tarijense* are highly resistant (Carter, 1987). Certain potato cultivars are also resistant (Shapiro et al., 1983).

Potatoes, tomatoes and aubergines are at risk wherever cultivated throughout the EPPO region. Wild solanaceous species occur widely and can act as a reservoir for infestation.

GEOGRAPHICAL DISTRIBUTION

EPPO region: Following its introduction from the USA to Bordeaux, France, in 1922, the beetle spread rapidly throughout the region despite intensive control operations to contain it. *L. decemlineata* is present in Austria (first reported in 1941), Belarus, Belgium (1935), Bulgaria (1958), Czech Republic, Estonia, France, Germany (1936), Greece (1963), Hungary (1947), Italy, Latvia, Libya, Lithuania, Luxembourg (1936), Moldova, Netherlands (1937), Poland (1946), Portugal (1943), Romania, Russia (European, Siberia, Far East), Slovakia, Spain (1935), Switzerland (1937), Turkey, Ukraine, Yugoslavia. It has been reported from but is not established in Denmark, Finland, Norway (1948), Sweden and the UK (1901) (including the islands of Guernsey and Jersey (1939), Thomas & Wood (1980)).
Africa: Libya.
Asia: Armenia, Azerbaijan, Georgia, Iran, Kazakhstan, Kyrgyzstan, Russia (Siberia, Far East), Tajikistan, Turkey, Turkmenistan, Uzbekistan.
North America: Canada (British Columbia to eastern provinces); Mexico, USA (widespread; probably originated in western USA it was first collected from wild

Solanaceae at what is now the border between Nebraska and Iowa in 1811; it had reached the Atlantic coast by 1874).
Central America and Caribbean: Costa Rica (found in the past but not established), Cuba, Guatemala.
EU: Present.
Distribution map: See IIE (1991, No. 139).

BIOLOGY

The yearly cycle starts in spring or early summer, depending on climate and physiological state, with the emergence from the ground of overwintering adult beetles. There is a tendency for mass emergence during the course of one or two days. The beetles make a (usually) short flight, or walk, to the nearest potato field. The finding of the potato plants appears to be largely by chance, although the odour of potato plants has been shown to be attractive. After feeding, the beetles mate. They must feed before mating; food intake is zero at 10°C and maximum at 25°C. Oviposition follows within a day or two, females laying their eggs (from 15 to 30°C), 10-30 at a time, in several orderly rows on the lower leaf surface. Egg-laying usually continues over a period of several weeks, until midsummer, with each female laying up to 2000 eggs. The eggs hatch in 4-12 days (provided temperatures are above 12°C) and the emerging larvae start to feed immediately. They seldom stop feeding, except to shed their skins; moulting occurs four times during the course of 2-3 weeks (optimum 30°C). Larvae are hardy and resistant to unfavourable weather, though heavy rain and strong winds may lead to high mortality, especially in the earlier instars. Cannibalism during the 1st instar is particularly common at high temperatures with a dry atmosphere.

Larvae from the same batch of eggs remain grouped together on the lower leaf surface until the first moult; they then migrate to the terminal buds. By the 4th instar, the larvae attack the petioles and stems. The mature larvae fall to the ground and bury themselves in the soil at varying depths (a few cm) according to conditions. Pupation, in smoothly lined cells, lasts 10-20 days, after which the first generation adult beetles emerge. In the northern part of the EPPO region, these beetles feed and then burrow 25-40 cm into the soil (deeper in dryish sandy soils than in clay soils) where they enter diapause and hibernate over winter. Mortality during hibernation in the Ukraine averaged 30%, but could be as high as 83%, due mainly to fungal and bacterial infections (Koval, 1984). The important factors in inducing hibernation are photoperiod and temperature, whereas it is primarily temperature which determines the length of diapause and emergence from the soil; in spring the first adults emerge at 68 day-degrees C above 10.5°C (Mailloux et al., 1988; Lefevere & de Kort, 1989) In warmer areas, the 1st generation beetles will begin to lay eggs, but fecundity of the succeeding generations is lower than for the first or for spring emergents, and the number of eggs laid by emergents also decreases by roughly 25% a month during the summer.

The number of generations is largely a function of temperature, varying between about four in the hottest areas of its habitat (cycle completed in 30 days) to one full and one partial generation near the colder extremes. There are some cold areas with only one partial generation: the beetle cannot really establish itself permanently in such areas. In general, sunny weather with a mean daily air temperature of 17-20°C results in mass spread and development but, if the temperature does not exceed 11-14°C and humidity is high, this does not occur and the population may actually decrease (Svikle, 1976). A detailed account of the bioenergetics of larval development in the laboratory in relation to temperature is given by Chlodny (1975).

For other details of biology see also Riley (1877), Johnson & Ballinger (1916), Grison (1963), Le Berre & Louveaux (1980), Louveaux & Piganeau (1980), Sokolov (1981), Bartlett (1985), Tauber et al. (1988a; 1988b).

DETECTION AND IDENTIFICATION

Symptoms

Both adults and larvae eat the foliage, eventually stripping all leaves from the haulm; exceptionally, the tubers are also eaten. Characteristic, black and rather sticky excrement is left on the stem and leaves by all stages.

Morphology

Eggs

Yellow or light-orange, long-oval, about 1.2 mm long, and found in rows on the underside of potato leaves.

Larva

Has a large abdomen and arched body; 1st instar is cherry-red with glistening black head and feet; later instars become progressively carrot-red, then pale-orange, with a line of several small black dots on each side of the body marking the spiracles.

Adult

A stout, oval, strongly convex and hard-backed beetle, about 1 x 0.6 cm; yellowish-brown except for five narrow black stripes on each of the two creamy-yellow wing covers; about a dozen small black spots on the top of the head and thorax; the tips of the legs are dark-brown or black.

Detection and inspection methods

Because of their size and distinctive coloration, adults and larvae are not difficult to observe by visual inspection. *L. decemlineata* has a tendency to release its hold on plants that are shaken and this characteristic can be used to detect insects hidden among foliage. Visual sampling of potato fields was found to be as efficient for estimating population density as the whole-plant bag-sampling method, and more efficient than sweep netting (Senanayake & Holliday, 1988). For area surveys, soil sampling at harvest for buried beetles in diapause gives reliable results (Glez, 1983).

MEANS OF MOVEMENT AND DISPERSAL

The main means of natural spread of the beetle over large areas is by wind-borne migration, particularly of the spring generation. Adults can also be carried over long distances in sea water.

Adults and larvae can be easily transported on potato plants and tubers, and in all forms of packaging and transport. Fresh vegetables grown on land harbouring overwintered beetles are common means of transport in international trade. For a review of interceptions in the UK, see Bartlett (1980).

PEST SIGNIFICANCE

Economic impact

L. decemlineata is one of the most widespread and destructive pests of potato. Both adults and larvae feed on this host, and often cause complete defoliation of the potato plants attacked, with considerable yield losses (50% of the crop in some EPPO countries). In favourable weather and biological circumstances, populations are liable to expand dramatically; even with 90% egg mortality and varying degrees of larval mortality, after 5 years without control, a population of 1.1×10^{12} could build up from a single pair of

parents. *L. decemlineata* is also suspected of spreading several potato diseases, including *Ralstonia solanacearum* and *Clavibacter michiganensis* subsp. *sepedonicus*.

Damage has also been reported on other crops; for example, tomato yield was reduced by 67% in a field test in Maryland, USA, when numbers of larvae increased from five to ten per plant (Schalk & Stoner, 1976). *L. decemlineata* is also considered to be a serious pest of aubergine in Europe and North America.

Control

A large amount of research has concentrated on finding and developing means of control. The following arthropod predators and parasites of *L. decemlineata* are known: *Carabus hampei*, *Chrysomelobia labidomerae*, *Chrysoperla carnea*, *C. sinica*, *Edovum puttleri*, *Euthyrhynchus floridanus*, *Lebia grandis*, *Myiopharus doryphorae*, *Oplomus dichrous*, *Perilla bioculatus*, *Podisus maculiventris*, *Rhynocoris* sp. In addition, the nematodes *Heterorhabditis heliothidis*, *Hexamermis* sp., *Pristonchus uniformis*, *Steinernema feltiae*, *S. glaseri*; the fungi *Beauveria bassiana*, *B. tenella*, *Paecilomyces farinosus*, *Penicillium funiculosum*; the bacterium *Bacillus thuringiensis*; the protozoa *Nosema* spp.; and certain iridoviruses have been used against the beetle with varying degrees of success. However, the use of insecticides remains the most common means of controlling the pest and, in many EPPO countries, such control is obligatory by law. Throughout the EPPO region where *L. decemlineata* is present, the beetle is considered not to be as important a pest of potato as previously. This is because effective plant protection products are available and the routine control of *L. decemlineata* has become incorporated into the established pattern of potato cultivation.

Phytosanitary risk

L. decemlineata is an A2 quarantine pest for EPPO (see OEPP/EPPO, 1981) and is of quarantine significance for APPPC, COSAVE, CPPC, IAPSC, JUNAC, NAPPO and OIRSA.

Because of its capacity for adaptation to different climatic conditions (Ushatinskaya & Ivanchik, 1982) and different host plants (Hsiao, 1982), this potato beetle is constantly moving into fresh areas and crossing international borders. The beetle has obviously not reached the extent of its geographic range in the EPPO region but its spread has slowed considerably in recent years, almost entirely due to international collaborative action, especially between France and the Channel Islands, with EPPO support (Portier, 1980). In Russia and other CIS countries, where *L. decemlineata* is spreading eastwards, an attempt was made (Vlasova, 1978) to estimate the potential final distribution; it was assumed that the requirement for one full generation would be a period in summer of at least 60 days of temperature over 15°C and winter temperatures not falling below -8°C. Establishment is not likely in colder areas of the EPPO region where only one partial generation could develop. Similarly, Worner (1988) tried to predict where *L. decemlineata* could establish in New Zealand. Potential distribution has been discussed by Jolivet (1991) for Asia and by Sutherst (1991) for the world.

A cost/benefit analysis performed by Aitkenhead (1981) indicated that the cost of the measures used to exclude *L. decemlineata* from the UK was less than the likely costs of control if introduced.

PHYTOSANITARY MEASURES

The Specific Quarantine Requirements of OEPP/EPPO (1990) allow importing countries the choice of whether to take measures or not with respect to *L. decemlineata*, and how stringent these measures should be, depending on the conditions prevailing in their countries and in the exporting countries. Countries may require that consignments of any

plants or plant products be found free from the pest after having been subjected to sorting and packaging techniques in suitable premises. In addition, they may require that potatoes and certain vegetable crops had been grown in a field which had been inspected during the growing season and found free from the pest and which was in an area where either the pest does not occur or is under intensive official control.

In laboratory tests in Ontario (Bond & Svec, 1977), methyl bromide fumigation of newly harvested potatoes successfully controlled *L. decemlineata* without injuring tubers. For control of adults, 16 mg/l for 4 h at 25°C was used, with an increase of 4 mg/l for each 5°C drop in temperature down to 15°C. Treatments for pupae are applied only at about 25°C and above. In Russia, methyl bromide fumigation of wagons containing both seed and ware potatoes is carried out. EPPO is preparing a fumigation schedule.

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