

PROJECT I.D.
1.1. Acronym: CIPLAGAS/ RTA-03-004-C4-1
1.2. Project title: Development of strategies for the integrated control of <i>Agriotes</i> spp. (O.Coleoptera, F. Elateridae) for potato crops
1.3. Financial backers: National Institute for Agricultural Research (INIA) and the Department of Agriculture and Fisheries of the Basque Government
1.4. Participating bodies: ITG AGRICOLA (Technical Institute and Livestock Management), Environmental Studies Centre (CCMA-CSIC)
NEIKER DETAILS
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1.6. Start date: January 2003
1.7. End date: January 2006

Summary:

Pre-sowing treatment of the soil with insecticides for potato crops is carried out as a preventive measure aimed at controlling potato wireworm (*Agriotes* sp.), although neither the species, their biology, nor their abundance have been studied in Spain. Until now, lindane has been applied systematically because of its effectiveness and cheapness. The recent prohibition of the use of lindane in the European Union (June 2002) means that farmers have no effective solution for controlling this plague. We need to find alternatives that are more environmentally friendly: new alternative products with less residual effect, less toxicity, greater selectivity and a method to determine whether treatment is needed or not. In the light of this problem, the following objectives have been set:

1. - Identification of the species of pest elateridae and entomopathogenic nematodes present in the Ebro Valley (Alava and Navarre), their distribution in the soil, ecology and biology. Development of the appropriate technology for establishing a programme for the integrated control of *Agriotes* larvae in potato crops. Identification of the species of pest elateridae present in the Upper Ebro Valley. Study of the different cycles of development of pest elateridae in the area: duration, season when adults appear, oviposition preferences.
2. - Development of a practical method for evaluating the risk of damage to crops by the use of bait traps, as opposed to the systematic treatment of all plots. Search for natural enemies of wireworm larvae and study of their possible use in integrated handling strategies for Spain.
3. - Study of the distribution and degree of aggregation of larvae on the surface of the soil to create a reliable predictive crop damage model by the use of bait traps.
4. - Evaluation of the use of traps with sexual pheromones to capture adults and estimate the risk of crop damage.
5. - Interest and practical effectiveness of different control techniques: evaluation of insecticides, trap crops, harvesting dates, irrigation and rotation.
6. - Identification of a threshold for crop intervention, according to varietal susceptibility, final destination of the product, cost and effectiveness of the different methods of control available, designing a practical method for farmers.
7. - Study of the effect of entomopathogenic nematodes on *Agriotes* spp. Larvae in field conditions. Identification of the effect on entomopathogenic nematodes of incorporating the remains of brassica crops to the soil. Study of the tolerance of entomopathogenic nematodes to agrochemicals commonly used with the crop. Determination and identification of entomopathogenic nematode species present in cultivated and natural areas close to crops in the

Upper Ebro Valley. Study of the virulence of autochthonous strains and commercial strains of entomopathogenic nematodes as regards elateridae larvae.

Results:

Regarding the biology of potato pest Elateridae

1. – We have identified the pest elateridae species that affect potato crops in Alava and Navarre. More exactly, we have identified the *Agriotes sordidus* species as the most important plague affecting the quality of tubers as a result of the holes caused in the same. We have identified the development cycles of the most abundant pest elateridae in the area (*Agriotes sordidus* and *Agriotes lineatus*): duration, season when adults appear and oviposition preferences.
2. – We have studied the population dynamics of different *Agriotes* species in Alava and Navarre, using specific pheromone traps. We have assessed the effectiveness of said pheromones in trapping adult insects.
3. – We have studied the life cycle of *Agriotes sordidus* in a field test using breeding boxes in Alava.

Regarding the integrated control strategies for handling the plague

Natural enemies

1. We have isolated 23 populations of entomopathogenic nematodes from 500 soil samples. Seventeen correspond to the species *Steinernema feltiae*, 2 to *S. krausei* and 4 to *S. carpocapsae*. They are all kept in the laboratory. This task was carried out by CCMA-CSIC.
2. We have identified an ectoparasitic mite of the *Leptus* genus in a population of adult *Agriotes sordidus* beetles. We do not feel that the presence of this ectoparasitic mite is very useful for control programmes, due to the fact that the presence of the mite neither kills nor significantly weakens the adult beetle.

Biological control:

3. Mortality studies have been carried out using the *S. feltiae* species of nematode on *Agriotes sordidus*. This nematode only causes 10% mortality 5 days after being applied to wireworm larvae, meaning that it is of little use for the integrated control of wireworm.
4. Laboratory biotests were carried out using strains of the entomopathogenic fungi *Metarhizium anisopliae* on wireworm larvae, with very promising results. With a view to carrying out field trials, as we were unaware of possible effects on Spanish elateridae of the *Agriotes* genus, we designed laboratory tests under controlled conditions that obtained larva mortality rate of close to 55% a fortnight after inoculation.
5. A field trial was carried out in 2006 on a field with wheat infected by the virulent strains of *Metarhizium anisopliae* to see how this potential wireworm larvae controller behaved in the field. The field test compared the biological controller with a chemical controller currently used in the sector and with an untreated plot.

Distribution of larvae in the soil

6. Three surveys were carried out in Alava to try and identify the aggregation patterns of *Agriotes sordidus* larvae in potato fields and attempt to correlate said patterns with the damage caused to crop. However, we were unable to create reliable model for predicting crop damage. Over the three years that the larvae were surveyed, we obtained abundant data on the crop, even when no larvae were found or when so few larvae were trapped that it was impossible to correlate the two factors.

Crop handling

7. We were unable to reach our goal of identifying a threshold for intervention on the crop according to varietal susceptibility, as the predictive survey of larvae did not adapt to the damage caused.

Impact:

The project has generated important knowledge about one of the most significant soil plagues from a financial viewpoint and one that affects numerous crops (potato, beetroot, etc.). It also provide know-how concerning control methods based on several factors:

1. – Based on the biology of the plague species (adult attraction pheromones, distribution of larvae in the soil, biological cycles of the plague in the field)
2. – Based on the testing of active materials to assess the effectiveness of different chemical treatments
3. – Based on natural enemies. Specifically using the entomopathogenic fungus *Metarhizium anisopliae* and, to a lesser degree, certain nematodes of the *Steinernema* genus.