Impact of climate change on the geographical spread of agricultural pests, diseases and weeds

B E A Knight, A A Wimshurst
Impact Reports, Oak Farm, 12 North Street, Burwell, Cambridgeshire, CB5 0BA, UK
Email: innovationmanagement@btopenworld.com

INTRODUCTION

A number of economically important pests, diseases and weeds have been demonstrated to be spreading or moving as a consequence of changes in weather patterns within both Europe and North America. New pest arrivals within the EU include western corn rootworm (WCR) (*Diabrotica viginifera viginifera*) into the UK in 2003; there is also the continued threat of Colorado beetle (*Leptinotarsa decemlineata*) in north west Europe.

Direct factors responsible for the movement and spread of pests and diseases include: the impact of higher temperatures on the number of pest generations per season, and increased humidity resulting in the enhanced incidence of fungal pathogens. Indirect factors include: changes in geographical production of host plants, and different cultivation practices as a consequence of climate change.

METHODS

The information presented in this paper is extracted from a broader study carried out by the authors in 2004, with contributions from expert climatologists and agronomists (Knight & Wimshurst, 2005). The main focus of the study relates to cropping patterns and pests, diseases and weeds in eastern and western Europe, and North America. The study involved literature research on the impact of climate change, and on the potential productivity of the main arable crops and on important pests (insects and nematodes), diseases and weeds. Estimated projections to 2020 were also made (with further comments on likely developments up to 2050) on changes in crop areas (due specifically to climatic factors rather than economic or social factors) and on the geographical development of important pests, diseases and weeds. The numeric projections are based on best estimates, with upper and lower limits (not based on mathematical modelling). The mid-range from the various Intergovernmental Panel on Climate Change (IPCC) scenarios was used. The general trends in climatic changes in Europe are for higher summer temperatures and wetter winters in northern latitudes, and for more extreme drought conditions in the south. A similar pattern is projected within North America. The baselines for the forecasts of crop areas are based on preliminary Food and Agriculture Organisation (FAO) data for 2004. Baseline pest, disease and weed infestation areas were derived from market research information produced by the agrochemical industry, complemented by a literature survey.

RESULTS

Projected trends for several pests, diseases and weeds are summarised in Table 1. Some pests, e.g. aphids (Aphididae), wireworms (*Agriotes* spp.) and soil nematodes, are projected to spread relatively little. Late potato blight (*Phytophthora infestans*) will follow host crops, declining in southern Europe. Stem and leaf diseases of wheat will increase in incidence with milder winters in northern Europe, but will decline in the south. In wheat, grass weeds (e.g. slender foxtail (*Alopecurus myosuroides*) and wild oat (*Avena fatua*)) will show little change, other than where the crop moves north and declines in southern Europe. Examples of the mid-point projections of WCR infestation areas in maize are shown in Table 2.

Table 1. Outline trends in selected pests, diseases and weeds by 2020.

Species/crop	General trend	Europe	North America
Western corn rootworm in maize	Spreads with temperature rise	Extension from current outbreaks	Spreads to 50% of crop area
European corn bor (*Ostrinia nubilalis*) in maize	More generations; spreads north	Moves with crop	More frequent outbreaks
Colorado beetle in potato	Adaptable; moves north	Could become established in the UK and Scandinavia	More frequent in Canada
Rhizomania in sugar beet	Spreads with mild winters and hot summers	Potential for outbreaks throughout this region	Low incidence throughout this region
Grass weeds in maize (e.g. *Setaria* and *Echinochloa*)	Lower germination in dry areas, but greater in north	Spreads and move north with expanding crop area	Marginal increase with crop

Table 2. Estimated impact of climate change on western corn rootworm infestations in maize.

Region	Crop area (million ha)		Crop area infested (million ha)	
	2004	2020	2004	2020
Europe	15.1	18.1	< 0.1	2.1
North America	30.8	32.3	12.0	19.0

Projected trends to 2020 are expected to continue up to 2050 and beyond, and are useful strategic indicators for the plant breeding and crop protection industries.

REFERENCES

Knight B E A; Wimshurst A A (eds) (2005). Impact of climate on crop production and management - now and in the future. *Impact Reports - Multi-client study*, 202 pp.

Determination of the occurrence and spread of the allergenic weed *Ambrosia artemisiifolia* in the territory of Vojvodina (Serbia)

Branko Konstantinovic, M Meseldzija, Bojan Konstantinovic, D Marisavljevic
Trg Dositeja Obradovica 8, 21000 Novi Sad, Serbia & Montenegro
Email: brankok@polj.ns.ac.yu

INTRODUCTION

The ruderal weed common ragweed (*Ambrosia artemisiifolia*) (Asteraceae) was introduced from North and Central America into Europe in the 1800s, together with clover seed (Priszter, 1960). With regard to damage resulting from its spread, since 1994 its control in Hungary has been obligatory, and regulated by an act of the Ministry of Agriculture within the framework of the Law on Agricultural Land (Levente *et al.*, 2003). Because of its wide ecological tolerance, it readily becomes the dominant weed in many different situations. It fruits abundantly, producing c. 150,000 seeds/plant annually, and germination capacity in the soil is maintained for more than 40 years (Levente *et al.*, 2003). Owing to the significant effect of common ragweed pollen as an allergen to human health and working capability, control of this weedy, ruderal species in Vojvodina is organized in the pre-flowering phase.

MATERIALS AND METHODS

During vegetative period (in both 2003 and 2004) common ragweed numbers and distribution in the region of Vojvodina were investigated, using the Braun-Blanquet (1951) method. The most efficient and the least toxic means of chemical control of this allergenic species were established, involving the use of efficient herbicides of low toxicity (that are both sanitary and environmentally sound), and also mechanical control (by mowing). Also, quantities of common ragweed pollen in the air were permanently measured, using the Hirst (1952) volumetric method.

RESULTS AND DISCUSSION

Common ragweed was found on both banks of the river Danube, near the suburbs of Petrovaradin, Sremski Karlovci and the city of Novi Sad, and also in Bogojevo, Odzaci, Bac, Backa Palanka; the weed was also spreading northwards towards Kula, Begec and Futog. In the centre of the Backa region, it is widespread in Stepanovicevo and its surroundings, but it is less numerous in Zmajevo and Vrbas. In the northern and central parts of the Banat region, it is present in small numbers, but has a tendency to spread. In the southern part of the Banat region, it is widespread. Spreading only alongside Serbian rivers, common ragweed has even invaded the city of Nis, in the southern part of Serbia. Since 2003, in the city of Novi Sad, systematic control has been adopted; being found there in over 100 locations, in 21 city zones, it has now invaded about 90 ha (Table 1). Chemical control involves the use of glyphosate which, because of its ecotoxicological and safety characteristics, can be applied within areas of human habitation. Based upon data collected after monitoring, in certain localities control measures have to be repeated.

Table 1. Common ragweed (*Ambrosia artemisiifolia*) number and coverage (in ha) in the city of Novi Sad, Serbia.

City zone	2003	2004
Liman	4.3	2.2
Detelinara	5.4	4.4
Donji Ribnjak	3.3	1.1
Kej	2.2	2.1
Novo Naselje	4.4	2.3
Mali Beograd	1.2	1.1
Avijatičarsko naselje	5.5	4.4
Industrijska zona	5.5	4.4
Sremska Kamenica	3.3	2.3
Petrovaradin	5.5	3.4
Dunavac-Ribarsko ostrvo	5.5	4.4
Stari grad	2.2	1.1
Gradsko groblje	4.4	3.2
Institut za topolarstvo-Kaćka šuma	2.1	3.3
Autoput Novi Sad-Beograd	3.4	5.5
Veternik	4.5	4.4
Salajka	3.3	3.2
Mišeluk	4.4	3.4
Telep	3.3	3.3
Kamenjar	3.2	2.2
Adice	2.2	1.1

During the two-year period over which common ragweed has been monitored and controlled, populations in Serbia have been significantly reduced. In 2004, monitoring of common ragweed pollen in the air also showed a significant reduction, compared with quantities recorded in the previous year. In the city of Novi Sad, application of combined control measures (mechanical and chemical) has lead to a reduction in numbers of common ragweed, as well as the quantity of pollen in the air. However, the problem of the spread of this invasive weed species has not been permanently solved, since neighbouring areas (both agricultural and non-agricultural) still remain as seed banks. Because of this, common ragweed must still be controlled in soya bean, sugar beet, maize and sunflower crops by the use of contact herbicides, and on non-agricultural land either mechanically by mowing or by the use of chemicals. In certain Serbian localities, the newly introduced ruderal species *Iva xanthifolia* (Asteraceae) was also found during these studies.

REFERENCES

Braun-Blanquet J (1951). *Pflanzensoziologie*. Wien.

Hirst J M (1952). An automatic volumetric spore trap. *Annals of Applied Biology* **39**, 257-265.

Levente K; Laszlo V; Gyula B (2003). A parlagfu (*Ambrosia artemisiifolia* L.) elleni biologiai vedekezes lehetosegi. *Novenyvedelem* **39**, 319-331.

Priszter Sz (1960). *Adventiv gyomnovenyeink terjedese*. Mezogazdasagi Kiado: Budapest.

Invasive alien pests, weeds and diseases in Brandenburg and their ways of introduction

M Lehmann
LVLF – Plant Protection Service, D-15236 Frankfurt an der Oder, Germany
Email: manfred.lehmann@lvlf.brandenburg.de

M Glavendekic
University of Belgrade, Kneza Viseslava 1, SMG-11030 Belgrade, Serbia and Montenegro

INTRODUCTION

The aim of the present paper is to review the development over the past 50 years of newly introduced or immigrated organisms within the territory of Brandenburg (formed from the three formal counties surrounding the capital, Berlin). Alien species may become more important over the next 150 years, during which time many may often become established before their invasive significance is recognized (Kegel, 2001).

MATERIAL AND SOURCES

The archives, publications and accumulated knowledge of staff within the official plant protection body, information from entomologists, botanists or weed scientists, and recently registered cases in the authors' offices are all sources of information on new, harmful organisms confirmed or thought to be (or to become) invasive species in Brandenburg. More than ten years after major political and economical changes, it has become increasingly necessary to collect and manage such data. Over the next ten years or so, the knowledge of a whole generation of plant protection specialists and biologists is in danger of being lost. It is essential, therefore, to continue their earlier work, and to monitoring invasive alien species with the collaboration of specialists in biology, plant protection and nature conservation.

RESULTS

In recent years, invasive species (e.g. those in Table 1) have become more and more linked to nurseries and public green areas, especially close to the urban-commercial centre of Berlin (region Berlin-Potsdam), associated with recent climatic changes and the special sub-continental climatic character of Brandenburg. In this region, there are several introductory pathways:

- increasing worldwide transportation, especially the plant trade from eastern and south-eastern Europe and Asia;
- traffic (including aid and military activities) and tourism;
- wind and surface-water transportation;
- freeways, railways, wind channels parallel to the rivers Elbe (Elbe valley = 'Bohemia-Saxonian Gate'), Neisse and Oder;
- garden exhibitions (BuGa, LaGa, Iga).

Table 1. Examples of important invasive or potentially invasive species in Brandenburg.

Pests (*), weeds (#), pathogens (†)	Year	Host(s)	Means of introduction
Helicoverpa armigera *	2002	vegetables	mirgating moths; imported vegetables
Cameraria ohridella *	1997	*Acer* spp., *Aesculus* spp.	traffic, wind, water
Phyllonorycter issikii *	2001	*Tilia* spp.	wind, trade
Cacoecimorpha pronubana *	2003; 2004	ornamentals, *Prunus laurocerasus*	tree-nursery trade
Argyresthia thuiella *	1975	*Thuja occidentalis*	tree-nursery trade
Argyresthia trifasciata *	1988	*Chamaecyparis*, *Juniperus*, *Thuya*	tree-nursery trade
Quadraspidiotus perniciosus *	pre-2000	*Malus domestica*	tree-nursery trade
Campylopus introflexus #	1967	dunes, edge of forest	?
Heracleum mantegazzianum #	1974	farm/grassland, private gardens, field margins	food production; ornamental plants
Reynoutria japonica #	post-1970	private gardens, river banks, field margins	bomb sites; soil/waste tips etc.
Phytophtora alni †	1997/ 1998	*Alnus glutinosa*	hybridization; surface water
Guignardia aesculi †	1980	*Aesculus* × *carnea*, *A. hippocastanum*	tree-nursery trade
Erwinia amylovora †	1972	fruit trees and other Rosaceae	tree-nursery trade, birds, bees, traffic
Plum Pox Virus †	1961; 1978	*Prunus* spp.	tree-nursery trade

In the past, most 'classical' invasive (primarily glasshouse) species have arrived in eastern Germany from Asia or America via the Netherlands, western Germany and the UK. In recent years, however, invasive species arriving from or via the Balkans and other East-European states have gained in importance.

ACKNOWLEDGEMENTS

We thank all former and current colleagues, especially Dr H Bröther, A Stübner, Dr M Richter and H Jentsch, for providing important information and valuable material.

REFERENCES

Kegel B (2001). *Die Ameise als Tramp - Von biologischen Invasionen*. Wilhelm Heyne Verlag: Munich.

Invasiveness of small balsam (*Impatiens parviflora*) in Poland: causes and effects

A Lipińska
Centre for Ecological Research PAN, Dziekanow Lesny, 05-092 Lomianki, Poland
Email: laga@o2.pl

INTRODUCTION

Small balsam (*Impatiens parviflora*) is an invasive plant species which has successfully colonized Europe and had a large impact on the environment. This quintessential invader arrived from the Himalayan region, and has since spread rapidly throughout Poland and in other European countries (Coombe, 1956; Perrins *et al.*, 1993). At the same time, a diminution in the range of yellow balsam (*Impatiens noli-tangere*) (a native species in Poland) has been observed.

In 2003–2004, there was a sudden and large-scale decline in the population size of yellow balsam across central Poland. However, no such decline occurred in northern Poland, or in populations of small balsam in either region. This situation may be connected with the presence of the netted carpet moth (*Eustroma reticulatum*) (Lepidoptera: Geometridae), whose larvae feed on yellow balsam (Hatcher *et al.*, 2004), but are not known to attack small balsam.

The aim of the current project, in which all aspects of invasion will be compared, is to investigate probable causes and results of the success of small balsam in Poland.

HYPOTHESES

The 'enemy release' hypothesis argues that unusual success of invasive plants results from reduced natural enemy attack (Elton, 1958). Allelopathy may be a mechanism by which small balsam may interfere with its neighbours (Hierro & Callaway, 2003). Soil biota in some invaded ecosystems may promote invasions; plant-soil feedback processes are also important. In this study it may be possible to prove that soil fauna numbers, their diversity and the release of chemical compounds into the environment are host-specific.

Diversity of arbuscular mycorrizal fungi, rhizosphere bacteria in and around the roots and different communities of non-mycorrizal fungi coexisting with seeds and seedlings of these species have all been suggested as reasons for the spectacular success of small balsam in Poland.

MATERIALS AND METHODS

The investigation consisted of both laboratory experiments and field observations in the Kampinos Forest, near Warsaw (the Mazowsze region), and in the Piska Forest, in Mikolajki (the Mazurian Lakeland).

Experiments were designed from spring to autumn 2004 at four adjacent experimental sites. All samples were taken three times a season (before bloom, during bloom and at seed maturity).

Using a steel soil corer, samples of 10 cm^2 in surface area and 10 cm depth were taken from each site. Springtails (Collembola) and mites (Acari) were extracted from soil cores using a Tullgren apparatus. The arbuscular mycorrhizal status of both species was also investigated. In summer 2004 an assessment of the presence of population of netted carpet moth was made in all known and surveyed sites for yellow balsam in the Piska Forest. Seed productivity of small balsam and yellow balsam was calculated only in the Mazurian Lakeland.

CONLUSIONS

Previous results have demonstrated that the success of small balsam may depend on the better ecological adaptation of this species (e.g. higher capacity of seed production) and lower susceptibility to pathogens. Also, it is possible that small balsam may exude chemicals from their roots and leaves that are detrimental to the growth of other plants.

Population crashes of yellow balsam in the Mazowsze region may linked to this species being particularly prone to attack by fungal pathogens. Important fluctuations in the size of yellow balsam population in the Piska Forest have also been associated with the presence of the endangered netted carpet moth. (Yellow balsam is believed to be the sole food plant for this moth.) Compared with small balsam, yellow balsam also accumulates more soil mezzofauna, which have an influence on its roots.

Arbuscular myccorhiza symbiosis is typical of both small and yellow balsam, but there are differences between the diversity of mycorrizal fungi in the roots of both species in both the Kampinos Forest and the Piska Forest. This situation may be connected with an increase in root colonisation by dark septate endophytic fungi, which is generally observed in cold-stressed environments in the Mazurian Lakeland.

REFERENCES

Coombe D E (1956). *Impatiens parviflora* DC. *Journal of Ecology* **44**, 701-713.

Elton C S (1958). *The Ecology of Invasions by Animals and Plants.* Metheum: London.

Hatcher P E; Wilkinson M J; Albani M C; Hebbern C A (2004). Conserving marginal populations of the food plant (*Impatiens noli - tangere*) of an endangered moth (*Eustroma reticulatum*) in a changing climate. *Biological Conservation* **116**, 305-317.

Hierro J L; Callaway R M (2003). Allelopathy and exotic plant invasion. *Plant and Soil* **256**, 29-39.

Perrins J; Fitter A; Williamson M (1993). Population biology and rates of invasion of three introduced *Impatiens* species in British Isles. *Journal of Biogeography* **20**, 33-44.

The butterfly *Cacyreus marshalli* in northern Italy, and susceptibility of commercial cultivars of *Pelargonium*

D Lupi
Istituto di Entomologia agraria, Via Celoria 2, 20133 Milano, Italy
Email: daniela.lupi@unimi.it

C Jucker
BioLomb – Fondazione Minoprio, V.le Raimondi 54, Vertemate con Minoprio (CO), Italy

INTRODUCTION

The ornamental geranium is a traditional and very common plant largely cultivated in Europe. However, the geranium bronze butterfly (*Cacyreus marshalli*) (Lepidoptera: Lycaenidae), introduced from South Africa and inserted in EPPO A2 list, is now threatening the popularity of both *Geranium* spp. and *Pelargonium* spp. This pest was first intercepted on imported plants and eradicated in the UK in 1978 (Sarto I Monteys, 1992). In 1986 it was found in Balearic Islands (Eitshberger & Stamer, 1990); it then occurred in the rest of Spain, Portugal, France, Belgium and the Principality of Monaco. In Italy, it was first detected in 1996; it has now spread throughout the country (Trematerra & Parenzan, 1997; Lupi & Jucker, 2004).

Damage is caused by the larvae, which excavate mines in the leaves and also eat floral buds and leaves. They can even produce galleries inside stems, which then become packed with frass. Before pupation, larvae emerge from stems, making circular holes. Their activity destroys plants and favours the appearance of pathogenic fungi or bacteria.

Because of the importance of *Pelargonium* as ornamental plants in gardens and terraces, a study to verify the biology of the geranium bronze butterfly, and the susceptibility of different commercial cultivars, was carried out in 2004 in the north of Italy.

MATERIALS AND METHODS

Studies on the biology of geranium bronze butterfly were conducted in Milan (nothern Italy) on *Pelargonium* spp. from April to the end of December, observing directly the presence of adult, larvae eggs or damage.

To test the susceptibility to the attack of the butterfly, 40 different ornamental geraniums were used (Table 1): 10 cvs of zonal pelargoniums (*Pelargonium* × *hortorum*); 3 cvs of ivy-leafed pelargoniums (*P. peltatum*); 3 cvs of regal pelargoniums (*P.* × *domesticum*); and 16 species or cvs of scented-leafed pelargoniums.

The plants were exposed to the pest from the end of May to the end of September, in two different localities. The plants were observed every week, and data on damage and their symptomatology were collected.

Table 1. Pelargoniums tested in the study.

Zonal	Ivy-leafed	Regal	Scented-leafed	
Fireworks cherry white	Balcon imperial	Burghi	Abrotanifolium	Orange fizz
Fireworks red white	Royal pink	Latemar	Asperum	Patons unique
Fireworks scarlet	Royal white	Pac randy	Attar of roses	Pink capitatum
Frank headley			Chocolate peppermint	Prince of orange
Happy orange			Concolor lace	Princeanum
Mrs pollock			Crispum major variegato	Purple unique
Real diana			Denticulatum	Queen of lemon
Sailing			Fair ellen	Royal oak
Samon flash			Filicifolium	Scarlet unique
White flash			Fragrans	Snowflake
			Lady plymouth	Tomentosum
			Odoratissimum	Wayward angel

RESULTS

Many overlapping generations of the pest occurred, with adults detected from the beginning of May to the middle of October. Damage was first observed on zonal and ivy-leafed pelargoniums in June; regal and scented-leafed pelargoniums were attacked later and less severely. Most of the plants tested were attacked. Only on some scented-leafed pelargoniums (Abrotanifolium, Concolor lace, Denticulatum, Fair ellen, Filicifolium, Odoratissimum, Purple unique, Prince of orange, Royal oak, Wayward angel) were no larvae or damage found. Further research is needed to detect the reasons for this apparent resistance.

ACKNOWLEDGEMENTS

This work has been done with a grant from the Regione Lombardia Research Project 'Record of exotic pests in Lombardy'.

REFERENCES

Eitschberger U; Stamer P (1990). *Cacyreus marshalli* Butler, 1898, eine neue Tagfalterart für die europäische Fauna? (Lepidoptera, Lycaenidae). *Atalanta Würzburg* **21**, 101-108.

Lupi D; Jucker C (2004). Il lepidottero *Cacyreus marshalli* minaccia le colture di geranio. *Clamer informa* **29**, 51-54.

Sarto I Monteys V (1992). Spread of the Southern African Lycaenid butterfly, *Cacyreus marshalli* Butler, 1898, (Lep: Lycaenidae) in the Balearic Archipelago (Spain) and considerations on its likely introduction to continental Europe. *Journal of Research on the Lepidiptera* **31**, 24-34.

Trematerra P; Parenzan P (2003). *Cacyreus marshalli*, lepidottero in rapida diffusione sui gerani. *Informatore Agrario*. **31**, 57-60.

Iva xanthifolia, a problematic weed in sugar beet in Serbia

D Marisavljević, D Pavlovic
Institute for plant protection and environment, Teodora Drajzera 9, Belgrade, Serbia
Email: marisavljevicd@ptt.yu

B Veljkovic
CHEMICAL AGROSAVA, P.Toljatija 5/IV, 11000 Belgrade, Serbia

Lj Radivojevic
Center for pesticides and environmental research, Banatska 31b, 11080 Zemun, Serbia

INTRODUCTION

Iva xanthifolia is a newly introduced weed in Serbia. The first report of its presence were in 1966 (Koljadzinski & Šajinović, 1978), predominantly along roads and tracks, and Veljković (1996) has since reported its presence in arable crops. The plants is well-adapted to Serbian growing conditions, has a high seed production and already causes problems in soya bean, maize, sunflower and sugar beet. The weed is also important elsewhere in eastern Europe (e.g. Milanova, 1999; László & Mária, 2000; Hódi, 2001). In Serbia, we began a four-year investigation (continuing the investigations of Marisavljevic & Veljkovic, 2002), to examine the possibilities for its chemical control in sugar beet.

MATERIAL AND METHODS

Field trials were done in the field naturally infested with 350 plants/m^2. Sugar beet was grown according to the local practice. The following combinations of herbicides were used: (a) triflusulfuron-methyl (0.01 kg a.i./ha) & phenmedipham + desmedipham (0.12 + 0.12 kg a.i./ha) single application, normal post-emergence; (b) triflusulfuron-methyl (0.02 kg a.i./ha) & phenmedipham + desmedipham (0.24 + 0.24 kg a.i./ha), split application; (c) phenmedipham + desmedipham (0.24 + 0.24 kg a.i./ha) & ethofumesate (1.5 kg a.i./ha) single application, normal post-emergence; (d) phenmedipham + desmedipham (0.24 + 0.24 kg a.i./ha) & clopyralyd (0.05 kg a.i./ha) single application, normal post-emergence; (e) phenmedipham + desmedipham (0.24 + 0.24 kg a.i./ha) & clopyralyd (0.06 kg a.i./ha), split application; (f) phenmedipham + desmedipham (0.24 + 0.24 kg a.i./ha) & metamitron (2.8 kg a.i./ha), split application; (g) phenmedipham + desmedipham (0.24 + 0.24 kg a.i./ha), ethofumesate (1.5 kg a.i./ha) & metamitron (2.1 kg a.i./ha), split application; (h) phenmedipham + desmedipham (0.24 + 0.24 kg a.i./ha), metamitron (2.1 kg a.i./ha) & clopyralid (0.025 kg a.i./ha), single application; (i) triflusulfuron-methyl (0.02 kg a.i./ha) + phenmedipham + desmedipham (0.18 + 0.18 kg a.i./ha) & metamitron (2.1 kg a.i./ha), split application; (j) triflusulfuron-methyl (0.015 kg a.i./ha), phenmedipham + desmedipham (0.12 + 0.12 kg a.i./ha) & metamitron (1.4 kg a.i./ha), single application. In all treatments with triflusulfuron-methyl, 0.05% 'Trend' (90% isodecylalcochol ethoxylate) was added. Herbicides were applied with a knapsack sprayer with a 2-m-wide boom and 8 flat-fan nozles (Spraying System 110-002). Spray volume was 400 litres/ha. Single applications were made at the cotyledon or 2- to 6-leaf stage of the weed. First treatments of split applications were at the cotyledon to 2-leaf stage, while the second application was at the 2- to 6-leaf stage of the weed.. The trials were set up using a randomized block design with four replicates; plot size was 25 m^2.

RESULTS AND DISCUSSION

Most of the 10 herbicide combinations tested achieved better than 80% efficiency (Table 1).

Table 1. Efficiency of herbicides tested.

Herbicide combination	Efficiency (%)	Herbicide combination	Efficiency (%)
(a)	79	(f)	90
(b)	97	(g)	83
(c)	93	(h)	90
(d)	80	(i)	100
(e)	81	(j)	97

A 100% effect was achived only with split application treatment (i), although split application treatments (b) and (j) also had a very good effect. All other combinations were unsatisfactory. Better results were achieved with normal post-emergence applications (at 2 to 4 leaves of *Iva xanthifolia*) rather than at early post-emergence (cotyledon to 2-leaf stage) and with split (rather than single) applications. The experimental field was heavily infested with *I. xanthifolia*, and we believe that this weed must be fully eliminated from sugar beet fields, because its size and strong competitive potential can result in a total loss of the crop. One plant/m^2 is sufficient to cause problems in sugar beet.

REFERENCES

Hódi L (2001). Effect of timing and overdosing of herbicide treatments on some imidazolinone-tolerant maize hybrids. *Magyar Gyomkutatás és Technológia* **2**, 41-45.

Koljadžinski B; Šajinović B (1978). Prilog proučavanju procesa naturalizacije adventivnih biljnih vrsta - *Ambrosia artemisiifolia* L. 1753. i *Iva xanthifolia* Nutt. 1818. (Asteraceae) u Vojvodini. *Bioistematika* **14,** 81-92.

László H; Mária G T (2000). Spreading of weed plant, *Iva xanthiifolia* Nutt. in Csongrád county. *Növényvédelem* 36, 5-7.

Marisavljević D; Veljković B (2002). *Iva xanthifolia* Nutt.: A problematical weed in sugar beet in Yugoslavia. *Proceedings of the 12th Symposium European Weed Research Society Wageningen 2002, Papendal, Arnhem, the Netherlands,* pp. 210-211.

Milanova S D (1999). *Iva xanthifolia* Nutt. - a new species in the adventive flora in Bulgaria. *11th European Weed Research Society Symposium (1999)*, p. 40.

Veljkovic B (1996): Rasprostranjenost novounešenih korovskih vrsta *Ambrosia arthemisiifolia* L. i *Iva xanthifolia* Nutt. u Jugoslaviji. *Zbornik radova Petog kongresa o korovima*, pp. 351-363.

Current status of *Pseudomonas corrugata* as an introduced agricultural pathogen in Brazil

O M Martins
Embrapa Recursos Genéticos e Biotecnologia, CP 02372, 70770-900 Brasília, DF, Brazil
Email: olinda@cenargen.embrapa.br

M E Couto
Embrapa Clima Temperado – Convênio EMATER, RS, 96001-970 Pelotas, RS, Brazil

INTRODUCTION

The use of plastic houses for tomato production in southern Brazil began in 1985. The main objective of using a protected environment was to shelter cultures from extreme climatic conditions, and thereby improve plant growth and harvesting. Pith necrosis, caused by the pathogenic bacterium *Pseudomonas corrugata*, was first observed on field-grown tomatoes in Paulinia, São Paulo, in 1988 (Rodrigues Neto *et al.*, 1990). In 1989, an outbreak of the disease occurred under field conditions and in a protected environment in the State of Rio Grande do Sul (Martins *et al.*, 1992). The symptoms were seen during the flowering and fruiting stages, and losses in protected tomato (cv. Monte Carlo) reached 40%. The spread of the disease occurred mainly when the plant buds were removed, and also by the contamination of plants owing to the presence of the pathogen in the irrigation water. Plants along the irrigation channels developed a dark-brown and water-soaked necrosis in the stem, followed by complete destruction of the pith. None of the infected plants recovered; instead, they wilted and died in a few days.

There were no further reports of the disease in Brazil, suggesting that the pathogen's absence in the field, as well as under protected conditions, was probably attributable to the use of resistant cultivars or healthy seeds. There had been no official control of the disease by the Ministry of Agriculture, Livestock and Food Supply.

MATERIALS AND METHODS

The pathogen was isolated from necrotic tomato pith, collected from different areas in field, and under plastic houses, in the State of Rio Grande do Sul. Sections of dark-brown and water-soaked tissues were used for bacterium isolation. Colonies grown on SPA medium were tested along with the type strain NCPPB 2445. Non-fluorescent bacteria that produced slightly irregular, rounded, mucoid buff-yellow colonies on SPA medium, were characterized by means of morphological, biochemical, physiological and pathogenicity tests.

Tomato plants (cv. Monte Carlo) with from six to eight expanded leaves were inoculated by stem puncturing at the axil of the first and second leaves, and then depositing a drop of bacterial suspension with 1×10^8 colony-forming units (CFU)/ml. Pathogenicity tests were carried out in the greenhouse, with temperatures ranging from 25 to 40°C.

Genetic variability of *P. corrugata* strains was studied by using BOX A1R elements, and PCR amplifications were done as described by Louws *et al.* (1994).

RESULTS AND DISCUSSION

Cultural, biochemical and physiological characteristics of isolates from different areas in southern Brazil were similar to those of the type strain, which allowed the species to be identified as *P. corrugata*. Hypersensitive reactions (HRs) on tobacco were positive after 24 h of infiltration. All strains tested were gram-negative, aerobic, non-fluorescent on King B medium, accumulated poly-beta-hydroxybutyrate (PHB) and grew at 37°C but not at 41°C; they were also oxidase and gelatin hydrolysis positive, but starch hydrolysis and levan test negative. On SPA medium, colonies were slightly irregular, round, mucoid and yellow (often with green centres), with the formation of a diffusible, non-fluorescent, yellowish-green pigment.

First symptoms appeared after 72 h of inoculation, characterized by the presence of small, water-soaked lesions around the inoculation point. Dark-brown lesions extended slowly along the stem.

The cluster analysis, based on similarity values for all pair-wise combinations, indicated four groups, when 50% of Jaccard's coefficient was considered. The type strain (NCPPB 2445) was clustered in a group that included strains from field-grown tomatoes in northern Rio Grande do Sul State. The strains from tomatoes grown under protection showed different patterns from those that originated from the field. The climatic and edaphic conditions from field-grown tomatoes are very different of those grown in plastic houses. Thus, the origin of the disease is not clear, and there is a lack of knowledge about the epidemiological aspects, transmission and control. No further reports have occurred in Brazil since the first epidemics in the States of São Paulo and Rio Grande do Sul. However, the inclusion of the pathogen in the official quarantine pest list, as an invasive species, should be considered.

REFERENCES

Louws F J; Fulbright D W; Stephens C T; De Bruijn F J (1994). Specific genomic fingerprints of phytopathogenic *Xanthomonas* and *Pseudomonas* pathovars and strains generated with repetitive sequences and PCR. *Applied and Environmental Microbiology* **60**, 2286-2295.

Martins O M; Couto M E; Patella A E (1992). Necrose da medula: uma nova doença do tomateiro no Rio Grande do Sul. *Horti Sul* **2**, 16-18.

Rodrigues Neto J.; Malavolta Jr V A; Ramos R S; Sinigaglia C (1990). Ocorrência de *Pseudomonas corrugata* em tomateiro no Estado de São Paulo. *Summa Phytopathologica* **16**, 279-284.

The longhorn beetle *Anoplophora chinensis* (form *malasiaca*), a new pest of woody ornamentals in Italy

M Maspero, C Jucker
Progetto BioLomb, Fondazione Minoprio, V.le Raimondi 54, 22070 Vertemate con Minoprio (CO), Italy
Email: biolomb@fondazioneminoprio.it

M Colombo
Istituto di Entomologia agraria, Università degli Studi di Milano, Via Celoria 2, 20133 Milano, Italy

M Ciampitti, B Cavagna, G Caremi
Servizio Fitosanitario della Regione Lombardia, Piazza IV Novembre 5, 20124 Milano, Italy

INTRODUCTION

Citrus longhorn beetle (*Anoplophora chinensis*, form *malasiaca*) (Coleoptera: Cerambycidae) is widely distributed in Japan and Korea (Lingafelter & Hoebeke, 2002). The first detection in Europe occurred in 2000, in Italy, in a nursery located between the provinces of Milan and Varese (Colombo & Limonta, 2001).

According to Directive 2000/29/CE (Att. 1, Part A, Sec. 1), citrus longhorned beetle is a quarantine pest in Europe and, in 2004, the Lombardy Region issued a Decree of Control and Eradication (B.U.R.L. – 2 February 2004).

The pest is a serious problem for the nursery industry, in the production of ornamental trees; it is also a potentially serious pest of citrus orchards and of many other established deciduous trees. Adults feed on the tender bark of small twigs and branches, and sometimes on leaf petioles. The female also chews through the bark of the host tree to the cambial layer, forming 'egg scars'; she then inserts her ovipositor and lays a single egg (Lingafelter & Hoebeke, 2002). Larvae feed and develop in the wood of the main roots and trunks, within which they excavate tunnels. When larval density is high, infested trees can die or fall down.

MATERIALS AND METHODS

Monitoring of citrus longhorn beetle was done by checking for the presence of holes, sawdust and oviposition scars in host trees, and by collecting adults and other stages. Such monitoring commenced at the core of the infestation, and was then extended out from this zone over increasing distances. All infested trees were located on a map, by means of GPS; a database, with information concerning these trees, was then created.

In order to limit the spread of the insect, one of three measures was chosen:

1. Trees showing evidence of the presence of the pest were cut down, and the plant parts removed and destroyed, in accordance with Phytosanitary measures (B.U.R.L. – 2 February 2004).

2. If stump removal was not possible, the stumps were killed with chemicals, and covered with a wire mesh cage for a period of two years, in order to capture any adults that might emerged. The wire mesh cages were also placed on the ground around the stumps, to cover a surface equivalent to the projection area of the tree crown.

3. At very low infestation rates on valuable trees, an exception was permitted by the Phytosanitary Service. Such trees were left uncut, but a wire mesh cage was placed around the base of each.

Besides the described actions, eggs, larvae, pupae and adults were also collected, to obtain more information on the development of the pest in the area under quarantine.

RESULTS

Adults flew from the end of May until the end of August, with peak numbers in the middle of June. Males occurred earlier than females. In our climate, citrus longhorn beetle is believed to require one to two years for a single generation to develop. Exit holes have been found only at the base of trees and on surface roots; up to 90 per tree have been recorded.

The insect has been found in 13 villages, all relatively close to the first point of detection, covering an area of approximately 60 km^2 in which quarantine measures have been adopted. During 2003–2004 about 400 trees were removed and the bases of 400 others covered with wire mesh cages, according to the Phytosanitary Decree in force. In Italy, citrus longhorn beetle primarily attacks species of *Acer* (48%), *Platanus* (15%), *Betula* (14%), *Carpinus* (7%) and *Fagus* (5%). Damage has also been found on species of *Aesculus*, *Corylus*, *Cotoneaster*, *Crataegus*, *Lagerstroemia*, *Malus*, *Populus*, *Prunus*, *Rosa*, *Quercus* and *Ulmus*.

ACKNOWLEDGEMENTS

This work has been done with a grant from the Regione Lombardia Research Project 'Record of exotic pests in Lombardy'.

REFERENCES

Colombo M; Limonta L, (2001). *Anoplophora malasiaca* Thomson (*Coleoptera Cerambycidae Lamiinae Lamiini*) in Europe. *Bollettino di Zoologia agraria e di Bachicoltura, Serie II,* **33**, 65-68.

Lingafelter S W; Hoebeke E R (2002). Revision of *Anoplophora*. *Entomological Society of Washington*, 1-236.

Monitoring of velvetleaf (*Abutilon theophrasti*) on arable land in Saxony, Germany, in the years 2000–2003

E Meinlschmidt
Sächsische Landesanst. f. Landw. Referat Pflzsch. Stübelallee 2, D-01307 Dresden, Germany
Email: Ewa.Meinlschmidt@fb4d.lfl.smul.sachsen.de

INTRODUCTION

In the year 2000, velvetleaf (*Abutilon theophrasti*) was registered as a weed on arable land for the first time in the Free State of Saxony by the official Plant Protection Service (Viehweger & Dittrich, 2004). As a result, the Saxon State Institute for Agriculture and regional agricultural authorities initiated a 4-year survey on its occurrence on arable land.

MATERIALS AND METHODS

In order to determine the occurrence of velvetleaf on arable land, and the means of its introduction, consultations of regional agricultural authorities were carried out in the years 2000–2003, on the following subjects:

- size of infested field (ha), soil type, valuation index of field and altitude (m above sea level);
- infestation levels of velvetleaf, estimated as weed coverage (%) and its distribution within the field;
- cultivated crop plant, crop rotation, catch crops, fertilizers used (such as stable manure, semi-liquid manure and poultry dung) and herbicides used in the infested crop.

RESULTS AND DISCUSSION

In the years 2000–2004, velvetleaf was found on arable land at 40 sites in Saxony (Table 1), covering a total area of 1,080 ha. However, only 5% of this area was directly infested by velvetleaf. The estimated density in the infested fields varied from just one velvetleaf plant to weed coverage of 25%. In 75% of the sites, the weed was found in sugar beet crops. The highest density of velvetleaf also occurred in sugar beet. In one case, the coverage of velvetleaf reached from 25 to 50%. The remaining occurrences were in maize, potatoes, spring barley, winter barley, winter rape, winter wheat and witloof chicory. In all but maize, only individual plants or small populations were found in each infested field. The distribution of this species in the fields was always irregular, although the weed grew mainly outside the crop rows. Most sites were located in the lowlands and hilly country in Saxony, at between 74 and 450 m above sea level. Apart from sandy soil velvetleaf grew on all soil types, but with a preference for sandy loam and loam.

During 2000–2003, mustard was cultivated as a catch crop in the rotation in 11 infested fields, oil radish in three fields, and oat and vetch in one field. Seventeen of 40 infested sites were fertilized with stable manure, seven with semi-liquid manure, three with stable manure and semi-liquid manure, and three with poultry dung. Only on four sites were neither catch crops cultivated nor organic fertiliser applied. In 2001, seeds of velvetleaf were found for the first time in mustard seeds in Ullendorf/Taubenheim. Mustard was cultivated there as a catch crop, before the infested sugar beet. In 2001 and 2002, seeds were detected by the seed trade control (in Saxony) in three imported seed lots of catch crops: two cases in mustard and one case in oil radish. In total, 5,000 seed lots from Saxony were analysed during seed certification, but no seeds of velvetleaf were found.

Table 1. Occurrence of *Abutilon theophrasti* in crops in Saxony in 2000-2003

	2000		2001		2002		2003	
Number of sites	10		4		11		15	
Meter about sea level	80–280		74–250		100–450		83–305	
Valuation index of fiel	50–75		61–65		30–86		50–88	
Soil type	sL–L		sL		sL–L–T		sL–L	
Size of fields	ha	%	ha	%	ha	%	ha	%
Sugarbeet	267	95	57	74	153	48	319	80
Maize	7	2			70	22	46	11
Potatoes					50	15		
Winter rape					37	11		
Witloof chicory							35	9
Winter wheat	8	3						
Spring barley			20	26				
Winter barley					12	4		
Total	282	100	77	100	322	100	400	100

sL = sandy loam; L = loam; T = clay soil

Under Saxon conditions the optimum environment for velvetleaf is provided by sugar beet crops. The velvetleaf plants are very noticeable in sugar beet, because of their height and leaf diameter, and chemical control of the weed is inadequate in this crop (Meinlschmidt, 2004). Biological characteristics predetermine velvetleaf to become a late-summer annual and, since 2000, it has been found every year, especially in root crops. This species does not appear to migrate into arable land from ephemeral or known, especially mapped non-arable, locations. Its seeds are introduced together with those of catch crops. Fertilizers (such as liquid and solid manure, and especially poultry dung) are other possible pathways. Seeds of velvetleaf can survive digestion in large animals, without loss of viability, and can be transported in the manure directly to the field. Imported animal feed could be the original source. Because of its biology and means of introduction, the future, further spread of velvetleaf on arable land cannot be ruled out.

REFERENCES

Meinlschmidt E (2004). Gebietsfremde potentiell invasive Ackerunkräuter in Sachsen. *Gesunde Pflanze* **56**, 86-92.

Viehweger G; Dittrich R (2004). Die Samtpappel (*Abutilon theophrasti* MED.) als neues Unkraut in Sachsen. *Gesunde Pflanze* **56**, 2-10.

Molecular identification and pathway analysis of the introduced pinewood nematode *Bursaphelenchus xylophilus*

K Metge, W Burgermeister
BBA, Messeweg 11/12, D-38104 Braunschweig, Germany
Email: k.metge@bba.de

INTRODUCTION

The pinewood nematode (PWN) (*Bursaphelenchus xylophilus*) is native to North America. In the past this invasive species has been spread by means of timber trade and package wood to several East Asian countries and, more recently, to Portugal (Evans *et al.*, 1996; Mota *et al.*, 1999). PWN is pathogenic to many pine species in its new areas of distribution, causing economic loss due to pine wilt disease. The identification of PWN and its differentiation from other species of *Bursaphelenchus* has been facilitated by application of the rDNA ITS-RFLP technique (Braasch *et al.*, 1999). In spite of EU quarantine regulations, living PWNs were found in 47 samples of conifer wood imported to EU countries during 2000 to 2004. In order to trace the origin of the PWN populations introduced to Portugal, Random Amplified Polymorphic DNA-PCR (RAPD-PCR) was performed to determine genetic relationships among PWN populations from different countries.

MATERIAL AND METHODS

Bursaphelenchus cultures from Europe, North America and East Asia (representing populations of different species and various geographic origins of PWN) were maintained in *Botrytis cinerea*/malt agar. Genomic DNA was extracted from mixed life stages of the nematodes, using the High Pure PCR Template Preparation Kit according to the recommendations of the manufacturer (Roche). ITS-RFLP for *Bursaphelenchus* species identification was performed as described previously (Braasch *et al.*, 1999). Using a pair of rDNA-specific primers, the internal transcribed spacer regions ITS1 and ITS2 of the rDNA were amplified by PCR. The PCR product was digested in parallel reactions applying the five restriction enzymes *Rsa* I, *Hae* III, *Msp* I, *Hinf* I and *Alu* I.

RAPD-PCR for assessing population relationships was done according to Braasch *et al.* (1995), employing a range of random decamer primers to amplify different patterns of DNA fragments of 30 PWN populations from the USA, Canada, Japan, China, South Korea and Portugal. The restriction fragments of the ITS-RFLP and the RAPD-PCR products were separated by agarose gel electrophoresis. The gels were stained with ethidium bromide (1µg/ml) and visualized using a UV transilluminator. PWN population relationships were calculated from bands scored from the fingerprint profiles of each primer, rated as presence or absence of bands. For cluster analysis data matrices of genetic distances were calculated using the Nei & Li coefficient, and the UPGMA method was applied to dendrogram constructions.

RESULTS AND DISCUSSION

Twenty-seven ITS-RFLP patterns were established, representing 26 different *Bursaphelenchus* species. The ITS-PCR products ranged from 820 bp to 1350 bp and permitted initial diagnostic differentiation. In addition to species differentiation, a European and an East Asian type of *B. mucronatus* could be distinguished. The ITS-RFLP technique has proven valuable for the identification of the quarantine pest PWN during inspections of coniferous package wood imported to Germany from Asia and North America.

The present pathway analysis of introduction of PWN to Portugal differentiated two main groups, a North American branch and an Asian/Portuguese branch. These groups do reflect the history of the world-wide spread of this invasive species. The North American branch includes clades built-up with populations of Canada and the USA. One population from Japan could neither be assigned to North American nor to the Asian/Portuguese group. However, various populations from the USA clustered together with populations from Canada. In general, these populations were genetically more diverse than the populations found in the Asian/Portuguese branch. This is expected since *B. xylophilus* is native to North America. Subclades of the Asian/Portuguese branch were obtained for China, South Korea, and Japan, but not for Portuguese populations. The clustering of widely separated populations from Asia and Portugal and the separation of the Portuguese PWN populations within this group indicate that the founders of the populations most probably were translocated two times to Portugal from their recently colonized sites in Asia and not from their native habitat in North America.

ACKNOWLEDGEMENTS

We thank Dr Thomas Schröder at BBA for providing *B. xylophilus* cultures. The research was financed by the EU FP5 programme, Contract No. QLK5-CT-2002-00672.

REFERENCES

Braasch H; Burgermeister W; Pastrik K-H (1995). Differentiation of three *Bursaphelenchus* species by means of RAPD-PCR. *Nachrichtenblatt für den Deutschen Pflanzenschutzdienst* **47**, 310-314.

Braasch H; Metge K; Burgermeister W (1999). *Bursaphelenchus*-Arten (Nematoda, Parasitaphelenchidae) in Nadelgehölzen in Deutschland und ihre ITS-RFLP-Muster. *Nachrichtenblatt für den Deutschen Pflanzenschutzdienst* **51**, 312-320.

Evans H F; McNamara D G; Braasch H; Chadoeuf J; Magnusson C (1996). Pest Risk Analysis (PRA) for the territories of the European Union (as PRA area) on *Bursaphelenchus xylophilus* and its vectors in the genus *Monochamus*. *European and Mediterranean Plant Protection Organisation, OEPP/EPPO, Bulletin* **26**, 199-249.

Mota M M; Braasch H; Bravo M A; Penas A C; Burgermeister W; Metge K; Sousa E (1999). First report of *Bursaphelenchus xylophilus* in Portugal and in Europe. *Nematology* **1**, 727-734.

Current status of the whitefly *Aleurodicus dispersus* as an invasive pest in the Cape Verte Islands

A H R R Monteiro, S Gomes, I Gomes, P R Queiroz, L H C Lima, M R V Oliveira
INIDA, Endereço São Jorge dos Órgãos, Santiago, PO Box 84, Cidade da Praia, Cabo Verde
E.mail: arendall@inida.gov.cv

INTRODUCTION

In the last three decades, the spiralling whitefly (*Aleurodicus dispersus*) has become an important international pest. The movement of plants and parts of plants (such as fruits) in international trade and tourism, and by natural dispersal, has favoured its introduction to new areas. In common with others whiteflies of economic importance, the immature and adult stages cause direct feeding damage by piercing and sucking of sap from foliage, and indirect damage following the accumulation all over host plants of honeydew and waxy flocculent material produced by the insects. Spiralling whitefly is a pest of tropical and subtropical crops, and highly polyphagous. Up to the 1970s, it had been recorded on 44 genera of plants, belonging to 26 botanical families (Mound & Halsey, 1978). This situation changed with the dispersal of the pest to new areas. Nowadays, the spiralling whitefly is one of the major pest of vegetable, ornamental and fruit crops around the globe (Lambkin, 1999). Important host crops include: banana (*Musa sapientum*), *Citrus* spp., coconut (*Cocos nocifera*), eggplant (*Solanum melanogena*), guava (*Psidium guajava*), *Hibiscus rosa sinensis*, Indian almond (*Terminalia catappa*), papya (*Carica papaya*), *Rosa* sp. and tomato (*Lycopersicon esculentum*) (Saminathan & Jayaraj, 2001). Spiralling whitefly has its origin in the tropical Americas, including Brazil. Although the pest has been recorded only once in Brasil, in the 1920s in the state of Bahia (Bondar, 1923), it now has official quarantine status because of its economic importance. In the Cape Verte Islands, on the West African coast, the pest was initially introduced in the first half of 2000; it has since become established, reaching urban, natural and agricultural areas of the islands that constitute the archipelago. Since then, the pest has been causing damage to many native plants, ornamentals and cultivated food crops (Anon., 2001; Monteiro, 2004). The present study was done in order to produce an inventory of the most common host plants of spiralling whitefly in this new habitat.

MATERIALS & METHODS

The host plant survey was done from March 2003 to February 2004, in the two most important islands of the Cape Verte archipelago (Santiago and Santo Antão), where agriculture is of importance and where there is considerable biological diversity. Whitefly infestation levels were also recorded on leaves of the host plants; plants were considered ‘heavily infested’ when 10 or more individuals were present per cm^2. RAPD analysis was done, using six random primers, to compare the molecular diversity among the various whitefly populations collected.

RESULTS & DISCUSSION

The main host plants recorded in the Cape Verte archipelago belonged to 64 botanical families, and included 205 species. Most species were in the families Euphorbiaceae (23%), Fabaceae (23%), Malvaceae (13%), Solanaceae (12%), Asteraceae (9%), Amarantaceae (8%) and Cucurbitaceae (7%).

The main hosts were *Acalypha wilkesiana* var. *musaica*, *Ageratum conyzoides*, banana, cassava (*Manihot esculenta*), castor (*Ricinus communis*), *Euphorbia pulcherrima*, guava, *H. rosa sinensis*, Indian almond, *Ipomoea batatas*, lima bean (*Phaseolus lunatus*), *Malvastrum cordifolium*, papaya, pigeon pea (*Cajanus cajan*), *Solanum nigrum* and *Solanus oleraceus*.

Among the native plants infested, nine were endemic: *Artemisia gorgonum*, *Campanula jacobeia*, *Campilantus glabel*, *Echium hypertropicum*, *Echium stenosiphon*, *Euphorbia tuckeyana*, *Kickxia bruneri*, *Nauplius daltoni* and *Policarpea gay*.

Approximately 80% of crops examined were affected by the pest, with losses varying from 10 to 100%. Some of the infested plant species recorded on the survey have previously been reported as hosts in other areas of the world.

Of the various plants examined, 45% had infestation densities greater than 10 individuals per cm^2; these included *A. wilkesiana* var. *musaica*, banana, cassava, *E. pulcherrima*, *H. rosa sinensis*, *Hymenocallis senegambica*, *M. cordifolium*, papaya, *Parietaria debilis* and *S. nigrum*.

When compared with those of coconut whitefly (*Aleurodicus cocois*), the molecular profiles obtained for spiralling whitefly showed 18% similarity.

REFERENCES

Anon. (2001). *Relatório Anual de Actividades do ano 2000*, Ministério de Agricultura, Alimentação e Ambiente Report, 31 pp.

Bondar, G (1923). *Aleyrodideos do Brasil.* Bahia.

Lambkin, T A (1999). A host list for *Aleurodicus dispersus* Russell (Hemiptera: Aleyrodidae) in Australia. *Australian Journal of Entomology* **38**, 373-376.

Montiero, A H R R (2004). *Introdução de Aleurodicus dispersus (Russell, 1965) (Hemiptera: Aleyrodidae), em Cabo Verde: caracterização molecular, faixa de hospedeiros e medidas fitossanitárias.* Dissertação apresentada a Universidade de Brasília, Agosto de 2004.

Mound, L A; Halsey, S H (1978). *Whitefly of the world. A systematic catalogue of the Aleyrodidae (Homoptera) with host plant and natural enemy data.* Chichester: John Wiley and Sons.

Saminathan, V R; Jayaraj, S (2001). Weeds as hosts of the spiralling whitefly, *Aleurodicus dispersus* Russell (Homoptera: Aleyrodidae) around Madurai, Tamil Nadu. *Pest Management and Economic Zoology* **9**, 27-30.

The influence of environmental conditions of the naturalisation of the alien millepede *Spinotarsus caboverdus* on Cape Verde

B Nascimento, H Sermann, C. Büttner
Humboldt-Universität zu Berlin, Institute for Horticultural Sciences, Berlin, Germany
Email: helga.sermann@agrar.hu-berlin.de

INTRODUCTION

The millepede *Spinotarsus caboverdus* (Class Diplopoda: Order Spirostreptida) belongs to the Odontopygidae, a family that is widely spread across tropical Africa (with the exception of Madagascar). Various diplopods have been spread by people through trading, and it can be assumed with confidence that the genus *Spinotarsus* was introduced to Cape Verde via the African continent, where it then became established locally (Brito, 1994). *S. caboverdus* was first found on Cape Verde in 1969 (Neves *et al.*, 1993) where, for 35 years, it has damaged major crops such as beans, maize, potato and sweet potato. Mechanical feeding damage leads to losses in plant tissue, and occurs throughout the year. Characteristic symptoms of feeding include holes in leaf laminae, leaf margins and fruits. Since its discovery, populations of *S. caboverdus* have greatly increased on Cape Verde, and neither chemical nor biological protection measures have been particularly successful. The aim of the study was to expand the biological knowledge regarding *S. caboverdus*, as a basis for the development of effective protection measures.

MATERIAL AND METHODS

Live specimens of *S. caboverdus* were collected on the island of Santo Antão, and subsequently transferred to Germany. The millepedes were then kept in either small or large groups in suitable cages (within an insectary) at a temperature of 22–26°C, a RH of from 50 to 80% and 12 h of illumination. Pieces of potato or sweet potato, lettuce and germinating beans were supplied as food. Sick and dead millipedes (as well as excrement from various potential predators) were collected at several times of the year on several sites on the island Santo Antão. This material was tested for residues, deposited in humidity chambers or animals were reared.

RESULTS

The temperature on the islands Santo Antão fluctuated between 20 and 30°C. Temperatures up to 30°C are favourable for the viability of females and males, and most egg-laying took place at these levels (Table 1). The lifecycle of *S. caboverdus* is adapted to environmental parameters, such as the rainfall period. Egg laying coincides with the rainfall period, because eggs and the first three juvenile stadia require high soil moisture. Moreover, the millepedes have no effective antagonists. It was observed that habitats of millepedes and toads coincided close to irrigation channels; however, substantial utilization of millepedes by toads as a food source occurred only in summer, when toad populations peaked. Entomopathogenic fungi found on Santo Antão also do not show clear potential as antagonists (Table 2). However, only a few of the isolated fungi have been shown to be entomopathogenic to date.

Table 1. Effects of temperature on various stages of *S. caboverdus* after 30 days at 75% humidity.

Temperature	Mortality (%)		Eggs	Hatched eggs
	Females	Males	(number)	(number)
20°C	10	0	33	31
25°C	10	0	35	29
30°C	40	70	60	39
35°C	100	100	6	0

Table 2. Isolated fungi from adults and eggs of *S. caboverdus*.

Stadium	Origin	Genus/species of fungi
Adult	Santo Antão	*Acremonium strictum*
		Aspergillus sp.
		Cylindrocladium sp.
		Fusarium semitectum
		Geotrichum sp.
		Gliocladium sp.
		Paecilomyzes sp.
Egg	Laboratory	*Doratomyces microsporus*
		Penicilium sp.
		Trichurus spiralis

CONCLUSIONS

It seems that no natural factors can stop population development. The millipedes can always find nourishment in fields planted with permanent crops (such as banana and sugarcane) as well as in vegetable crops. Abiotic factors, such as temperature, vary with small amplitudes (20-30°C) and so do not have a negative influence on the reproduction and development of the millepedes. There are no effective antagonists. The population of toads remains limited in terms of time and space. Also, potential entomopathogenic fungi found on Santo Antão do not show a clear function as antagonists.

REFERENCES

Brito M J (1994). The millipede of Santo Antão, *Spinotarsus caboverdus*: survey for pathogenic microorganisms, biossay tests of fungal pathogens against *S. caboverdus* and *Melanoplus sanguinipes*. Unpublished thesis, Montana State University, Bozeman – Montana, USA.

Neves A M; van Harten A; McKillup S C (1993). The Millipede *Spinotarsus caboverdus* Pierrard (Diplopoda, Odontopygidae), an Important Pest of Agricultural Crops on the Island of S. Antão. *Courier Forschungs-Institut Senckenberg* **159**, 327-334.

Phytophagous mites with potential to become invasive species in Brazil

D Navia, R S Mendonça
Embrapa Recursos Genéticos e Biotecnologia, CEP 70.770-900, Brasilia, DF, Brazil
Email: navia@cenargen.embrapa.br

INTRODUCTION

Phytophagous mites are very prone to become invasive aliens, and many species are directly harmful as crop pests in agricultural systems. Gall mites or rust mites (superfamily Eriophyoidea) and spider mites (superfamily Tetranychoidea) are also efficient vectors of viruses and other causal agents of plant diseases. Populations of phytophagous mites quickly develop resistance to pesticides, enhancing their potential as pests; about 71 species of the 540 arthropods known to be resistant to pesticides are mites (Michigan State University, 2002). Mites are often difficult to detect, owing to their small size and because they are often hidden on the host plant and, usually, symptoms of mite infestation appear only when populations become large. Mites have a considerable capacity to survive adverse conditions (such as low winter temperatures); they can also reproduce parthenogenetically (and so can start a new population from an individual female). Finally, phytophagous mites can be readily introduced into a region on a specific host plant or plant product; they may then spread in the environment and, if they do not find the preferred host plant, less specialized species may well adapt to another host.

There have been many inadvertent introductions of phytophagous mites to new areas, where they found conditions suitable for their development in the absence of efficient natural enemies, resulting in accentuated damage to infested crops and consequent serious socio-economic problems: cassava green mite (*Mononychellus tanajoa*), coconut mite (*Aceria guerreronis*) and the spider mite *Tetranychus evansi* are examples. At present, very few phytophagous mites have been officially recognized as quarantine pest in Brazil. However, the risk of introductions through the importation of fresh fruits, propagation material or by natural means is high, especially as international trade has intensified.

The aim of this study was to define phytophagous and to summarize information about mites with greatest potential to become invasive species in Brazil, with particular reference to those likely to be introduced through international trade.

RESULTS AND DISCUSSION

Fourteen mite species (see Hughes, 1976; Bolland *et al*., 1998; Cho *et al*., 1998; Amrine Jr. & De Lillo, 2003) have been considered as potentially invasive species in Brazil (Table 1). It is necessary to adopt quarantine measures to avoid (or at least delay) the introduction of such species, and thereby prevent the potentially disastrous consequences they might cause to cereal, legume, fruit, ornamental, vegetable crops or to stored products in Brazil. Their introduction (and the emergency need to use chemical pesticides for their control) could endanger important food source for the Brazilian population, and also have unwelcome effect on agribusinesses and the environment.

Table 1. Mites with potential to become invasive species in Brazil – geographic distribution, pathways and crops under risk. (SP = stored products; FR = fruits; PM = propagation material; S = Seeds; N = natural ways.)

Species	Distribution	Pathways	Risk Crops/Products
Acarus siro	almost cosmopolitan	SP	stored products
Aculus schlechtendali	North America, South America (Chile), Europe, Asia, Oceania	FR, PM	apple, pear
Amphitetranychus viennensis	Europe, Asia	FR, PM	apple, pear, strawberry, plum, peach, ornamentals
Brevipalpus chilensis	Chile	FR, PM	apple, citrus, kiwi, grape, passion fruit, ornamentals
Brevipalpus lewisi	North America, Europe, Asia, Africa (Egypt), Oceania	FR, PM	citrus, grape, ornamentals
Calacarus citrifolii	Africa (South Africa), Asia (India, Taiwan)	FR, PM	citrus, green pepper, papaya, , banana, passion fruit, peach
Eotetranychus carpini	North America, Asia, Europe	FR, PM	apple, peach, grape, plum, pear, ornamentals
Eutetranychus orientalis	Asia, Africa	FR, PM	fruits, vegetables, ornamentals, forest, soybean, cotton, cassava, bean, sugarcane, egg plant, corn
Halotydeus destructor	Africa (South Africa), Oceania	PM	pasture, legume
Raoiella indica	Asia, Africa, Central America	FR, PM	bean, coconut, other palm trees
Steneotarsonemus spinki	Asia, Central America	S, N	rice
Tetranychus mcdanieli	North America, Europe (France)	FR, PM	apple, peach, grape, ornamentals
Tetranychus pacificus	North America	FR, PM	soybean, bean, corn, cotton, appl peach, plum, pear, citrus, grape
Tetranychus turkestani	Central America (Costa Rica), North America, Europe, Asia, Africa, Oceania	FR, PM	strawberry, melon, peach, pear, grape, rose.

REFERENCES

Amrine Jr J W; De Lillo E (2003). *Catalog of Eriophyoidea.* Michigan: West Virginia University, 2003. (File Maker 4.0.).

Bolland H R; Parsons M; Flechtmann C H W (1998). *World catalogue of the spider mite family (Acari: Tetranychidae), with references to taxonomy, synonymy, host plants and distribution.* Brill Academic Publishers: Leiden.

Cho M R; Kim D S; Im D S (1999). A new record of tarsonemid mite, *Steneotarsonemus spinki* (Acari: Tarsonemidae) and its damage on rice in Korea. *Korean Journal of Applied Entomology* **38**, 157-164.

Hughes M A (1976). *The mites of stored food and houses.* HMSO: London.

Michigan State University (2002). *Database of Arthropods Resistant to Pesticides.* www.cips.msu.edu/resistance/rmdb/index.html//

Steneotarsonemus spinki – an invasive tarsonemid mite threatening rice crops in South America

D Navia, R S Mendonça, L A M P de Melo
Embrapa Recursos Genéticos e Biotecnologia, Cx.P 02372, 70.770-900, Brasilia, DF, Brazil
Email: navia@cenargen.embrapa.br

INTRODUCTION

The rice mite (*Steneotarsonemus spinki*) (Tarsonemidae) has been a serious pest of rice crops (*Oryza sativa*) in Asia since the 1930s (Jagadiswari & Prakash, 2003; Lo & Ho, 1979; Xu *et al.*, 2001). It was first reported in the Caribbean region in the late 1990s (in Cuba, the Dominican Republic and Haiti) (Ramos & Rodriguez, 2000) and in continental Central America towards the end of 2004 (in Costa Rica, Nicaragua and Panama) (C. Sanabria, personal communication). To date, this pest has not been reported in South America, where it has quarantine status.

METHODS

A pest risk analysis, following FAO (2001) standards, was done to evaluate the risks of the introduction and spread of rice mite in South America, and to identify areas potentially at risk and risk management options to guide a contingency programme. Stage 1 of the work was to identify pathways of quarantine concern. In Stage 2, the probabilities of entry, establishment and spread of rice mite in South America (and the potential economic consequences) were evaluated; establishment potential was assessed using the CLIMEX model (Sutherst, 1999), and climatic parameters appropriate to the main rice-production regions in South America. In Stage 3, management options to reduce risks identified in Stage 2 were considered.

RESULTS AND DISCUSSION

The risks of entry, establishment, spread of rice mite, and the potential for subsequent economic losses, in South America were regarded as high. Two potential pathways of entry have been identified: (a) via rice seeds (Rao *et al.*, 2000) (whether for commercial or scientific purposes), and (b) via natural means (including transfer by wind, water, insects and birds) (Almaguel *et al.* 2003), although the former is as yet unconfirmed. The entry of rice mite to South America seems unavoidable, considering the means of natural dissemination and its current geographical distribution. Also, the mite has spread rapidly during 2004 from Costa Rica to Panama (which could be considered an 'entry door' to South America). Detection of rice mite is difficult, owing to its small size (females 274 μm long) (Smiley, 1967), inconspicuous colour and protected position on host plants.

The results of CLIMEX analysis suggest that the probability of establishment and spread of the pest in South America is also high, owing to climatic conditions being favourable for its development in the areas at risk; the ecoclimatic index ranges from 25 (= low to medium) to 75 (= high) in the main rice-production areas of Brazil. Areas of highest risk are in the north, south-east and centre of Brazil. The establishment risk is also compounded by the availability of suitable host plants and the pest's ability to adopt alternative hosts. Rice, which is grown throughout South America, is the main host, and readily available; the mite also breeds on an American wild rice (*Oryza latifolia*) in Costa Rica and Panama (C. Sanabria, personal communication), which suggests it could also infest wild *Oryza* spp. in South America. Further, rice mite has a high reproductive potential, reproducing sexually or through arrhenotokous parthenogenesis (such that an individual female can copulate with its male descendents and originate new colonies) (Xu *et al.*, 2001); also, the lifecycle is short (8–17 days @ 25°C) (Ramos & Rodriguez, 2000) and the oviposition rate high (≅ 50 eggs/female) (Lo & Ho, 1979; Xu *et al.*, 2001). Finally, there are no known natural enemies in the risk areas of Brazil. Worldwide, just two predators have been confirmed: namely, the mites *Amblyseius taiwanicus* and *Lasioseius parberlesei* (Lo & Ho, 1979), neither of which occurs in South America.

The economic consequences of following the introduction of rice mite to in Brazil could be disastrous. In China, rice crop losses of from 30 to 90% have been reported (Xu *et al.*, 2001). In Cuba, in the first year of infestation, crop losses were estimated to reach 70% (Ramos & Rodriguez, 2000). Brazil, the premier rice-producing country in South America, has an average harvest of c. 12.7 million tonnes/year. Therefore, future crop losses of from 30% to 70% (equivalent to 3.8–8.9 million tonnes/year) could endanger one of the main food sources of the whole population, and seriously impair the country's rice industry. Further, emergency control of the mite (using chemical pesticides) would add to production costs and also have an undesirable environmental impact.

REFERENCES

Almaguel L; Santos A; Torre P; Botta E; Hernández J; Cáceres I; Ginarte A (2003). Dinâmica de población e indicadores ecológicos del ácaro *Steneotarsonemus spinki* Smiley 1968 (Acari: Tarsonemidae) em arroz de riego em Cuba. *Fitosanidad, La Habana* **7**, 23-30.

FAO (2001). *Pest risk Analysis for Quarantine Pests*. Publication No. 11, 26 pp.

Jagadiswari R; Prakash A (2003). Panicle mite causing sterility farmer's paddy fields in India. *Journal Applied Zoology Research* **14**, 212-217.

Lo K C; Ho C C (1979). Ecological observations on rice mite, *Steneotarsonemus spinki* (Acarina: Tarsonemidae). *Journal of Agricultural Research of China* **28**, 181-192.

Ramos M; Rodríguez H (2000). Ciclo de desarollo de *Steneotarsonemus spinki* Smiley (Acari: Tarsonemidae) en laboratório. *Revista de Protección Vegetal* **15**, 751-752.

Rao P R M; Bhavani T R M; Rao T R M; Reddy P R (2000). Spikelet sterility/grain discoloration en Andhra Pradesh, India. *International Rice Research Notes* **25**, 40 pp.

Smiley R L (1967). Further studies on the Tarsonemidae (Acarina). *Proceedings of the Entomological Society of Washington* **69**, 127-146.

Sutherst R W (1999). Predicting the survival of immigrant insect pests in new environments. *Crop Protection* **10**, 331-333.

Xu G L; Wu H J; Huan Z L; Mo G; Wan M (2001). Study on reproductive characteristics of rice mite, *Steneotarsonemus spinki* Smiley (Acari: Tarsonemidae). *Systematic and Applied Acarology* **6**, 45-49.

Current status of the whitefly *Bemisia tabaci* as an introduced pest in Brazil

M R V Oliveira, P R Queiroz, K R Vilarinho, L H C Lima
Embrapa Recursos Genéticos e Biotecnologia, P. O. Box 02372, CEP 70.849-970, Brasília, DF, Brazil
E-mail: vilarin@cenargen.embrapa.br

INTRODUCTION

Since it was first described, the tobacco whitefly (*Bemisia tabaci*) has become one of the most important agricultural pests in subtropical and tropical areas worldwide. In the last twenty years, probably owing to international trade and accidental human-assisted introduction, this notorious pest has continued to expand its range and, consequently, its status as an agricultural pest has become greatly aggravated (Oliveira *et al.*, 2001).

Tobacco whitefly is highly polyphagous, having been recorded on many herbaceous and annual plants, including crops and weeds. The ease with which this insect changes from host to host and acclimatizes to different regions of the world may have contributed to the wide range of intraspecific variations in its pseudo-pupal characters, leading to 22 synonymies (Mound & Halsey, 1978) and six population groups (De Barro *et al.*, 2004).

In the 1980s, increases in field populations of tobacco whitefly in Hawaii, Puerto Rico and the USA resulted in plant disorders of unknown etiology. In Brazil, mock tomato (*Solanum gilo*) and okra (*Abelmoschus esculentus*) crops heavily infested by the B biotype (which showed evidence of blanching and woody fruits, respectively) became inedible and were rejected by consumers. These symptoms have not been reported previously.

CURRENT STATUS IN BRAZIL

Tobacco whitelfy (as the cotton strain or A biotype) was introduced into Brazil in 1928 (Bondar, 1928), where it was considered an occasional pest and a vector of phytoviruses in beans, soybeans and tomato. However, with the introduction of the B biotype in the early 1990s (probably through the international trade of ornamentals), problems with this insect became huge.

The molecular method RAPD-PCR has shown specific DNA profiles for both native and introduced biotypes, and has further shown that spread of the pest was rapid. Tobacco whitefly is now established in 23 out of 26 states, as well as in the Federal District. Further, it has been found infesting a number of previously unreported crops and weeds (Oliveira *et al.*, 2000; Lima *et al.*, 2000; Lima *et al.*, 2002).

Crop production in Brazil has probably been seriously affected by tobacco whitefly. This includes production of beans, cabbage, cotton, melon, okra, tomato and water melon, and several other crops. To date, accumulated losses have exceeded 7 billion US$. Insecticides have been used weekly to control populations in some areas and on some crops, New weed hosts have also been colonized, and this has helped to increase whitefly populations. Such weeds include: *Borreria verticilliata* (Rubiaceae), *Cleome espinosa* (Cleomaceae), *Herisanthia hemoralis* (Malvaceae), *Senna obtusifolia* (Leguminosae) and *Stachytarpheta sanguinea* (Verbenaceae) (Oliveira *et al.*, 2000); *Diodia teres* (Rubiaceae), *Herissantia crispa* & *Pavonia cancellata* (Malvaceae), *Ipomoea grandiflora* (Convolvulaceae), *Phyllanthus tenellus* (Euphorbiaceae) and *Solanum ambrosiacum* (Solanaceae) (Vasconcelos *et al.*, 1999).

The global distribution of whitefly-transmitted (WFT) geminiviruses is closely related to the pantropical dissemination of their polyphagous whitefly vector complex (Morales & Anderson, 2001). In Brazil, the crops most affected are tomatoes and beans. Although no real economic estimates of losses have been made, the tomato industry (especially in the north-east of the country), has suffered considerably as a result of infestations by the B biotype; in the last 4 years, more than 11,000 jobs have been lost because (amongst other factors) of the WFT geminivirus (Oliveira & Faria, 2000). The area cultivated with common beans is over 9 million ha, with Brazil producing over 50% of the total crop harvested. In these regions, bean golden mosaic virus (BGMV) is now considered the most limiting pathogen of this crop, where over 1 million hectares traditionally planted to beans have been abandoned owing to the presence of WFT geminivirus (Morales & Anderson, 2001).

REFERENCES

Bondar, G (1928). Aleyrodideos do Brasil. *Boletim Laboratório Pathologia e Veterinária do Estado da Bahia* **5**, 1-37.

Lima, L H C; Návia, D; Oliveira, M R V (2000). Survey of *Bemisia tabaci* (Genn.) (Hemiptera: Aleyrodidae) biotypes in Brazil using RAPD markers. *Genetics and Molecular Biology* **23**, 1-5.

Lima, L H C; Campos, L; Moretzsohn, M C; Návia, D; Oliveira, M R V (2002). Genetic Diversity of *Bemisia tabaci* (Genn.) poopulations in Brazil revealed by RAPD markers. *Genetics and Molecular Biology* **25**, 217-223.

Morales, F J; Anderson, P K (2001). The emergence and dissemination of whitefly-transmited geminiviruses in Latin America. *Archives of Virology* **146,** 415-441.

Mound, L A; Halsey, S H (1978). *Whitefly of the world. A systematic catalogue of the Aleyrodidae (Homoptera) with host plant and natural enemy data.* New York: Wiley.

Oliveira, M A S; Icuma, I M; Alves, R T; Oliveira, J N S; Oliveira, M R V; Lima, L H C; Lira, G S (2000). Avaliação de surtos de mosca-branca em áreas do sistema produtivo de melão, soja e feijão. *Brasilia: Embrapa Cerrados, Comunicado técnico* **17**, 10 pp.

Oliviera, M R V; Henneberry, T J; Anderson, P (2001). History current status, and collaborative research projects for *Bemisia tabaci*. *Crop Protection* **20**, 709 –723.

Oliveira, M R V; Faria, M R (2000). Mosca-branca do complexo *Bemisia tabaci* (Gennadius) (Hemiptera, Aleyrodidae): bioecologia e medidas de controle. *Brasília: Embrapa Recursos Genéticos e Biotecnologia, Documentos* **48**, 111 pp.

Vasconcelos, S D; Bezerra, M A S; Oliviera, D L (1999). Ocorrência de predadores associados à mosca-branca *Bemisia tabaci* raça B em plantas invasoras do semi-árido brasileiro. In: VIII Encontro Latino-Americano e do Caribe sobre moscas brancas e geminivírus, 1999. *Recife. Anais. Recife: IPA, 1999,* 179 pp.

The introduction and dispersal of whiteflies in the cassava production areas of Brazil

M R V Oliveira, K R Vilarinho, P R Queiroz, L H C Lima
Embrapa Recursos Genéticos e Biotecnologia, PO Box 02372, CEP 70.849-970, Brasília, DF, Brazil
E-mail: vilarin@cenargen.embrapa.br

INTRODUCTION

Cassava (*Manihot esculenta*) has its original centre of production in Brazil, but is now cultivated in all tropical regions of the world. Cassava is the main food for thousands of people, being in fourth place just behind rice, sugar and corn (Carvalho *et al.*, 2000). Five countries (Brazil, the Democratic Republic of Congo, Indonesia, Nigeria and Thailand) are responsible for almost 70% of the world's cassava production. The Food and Agriculture Organisation (FAO) has estimated that future world production will reach 210 millions tonnes by 2005, associated with increasing yields of from 10 to 40 t/ha. In Brazil, up to the last decade, cassava was produced as a subsistence crop by small and poor farmers, mainly in northern and north-eastern regions. However, in response to an increase in food consumption, and demands from the textile and food industries, the cultivation patterns have changed, with the southern, south-eastern and western regions now responsible for more than 60% of the cassava production. Before the 1990s, insect pests (mainly whiteflies) caused little damage to cassava plants. However, the establishment of monoculture in some areas of the country, the movement of cassava plants between countries, domestic cultivation and the transit of pests associated with plant material have all contributed to the invasiveness and dispersal of economically important whiteflies.

MATERIALS AND METHODS

A survey of whiteflies occurring in Brazilian cassava crops was conducted in 13 states: Alagoas, Bahia, Distrito Federal, Goiás, Ceará, Mato Grosso do Sul, Paraiba, Pernambuco, Piauí, Rio de Janeiro, Rio Grande do Norte, São Paulo and Tocantins.

All specimens collected were identified through morphological and molecular methods. In the latter case, five random primers were used in RAPD-PCR amplifications to analyze the genetic variability.

RESULTS AND DISCUSSION

The whitefly species most commonly found in cassava crops were: *Aleurothrixus aepim*, *Bemisia tabaci* biotype B, *B. tuberculata* and *Trialeurodes variabilis* (Oliveira *et al.*, 2001).

A. aepim was found in the states of Alagoas, Bahia, Ceará, Minas Gerais, Paraíba, Piauí and Tocantins. In Bahia, this species (which is considered a secondary pest of cassava, but with occasional outbreaks) was the predominant species at the time of sampling. *T. variabilis*, which was found in the Distrito Federal, Goiás, Rio de Janeiro and São Paulo, is of the same minor status.

Regarding the results obtained, the main concern was for *B. tabaci* biotype B and for *B. tuberculata*. *B. tabaci* biotype B, which was introduced to Brazil in the early 1990s, through the state of São Paulo, has now spread to 23 out of 26 states and also to the Federal District. It was found feeding on cassava plants (with up to 3 nymphs/cm^2) in the Federal District, Goiás and Rio Grande do Norte. However, to date, no damage to cassava plants has been reported. Intensive surveys of this biotype were conducted in other areas of Brazil, but fortunately this was not found feeding on cassava. The threat of new introductions of others biotypes of *B. tabaci* must be considered on cassava plants (especially from a quarantine point of view) because, in Africa, the *B. tabaci* species complex (as a vector of African cassava mosaic virus) is responsible for considerable losses (Fauquet *et al.*, 2000).

B. tuberculata is a usually a secondary pest in Brazil. However, after its appearance in the southern, south-eastern and western regions, its pest status has changed (probably associated with the huge extension of areas cultivated with cassava), and it is now becoming of great concern to farmers. In the state of Mato Grosso do Sul, in a cultivated cassava area of 12,500 ha, leaf samples collected in the years 2000 and 2004 revealed a population densities of 13.6 eggs/cm^2 & 30.8 nymphs/cm^2, and 44.7 eggs/cm^2 & 69.0 nymphs/cm^2, respectively. The spread of cassava to the southern and western states of the country, and the increase of cassava production for industrial purpose, has clearly favoured the introduction and establishment of this insect in these areas, where it is now causing significant damage and losses. Clouds of adults were observed everywhere in both years. Other crops, including okra, tomato and sweet potato, are also host of the pest in these areas.

The RAPD analyses revealed a difference in the molecular profiles among the populations of *B. tuberculata* collected in the 2000 from those collected in 2004, with just 66% similarity, suggesting a possible change in the genetic composition of this Brazilian species. The *B. tuberculata* molecular markers generated by RAPD can be used in monitoring programmes, and further investigations will be very important to support scientific research and integrated pest management of this important quarantine insect.

REFERENCES

Fauquet, C M; Maxwell, D P; Groneaborn, B; Stanley, J (2000). Revised proposal for naming geminiviruses. *Archives of Virology* **8**, 1743-1761.

Carvalho, L J C B; Cabral, G; Campos, L (2000). Raiz de reserva de mandioca: um sistema biológico de múltipla utilidade. *Brasília: Embrapa Recursos Genéticos e Biotecnologia*, *Documentos* **44**, 16 pp.

Oliveira, M R V; Moretzsohn, M C; Queiroz, P R; Lago, W N M; Lima, L H C (2001). Levantamento de moscas-brancas na cultura de mandioca no Brasil. Brasília: Embrapa Recursos Genéticos e Biotecnologia. *Boletim de Pesquisa e Desenvolvimento* **3**, 20 pp.