Prepared by CABI and EPPO for the EU under Contract 90/399003

Data Sheets on Quarantine Pests

Tomato ringspot nepovirus

IDENTITY

Name: Tomato ringspot nepovirus
Synonyms: Tobacco ringspot No. 2
Nicotiana virus 13
Peach yellow bud mosaic virus (strain)
Blackberry (Himalaya) mosaic virus
Winter peach mosaic virus
Grape yellow vein virus (strain)
Taxonomic position: Viruses: Comoviridae: *Nepovirus*
Common names: TomRSV (acronym)
Ringspot and mosaic (in various hosts), Eola rasp leaf (in cherries), yellow bud mosaic (in peaches), yellow vein (in grapes), stunt or stub head (in *Gladiolus*), decline, crumbly berry and yellow blotch curl (in raspberries), chlorosis (in *Pelargonium*) (English)
Tomatenringfleckenkrankheit (German)
Notes on taxonomy and nomenclature: The name "tomato ringspot" has been applied to two apparently unrelated viruses. Price's isolate is the type virus, while that described by Samson & Imle (1942) is probably related to tomato top necrosis virus (Stace-Smith, 1984).
EPPO computer code: TMRSXX
EPPO A2 list: No. 102
EU Annex designation: I/A1

HOSTS

In nature, TomRSV occurs mostly in woody and ornamental plants, rather than in herbaceous hosts, including raspberries, *Rubus laciniatus*, grapes, peaches, cherries and other *Prunus* spp., black currants, gooseberries, strawberries, *Pelargonium*, *Hydrangea*, *Gladiolus* and *Fraxinus americana*.

The experimental host range is very wide, with species in more than 35 dicotyledonous and monocotyledonous families being susceptible. Many weeds such as *Taraxacum officinale* can constitute reservoirs for the disease. *Stellaria media* has been shown to carry symptomless infection.

GEOGRAPHICAL DISTRIBUTION

EPPO region: TomRSV has a very restricted distribution in the EPPO region and some so-called records refer to interceptions of the virus on *Pelargonium* imported from North America. Where there is confirmation that the virus occurs, it is often not clear which host is concerned, although it is agreed that TomRSV does not occur in fruit trees in the EPPO region. The situation can be summarized as follows: locally established in Bulgaria, Germany (rare), Italy (rare), Slovakia, Slovenia, Turkey, Yugoslavia. Czech Republic

(found but not established), Denmark (occurred locally in *Pelargonium* in early 1980s; confirmed as eradicated in 1988), Egypt, Greece (unconfirmed report), Norway (found in the past in *Pelargonium* but eradicated), Russia (Far East), Sweden, UK (found in the past in *Pelargonium* but eradicated).

The vector, *Xiphinema americanum*, has been reported from Poland and Russia, but according to recent taxonomic evidence these records most probably refer to another species, *X. pachtaicum*, which is widely distributed throughout the EPPO region and is not known to be a virus vector (EPPO/CABI, 1996).

North America: Canada (British Columbia, Ontario), USA (California, Maryland, Michigan, New York, Oregon, Pennsylvania, South Carolina, Washington). Widespread in temperate regions where the vector occurs.

Central America and Caribbean: Puerto Rico (on orchids).

South America: Chile (on raspberries), Peru.

Asia: China (Zheijiang), Japan, Korea Republic, Russia (Far East), Taiwan (on grapes; unconfirmed), Turkey.

Oceania: Australia (South Australia), New Zealand (on red currants).

EU: Present.

BIOLOGY

TomRSV is occasionally transmitted to raspberry seed via the maternal tissue; there is no evidence that healthy mother plants become infected via infected pollen (Braun & Keplinger, 1973). However, pollen transmission to seed has been demonstrated in *Pelargonium* (Scarborough & Smith, 1977). The virus has also been transmitted occasionally through seed of tomatoes, tobacco and grapes, and frequently through seed of *Gomphrena globosa*, strawberries, *Pelargonium* and soyabean cv. Lincoln. Transmission experiments with *Cuscuta* spp. have proved negative. The virus is readily transmissible by grafting and by sap inoculation to herbaceous hosts; sap transmission from the latter to *Rubus* has not been achieved. In raspberry fields, spread is predominantly from an infected plant to adjoining healthy ones, with an average annual rate of spread of about 2 m. Spread by root grafts may occur, but nematode vectors are the most important transmission agents. Infected seeds may be important as a continuing source of virus in the soil.

The nematode vector is *Xiphinema americanum sensu lato*, the American dagger nematode. This is, however, a species complex and may contain more than 20 distinct species; there is, at present, some dispute as to the validity of some of the species described (Lamberti & Bleve-Zacheo, 1979; see also the data sheet on *Xiphinema americanum sensu lato* (EPPO/CABI, 1996). It is therefore not possible to provide a definitive list of vector species. The following have been suggested as being possible vectors (Brown, 1989): *X. americanum*, *X. californicum*, *X. incognitum*, *X. occidium*, *X. rivesi*, *X. thornei*, *X. utahense*.

Adults, as well as three larval stages, can transmit the virus, acquiring it within 1 h and inoculating it into healthy plants within 1 h.

X. americanum requires at least 1 year to complete its life cycle and can mature and survive (but not multiply) in soil in the absence of a host plant. It does not survive long periods in frozen soil, and numbers decline at high and low moisture levels. The optimum temperature for reproduction is 20-24°C.

For additional information, see Teliz *et al.* (1966), Keplinger *et al.* (1968), Converse & Stace-Smith (1971).

DETECTION AND IDENTIFICATION

Symptoms

In general, the symptoms described here cannot be taken as proof of the presence of TomRSV; further tests, such as sap transmission to herbaceous indicator hosts and serological tests, are essential for positive identification.

On raspberries

Symptom development is variable, but canes are stunted, and both fruit size and yield are reduced. Chlorotic ringspot markings may be evident on leaves of young plants. In subsequent years, very few foliar markings are apparent but leaves on new canes show epinasty and early abscission. By the third year of infection, 10-80% of fruiting canes may be killed (Smith, 1972). There is usually a border of symptomless plants around a group of visibly infected plants.

On grapes

Symptoms are difficult to diagnose early in the season unless vines are severely affected, in which case they have many winter-killed buds and weak, stunted shoot growth. By about 9 weeks after the start of vine growth, shoot and foliage symptoms are conspicuous on one or more shoots. Leaves develop ringspots and mottling, are reduced in size, and rosetted due to the shortening of internodes (Yang *et al.*, 1986). Fruit clusters are reduced in size with many berries aborting. Removal of bark from trunks and stems of diseased vines may reveal thickened, spongy phloem tissue with numerous necrotic pits (Uyemoto, 1975).

On field-grown tomatoes

There is a conspicuous curling and necrosis of the terminals of one or more actively growing shoots. The basal portions of younger leaves develop brown, clearly defined, necrotic rings and sinuous lines. The petioles of the necrotic leaves and adjacent stem tissue are often marked with necrotic streaks and rings. If fruits are infected early, they develop faint to conspicuous, grey to brown, corky, superficial and frequently concentric rings or portions of rings (Smith, 1972).

On peaches

With the peach yellow bud mosaic strain, pale-green to pale-yellow, oblong, feather-edged blotches develop along the main vein or large lateral veins of the leaves. Buds either produce rosettes of small and often distorted leaves, with or without mottling, or are pale-yellow and later die. No flower symptoms are known, but fruit may be dwarfed and malformed. Some strains of TomRSV cause stem-pitting symptoms in peach and other *Prunus* spp. (Teliz *et al*., 1966).

On *Pelargonium*

Young leaves may develop ringspot symptoms or faint systemic, chlorotic flecks and a mottle with slight leaf distortion. Older leaves may show chlorotic bands in an oak-leaf pattern, or symptoms may fade, so that plants show only a slight dwarfing compared with healthy ones (although plants are still infective). Flowers show no definite colour break, but may be uneven and distorted (Rydén, 1972).

For additional information, see Samson & Imle (1942), Converse & Stace-Smith (1971), Rydén (1972), Uyemoto (1975).

Morphology

TomRSV has relatively unstable, isometric particles with angular outlines, about 28 nm in diameter, sedimenting as three components and containing single-stranded RNA.

Detection and inspection methods

Mechanical transmission to herbaceous plants can be used as a detection method. *Chenopodium amaranticolor* and *C. quinoa* develop small chlorotic local lesions and a systemic apical necrosis. Cucumbers show local chlorotic spots, systemic chlorosis and mottle. Other herbaceous hosts such as tobacco, *Petunia hybrida*, *Phaseolus vulgaris* and cowpeas can also be used. For the detection of TomRSV on almonds, cherries, peaches and plums, woody indicators (e.g. *Prunus persica* cv. Elberta or GF 305, *Prunus tomentosa* IR 473/1 or IR 474/1) can be used. Serological methods, such as direct and indirect ELISA, and ISEM can be used to detect the virus. All these methods have been described in EPPO Quarantine Procedures Nos 28, 31 and 32 (OEPP/EPPO, 1990b, 1991a, 1991b).

MEANS OF MOVEMENT AND DISPERSAL

Long-range dispersal in trade is in host plants and parts of plants, including seeds; accompanying soil may harbour infective seeds and the nematode vector.

PEST SIGNIFICANCE

Economic impact

The rapid spread of TomRSV in grapes in New York has led to a serious decline, particularly of the cultivar Cascade (Siebel 13053) (Uyemoto, 1975). In Oregon, fruit from TomRSV-infected raspberry canes weighed 21% less individually than from healthy canes, and the yield was more than halved, since TomRSV has a particularly adverse effect on drupelet set of certain cultivars (Daubeny *et al*., 1975; Freeman *et al*., 1975). In addition, fruit quality is reduced, the fruits being crumbly and therefore unmarketable (Mircetich, 1973). The progressive decline in raspberries is such that, by the third year of infection, up to 80% of fruiting canes may be killed.

The virus is of some economic importance in those EPPO countries where it occurs. An isolate of TomRSV from *Pelargonium* in the UK (probably imported from the USA) caused severe symptoms on several glasshouse crops; thus, the virus presents a serious threat to the glasshouse industry, especially where salad and ornamental crops are grown together.

It is possible that European *Xiphinema* species, such as *X. pachtaicum*, which is widespread in the EPPO region, could transmit the virus. This species has a wide host range, including many hosts of TomRSV. However, there are no reports of transmission experiments with *X. pachtaicum* and TomRSV. In North America, *X. rivesi* has been implicated as a vector of TomRSV; although present in Europe, it has a very limited host range and would not probably play a significant role in virus distribution.

Control

Control of TomRSV in established plantings of fruit tree or berry crops is difficult. The use of resistant cultivars (e.g. for grapes) and the use of healthy planting material can reduce the disease. In addition, it is necessary to achieve good control of weeds.

Phytosanitary risk

TomRSV is an A2 quarantine pest for EPPO (OEPP/EPPO, 1982) and has quarantine significance for IAPSC. The main quarantine danger concerns fruit crops, since it has not been found on fruit stocks in the EPPO region. So for fruits, it practically has A1 status.

PHYTOSANITARY MEASURES

For *Pelargonium* plants imported from countries where the virus is present, EPPO recommends (OEPP/EPPO, 1990a) that these plants should be derived by no more than four generations from mother plants which have been tested by EPPO quarantine procedure No. 28 (OEPP/EPPO, 1990b) and found free from the virus, and that they were grown in the absence of the nematode vector *Xiphinema americanum sensu lato* and were visually inspected during the last growing season and found to be free from symptoms of infection by TomRSV.

For plants for planting (except seeds) of *Malus* and *Prunus*, EPPO recommends that they should come from a field inspected for TomRSV and be found free from the virus. If they come from a country where TomRSV occurs, they should be derived (not further than the second generation) from mother plants tested for TomRSV according to EPPO quarantine procedure No. 32 (OEPP/EPPO, 1991b), and maintained under conditions designed to prevent reinfection. Grapes are not mentioned in the EPPO recommendations, but similar requirements seem appropriate in this case.

For plants for planting (except seeds) of *Rubus*, EPPO recommends that they should come from a field inspected for TomRSV and found free from it. If they come from a country where the virus occurs in *Rubus*, they must be derived from mother plants tested for the virus according to EPPO quarantine procedure No. 31 (OEPP/EPPO, 1991a) and maintained under conditions designed to prevent reinfection. As TomRSV can be transmitted by seeds of *Rubus*, seedlings and seeds should also be derived from such plants.

BIBLIOGRAPHY

Braun, A.J.; Keplinger J.A. (1973) Seed transmission of tomato ringspot virus in raspberry. *Plant Disease Reporter* **57**, 431-432.

Brown, D.J.F. (1989) Virus transmitted by nematodes. *Bulletin OEPP/EPPO Bulletin* **19**, 453-461.

Converse, R.H.; Stace-Smith, R. (1971) Rate of spread and effect of tomato ringspot virus on red raspberry in the field. *Phytopathology* **61**, 1104-1106.

Daubeny, H.A.; Freeman, J.A.; Stace-Smith, R. (1975) Effects of tomato ringspot virus on drupelet set of red raspberry cultivars. *Canadian Journal of Plant Sciences* **55**, 755-759.

EPPO/CABI (1996) *Xiphinema americanum sensu lato*. In: *Quarantine pests for Europe*. 2nd edition (Ed. by Smith, I.M.; McNamara, D.G.; Scott, P.R.; Holderness, M.). CAB INTERNATIONAL, Wallingford, UK.

Freeman, J.A.; Stace-Smith, R.; Daubeny, H.A. (1975) Effects of tomato ringspot virus on the growth and yield of red raspberry. *Canadian Journal of Plant Sciences* **55**, 749-754.

Keplinger, J.A.; Braun, A.J.; Providenti, R. (1968) Crumbly berry of red raspberry caused by tomato ringspot virus. *Plant Disease Reporter* **52**, 386-390.

Lamberti, F.; Bleve-Zacheo, T. (1979) Studies on *Xiphinema americanum sensu lato* with descriptions of fifteen new species. *Nematologia Mediterranea* **7**, 51-106.

Mircetich, S.M. (1973) Recent developments in the etiology and control of peach stem pitting. *Virginia Fruit* **61**, 59-64.

OEPP/EPPO (1982) Data sheets on quarantine organisms No. 102, Tomato ringspot virus. *Bulletin OEPP/EPPO Bulletin* **12** (1).

OEPP/EPPO (1990a) Specific quarantine requirements. *EPPO Technical Documents* No. 1008.

OEPP/EPPO (1990b) EPPO quarantine procedures No. 28, Tomato ringspot nepovirus in pelargonium - inspection an test methods. *Bulletin OEPP/EPPO Bulletin* **20**, 273-276.

OEPP/EPPO (1991a) EPPO quarantine procedures No. 31, *Rubus* viruses - inspection and test methods. *Bulletin OEPP/EPPO Bulletin* **21**, 241-244.

OEPP/EPPO (1991b) EPPO quarantine procedures No. 32, Tomato ringspot nepovirus in fruit tree and grapevine inspection and test methods. *Bulletin OEPP/EPPO Bulletin* **21**, 245-250.

Rydén, K. (1972) *Pelargonium* ringspot - a virus disease caused by tomato ringspot virus in Sweden. *Phytopathologische Zeitschrift* **73**, 178-182.

Samson, R.W.; Imle, E.P. (1942) A ringspot type of virus disease in tomato. *Phytopathology* **32**, 1037-1047.

Scarborough, B.A.; Smith, S.H. (1977) Effects of tobacco and tomato ringspot viruses on the reproductive tissues of *Pelargonium* x *hortorum*. *Phytopathology* **67**, 292-297.

Smith, K.M. (1972) *A textbook of plant virus diseases* (edition 3), pp. 541-544. Longman, London, UK.

Stace-Smith, R. (1984) Tomato ringspot nepovirus. *CMI/AAB Descriptions of Plant Viruses* No. 290. Association of Applied Biologists, Wellesbourne, UK.

Teliz, D.; Grogan R.G.; Lownsberry G.F. (1966) Transmission of tomato ringspot, peach yellow-bud mosaic, and grape yellow-bud mosaic, and grape yellow-vein viruses by *Xiphinema americanum*. *Phytopathology* **56**, 658-663.

Uyemoto, J.K. (1975) A severe outbreak of virus-induced grapevine decline in cascade grapes in New York. *Plant Disease Reporter* **59**, 98-101.

Yang, I.L.; Deng, T.C.; Chen, M.J. (1986) Sap transmissible viruses associated with grapevine yellow mottle disease in Taiwan. *Journal of Agricultural Research of China* **35**, 504-510.