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Data Sheets on Quarantine Pests

Beet necrotic yellow vein furovirus

IDENTITY

Name: Beet necrotic yellow vein furovirus
Taxonomic position: Viruses: *Furovirus*
Common names: BNYVV (acronym)
Rhizomania (English)
Rhizomanie (French)
Rizomanía (Spanish)
Notes on taxonomy and nomenclature: Beet soil-borne furovirus (BSBV) has been shown to have the same host range and vector as BNYVV, and to cause similar symptoms (Henry *et al.*, 1986; Lesemann *et al*., 1989). BSBV was classified into three serotypes, of which serotype 2 has the widest distribution being present in Germany, Sweden, the UK and the USA, and possibly more European countries. In the USA, Wisler *et al*. (1994) found isolates of 'beet soil-borne mosaic furovirus' to be distinct from BNYVV. Lindsten & Rush (1994) found that an isolate from the USA was identified as BSBV when tested in Sweden.
Experiments conducted in Germany showed that BSBV serotype 2 has been found in most sugarbeet fields where BNYVV and rhizomania occur (Prillwitz & Schlösser, 1992). Further tests showed that BSBV serotype 2 decreased the tap root weight up to 40% and that its symptoms could not be distinguished visually from those of BNYVV. It was, therefore, concluded that BSBV serotype 2 is a part of the rhizomania disease complex (Prillwitz & Schlösser, 1992). Yield losses due to BSBV were confirmed experimentally by Kaufmann *et al*. (1993).
EPPO computer code: BTNYVX
EPPO A2 list: No. 160
EU Annex designation: I/B

HOSTS

All cultivated forms of *Beta vulgaris* are susceptible (sugarbeet, fodder beets, beetroots, mangolds, spinachbeets) and also spinach (*Spinacia oleracea*). Weeds have never been found to carry the virus in the field, although all Chenopodiaceae may be infected by mechanical inoculation.

GEOGRAPHICAL DISTRIBUTION

In the EPPO region, rhizomania damage was first observed in Italy during the 1950s, in the Po plain and the Adige Valley (Canova, 1959). From 1971 to 1982 it was observed in an increasing number of central and southern European countries: Austria, France, Germany, Greece, Yugoslavia (Koch, 1982). It has also been found in most of eastern Europe: Bulgaria, Hungary, Romania, Russia. In 1983, it was discovered further north: Belgium, northern France, Netherlands, Switzerland (Richard-Molard, 1985). The disease is now considered to occur in most sugarbeet-growing countries in the EPPO region. In 1987 (Hill, 1989), a single focus was discovered in eastern England (under eradication); several more

foci have been found in the same area of the UK since. The virus is absent from Ireland, and also from the Nordic countries except Sweden, where BNYVV has been reported; however, other soil-borne viruses may be responsible for rhizomania symptoms (Lindsten, 1989).
EPPO region: Austria, Belgium, Bulgaria, Croatia, Czech Republic, France, Germany, Greece, Hungary, Italy, Netherlands, Poland (Paczuski & Szyndel, 1994), Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, UK (very limited distribution, in England only; under eradication), Russia (European), Turkey, Yugoslavia (Federal Republic).
The absence of BNYVV from Denmark has been confirmed by survey (Danielsen *et al*., 1992).
Asia: China (Neimenggu, Ningxia, Xinjiang), Japan (Hokkaido), Kazakhstan, Kyrgyzstan, Mongolia, Turkey.
North America: USA (California, Colorado, Idaho, Nebraska, New Mexico, Texas, Washington, Wyoming).
EU: Present.

BIOLOGY

Putz *et al*. (1990) have provided a general review of the disease. Twelve isolates of various origins (Europe, Japan, USA) have identical RNA1 and RNA2 (see Morphology); slight variations were shown to exist between RNA3 and RNA4 (Kuszala *et al*., 1986). The sequences found in the latter are not homologous with any found in RNA1 and RNA2. RNA3 and RNA4 are thus not subgenomic. RNA2 carries the code for the capsid protein which is common to all isolates, which thus form a single serotype. One isolate (F5) contains a fifth particle composed of deleted RNA4 (Lemaire *et al*., 1988); this isolate seems more aggressive to beet than the others. The virus is mainly found in the small roots and is less concentrated in the tap-root. The virus only occasionally enters the aerial parts - leaves and stems - and has never been observed in seeds.

PCR studies (Kruse *et al*., 1994) have recently shown the existence of two major strain groups of BNYVV, A and B. Type A was detected in Austria, Belgium, France (parts), Greece, Italy, Netherlands, Slovakia, Spain, UK (England), former Yugoslavia, and also in Asia (China, Japan, Kazakhstan, Turkey) and North America (USA). Type B occurred in Germany and parts of France. Mixed infections were detected at the borderline regions between areas of the A and B types.

BNYVV is transmitted to *Beta* spp. and preserved in the soil by *Polymyxa betae*, a plasmodiophoromycete soil fungus, which is an intracellular parasite restricted to the roots of Chenopodiaceae. It is present in most soils where beet has been grown (in all parts of Europe) and is not known to cause any significant damage in itself. The viral particles have been observed in the zoospores of the fungus. The spores (cystosori), which are the resistant stage, preserve the virus in the soil for many years.

There may be other beet viruses transmitted by *P. betae*. One, beet soil-borne furovirus (see Notes on taxonomy and nomenclature), has been described in the UK as the cause of 'Barney patch disorder' (Henry *et al*., 1986). It is also a furovirus, but is not serologically related to BNYVV. It can be differentiated from BNYVV by a PCR-based method (Rush *et al*., 1994). Kastirr *et al.* (1994) found BSBV to be more widely and uniformly present in isolates of *P. betae* from different parts of Europe than BNYVV. Danielsen *et al.* (1992) found BSBV to be widespread in Denmark, where BNYVV is absent.

DETECTION AND IDENTIFICATION

Symptoms

Beets grown in heavily infested fields show quite characteristic symptoms on developed roots: uncoordinated proliferation of partially necrosed small roots pepper-and-salt beard - which gives its name to the disease (rhizomania - root madness). The root is often constricted (funnel-shaped) and cutting the root shows browning of the vascular ring, or even of the whole tip of the root.

In a less heavily infested field, symptoms may be less extensive and may affect only one lateral root, without constriction, and possibly without the beard. Some of these symptoms can be due to other causes (nematodes, poor soil structure, etc.). The presence of tumour-like deformations, especially on the rootlets, is characteristic.

The most useful leaf symptom is visible at the end of the growing season, after rainfall; leaves become very pale-green, translucent and upright, and are distributed in foci throughout the field. The leaf yellowing followed by necrosis along the veins, seen in Japan and giving the virus its name (Tamada, 1975), is highly characteristic but infrequent.

However, BYNVV can also cause latent infections with no visible symptoms. This is especially the case under cool spring conditions (Lindsten, 1986). Recent studies suggested that the infection of beet roots by *P. betae* and the transmission of the virus is partly inhibited by low temperatures (Goffart & Maraite, 1992).

Usually, the disease is present as foci in the field. Slowing down of growth can be observed after 2-3 months of crop growth; early wilting is also observed during dry periods, at the beginning of July.

Morphology

The virus is rod-shaped, with a helical symmetry; its diameter is about 20 nm; French isolates have a quadripartite genome, displayed as four particles, the lengths of which are 390, 265, 100 and 85 nm, these corresponding to four RNAs with 7100, 4800, 1800 and 1500 nucleotides, respectively. The virus has been completely sequenced (Bouzoubaa *et al*., 1987).

Detection and inspection methods

In beet, the most efficient and easy detection method is an ELISA test, done on raw juice extracted from lateral roots or from the tip of the taproot (Putz, 1985). The sensitivity threshold is 2-6 ng of virus per g of tissue. Results obtained in this way are more reliable than those obtained by inoculation of indicator plants (*Chenopodium quinoa*). Quick test methods are now available (Schaufele *et al*., 1995).

In soil or adherent soil, a biological test is required. Beet plants are grown in suspect soil, and an ELISA test is performed on their roots. For very small soil samples, miniaturized tests have been devised (Merz & Hani, 1985). Bait plant tests to estimate soil infestation with BNYVV using pre-grown sugarbeet seedlings can be used to estimate the level of infestation (Goffart *et al.*, 1989) as well as to calculate potential yield losses. However, these tests are not reliable enough for detecting very low levels of infestation and are, therefore, unsuitable for establishing that fields are free from the virus (Büttner & Bürcky, 1990).

MEANS OF MOVEMENT AND DISPERSAL

The main means of spread is roots of infected plants, infected beet stecklings (possibly imported by breeders), and soil containing *P. betae* carrying BNYVV (which could accompany beet roots or potatoes, or possibly beet seed, or any vegetables grown on infested land). Sugarbeet waste, washing water and agricultural equipment (especially

harvesters) have been shown to be the main carriers at the local level. Stable manure can also play a role in the dispersal of BNYVV since *P. betae* is capable of passing undamaged through the digestive tracts of animals (Heijbroek, 1988).

PEST SIGNIFICANCE

Economic impact

Rhizomania causes severe damage wherever it is present; losses can amount to 50-70% of root weight and two to more than four percentage points of sugar content. Since BNYVV survives in the soil for many years without any decrease in intensity, its presence makes it necessary to avoid growing sugarbeet in heavily infested soils.

BNYVV has shown a great capacity for local dispersal from contaminated fields, and for spread to regions previously free from the virus. The exact origin of the epidemic since the 1970s is obscure. However, it is certain that large areas of beet cultivation in Europe were until recently free from BNYVV and there has been considerable spread within European countries. Its absence from certain countries and regions has been confirmed by intensive surveying.

Control

Chemical control methods against the vector are either too expensive (methyl bromide soil disinfection) or ineffective. The search for tolerant or resistant cultivars has been actively carried out since 1978: the results obtained have been very encouraging. Progress is made each year and the best new cultivars limit losses to 15% on heavily infested soils. Büttner *et al.* (1994) propose a soil test to determine the risk of rhizomania, as an aid to selection of the appropriate cultivar to be sown.

Phytosanitary risk

BNYVV is an EPPO A2 quarantine organism (OEPP/EPPO, 1988) but is not of quarantine significance for any other regional plant protection organization. Within the EPPO region, sugarbeet is grown extensively and represents a major cash crop for agricultural producers. Considerable areas are still free from the virus, especially in northern Europe. However, biological and epidemiological studies seem to indicate that the climatic zone where the organism can induce considerable yield losses is defined by the temperature requirements of the pathogen. If further research in these directions confirms these suggestions, a reevaluation of the phytosanitary risk of BNYVV would be necessary.

PHYTOSANITARY MEASURES

Measures aim to prevent spread into new countries and to limit spread within already infested countries. Areas in which beet seed and beet stecklings are produced should be kept under constant phytosanitary observation. Any imported seed or stecklings should come from a field (or preferably area) where BNYVV does not occur. Beet seed from infested areas should be kept particularly free from impurities (soil) and should contain not more than 0.5% inert matter (other than pelleting material) in the case of certified seed and 1% in the case of basic seed (OEPP/EPPO, 1990).

Countries where BNYVV does not occur would be well advised to recommend importers of vegetables from infested countries to take special precautions on the disposal of waste vegetable matter, soil waste and liquid waste (MAFF, 1985). Methyl bromide fumigation has been used successfully for small-scale eradication of BNYVV from infested plots in England (Henry *et al.*, 1992), but the method is probably impractical on a larger scale.

BIBLIOGRAPHY

Bouzoubaa, S.; Quillet, L.; Guilley, H.; Jonard, G.; Richards, K. (1987) Nucleotide sequence of beet necrotic yellow vein virus RNA-1. *Journal of General Virology* **68**, 615-626.

Büttner, G; Bürcky, K. (1990) Experiments and considerations on the detection of BNYVV in soil by means of bait plants. *Zeitschrift für Pflanzenkrankheiten und Pflanzenschutz* **97**, 56-64.

Büttner, G.; Mutzek, E.; Bürcky, K. (1994) [Possibilities of rhizomania forecasts as decision aids for the selection of suitable varieties]. *Gesunde Pflanzen* **46**, 33-39.

Canova, A. (1959) [On the pathology of sugar beet]. *Informatore Fitopatologico* **9**, 390-396.

Danielsen, S.; Mugrabi, M.; Albrechtsen, M.; Thomsen, A. (1992) Rhizomania in sugar beet. Survey for beet necrotic yellow vein virus (BNYVV) and beet soil borne virus (BSBV) in Denmark 1988-1989 and host range of *Polymyxa betae*, BNYVV and BSBV. *Tidsskrift for Planteavl* **96**, 309-316.

Goffart, J.P.; Horta, V.; Maraite, H. (1989) Inoculum potential and host range of *Polymyxa betae* and beet necrotic yellow vein furovirus. *Bulletin OEPP/EPPO Bulletin* **19**, 517-525.

Goffart, J.P.; Maraite, H. (1992) Influence of temperature on *Polymyxa betae* and beet necrotic yellow vein virus (BNYVV). *Mededelingen van de Faculteit Landbouwwetenschapen, Rijksuniversiteit Gent* **57** (in press).

Heijbroek, W. (1988) Dissemination of rhizomania by soil, beet seeds and stable manure. *Netherlands Journal of Plant Pathology* **94**, 9-15.

Henry, C.M.; Jones, R.A.C.; Coutts, R.H.A. (1986) Occurrence of a soil-borne virus of sugar beet in England. *Plant Pathology* **35**, 585-591.

Henry, C.M.; Bell, G.J.; Hill, S.A. (1992) The effect of methyl bromide fumigation on rhizomania inoculum in the field. *Plant Pathology* **41**, 483-489.

Hill, S.A. (1989) Sugarbeet rhizomania in England. *Bulletin OEPP/EPPO* **19**, 501-508.

Kastirr, U.; Pfeilstetter, E.; Burgermeister, W. (1994) Virus content and virulence of *Polymyxa betae* isolates obtained from different regions in Europe. *Journal of Phytopathology* **141**, 369-374.

Kaufmann, A.; Koenig, R.; Rohloff, H. (1993) Influence of beet soil-borne virus on mechanically inoculated sugar beet. *Plant Pathology* **42**, 413-417.

Koch, F. (1982) [Rhizomania of sugar beet]. In: *Compte Rendu du 45e Congrès d'Hiver de l'Institut International de Recherches Betteravières*, pp. 211-238. Institut International de Recherches Betteravières, Brussels, Belgium.

Kruse, M.; Koenig, R.; Hoffmann, A.; Kaufmann, A.; Commandeur, U.; Solovyev, A.G.; Savenkov, I.; Burgermeister, W. (1994) Restriction fragment length polymorphism analysis of reverse transcription-PCR products reveals the existence of two major strain groups of beet necrotic yellow vein virus. *Journal of General Virology* **75**, 1835-1842

Kuszala, M.; Ziegler, V.; Richards, K.; Putz, C.; Guilley, H.; Jonard, G. (1986) Beet necrotic yellow vein virus: different isolates are serologically similar but differ in RNA composition. *Annals of Applied Biology* **109**, 155-162.

Lemaire, O.; Merdinoglu, D.; Valentin, P.; Putz, C.; Ziegler-Graff, V.; Guilley, H.; Jonard, G.; Richards, K. (1988) Effect of beet necrotic yellow vein virus RNA composition on transmission by *Polymyxa betae*. *Virology* **162**, 232-235.

Lesemann, D.E.; Koenig, R.; Lindsten, K.; Henry, C. (1989) Serotypes of beet soil-borne furovirus from FRG and Sweden. *Bulletin OEPP/EPPO Bulletin* **19**, 539-540.

Lindsten, K. (1986) [Rhizomania - a complicated disease in sugar beets which can also occur in Sweden]. *Växtskyddsnotiser* **50**, 111-118.

Lindsten, K. (1989) Investigations concerning soil-borne viruses in sugarbeet in Sweden. *Bulletin OEPP/EPPO Bulletin* **19**, 531-537.

Lindsten, K.; Rush, C.M. (1994) First report of beet soilborne virus in the United States. *Plant Disease* **78**, 316.

MAFF (1985) *A code of practice for the safe disposal of waste from imported vegetables*. Ministry of Agriculture, Fisheries and Food, London, UK.

Merz, V.; Hani, A. (1985) [A bait plant test to determine infection potential of BNYVV and *Polymyxa betae* in soil samples]. In: *Compte Rendu du 48e Congrès d'Hiver de l'Institut International de Recherches Betteravières*, pp. 421-430. Institut International de Recherches Betteravières, Brussels, Belgium.

OEPP/EPPO (1988) Data sheets on quarantine organisms No. 162, Beet necrotic yellow vein virus. *Bulletin OEPP/EPPO Bulletin* **18**, 527-532.

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

Paczuski, R.; Szyndel, M.S. (1994) [The occurrence of rhizomania in Poland]. *Ochrona Roslin* **38**, 9-10. 5

Prillwitz, H.; Schlösser, E. (1992) Beet soil-borne virus: occurrence, symptoms and effect on plant development. *Mededelingen van de Faculteit Landbouwwetenschapen, Rijksuniversiteit Gent* **57** (in press).

Putz, C. (1985) Identification methods for beet necrotic yellow vein virus (BNYVV) and related viruses in beets. In: *Compte Rendu du 48e Congrès d'Hiver de l'Institut International de Recherches Betteravières*, pp. 391-398. Institut International de Recherches Betteravières, Brussels, Belgium.

Putz, C.; Merdinoglu, D.; Lemaire, O.; Stocky, G.; Valentin, P.; Wiedemann, S. (1990) Beet necrotic yellow vein virus, causal agent of sugarbeet rhizomania. *Review of Plant Pathology* **69**, 247-254.

Richard-Molard, M. (1985) Rhizomanie - situation en 1985. In: *Compte Rendu du 48e Congrès d'Hiver de l'Institut International de Recherches Betteravières*, pp. 347-360. Institut International de Recherches Betteravières, Brussels, Belgium.

Rush, C.M.; French, R.; Heidel, G.B. (1994) Differentiation of two closely related furoviruses using the polymerase chain reaction. *Phytopathology* **84**, 1366-1369.

Schaufele, W.R.; Buchse, A.; Buttner, G.; Munzel, L. (1995) [RIZO-QUICK: possibility to improve the field diagnosis for rhizomania]. *Zuckerindustrie* **120**, 294-298.

Tamada, T. (1975) Beet necrotic yellow vein virus. *CMI/AAB Descriptions of Plant Viruses* No. 144. Association of Applied Biologists, Wellesbourne, UK.

Wisler, G.C.; Liu, H.Y.; Duffus, J.E. (1994) Beet necrotic yellow vein virus and its relationship to eight sugar beet furo-like viruses from the United States. *Plant Disease* **78**, 995-1001.