Review

Viruses and their significance in agricultural and horticultural crops in Finland

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This paper reviews the plant viruses and virus vectors that have been detected in agricultural and horticultural crop plants and some weeds in Finland. The historical and current importance of virus diseases and the methods used for controlling them in cereals, potato, berry plants, fruit trees, ornamental plants and vegetables are discussed. Plant viruses have been intensely studied in Finland over 40 years. Up to date, 44 plant virus species have been detected, and many tentatively identified viruses are also reported. Control of many virus diseases has been significantly improved. This has been achieved mainly through changes in cropping systems, production of healthy seed potatoes and healthy stocks of berry plants, fruit trees and ornamental plants in the institutes set up for such production, and improved hygiene. At the present, barley yellow dwarf luteovirus, potato Y potyvirus and potato mop-top furovirus are considered to be economically the most harmful plant viruses in Finland.

Key words: berry plants, cereals, healthy plant production, onion, potato, vegetables, virus control, virus transmission, virus vector, yield losses

Introduction

Plant viruses cause huge economic losses in many crop species worldwide (Matthews 1991). In Finland, too, severe outbreaks of virus infections frequently affect many crops, but, fortunately, the climate restricts occurrence of insect species that can transmit viruses in the field (Rovainen 1947, Heikinheimo 1959, Vappula 1962, Raatikainen 1967, Kurppa and Rajala 1986). The very long days of summer reduce the time need-
Viruses detected in crop plants in Finland

The viruses listed in Table 1 have been identified on the basis of the symptoms they cause in experimentally inoculated test plant species. The majority have also been identified by serological tests and the morphology of particles observed under the electron microscope. Many, but not all, of the viruses in Table 1 have been tested for transmission by specific vector species. However, it is possible that many of the viruses for which no vector has been identified in Finland are transmitted here by a vector related to those identified elsewhere (Table 1). At this point, it is appropriate to note that *Myzus persicae*, one of the most efficient and important aphid vectors of viruses elsewhere, is not known to overwinter in the wild in Finland. It does, however, in the greenhouses and can spread to near-
Table 1. Viruses identified in agricultural and horticultural crops in Finland, and their vectors.

| Virus                          | Host species                         | Transmission |
|-------------------------------|--------------------------------------|--------------|
|                               | Finland                               | Elsewhere    | Reference |
|                               | By vectors\(^a\)                      | Through seeds\(^b\) |            |
| Agropyron mosaic virus         | Agropyron repens, Agropyron repens,  | eriophydid   | Bremer 1964, 1974a, [118] |
|                               | wheat                                | nites        |           |
| Alfalfa mosaic virus           | luzerne                               | aphids E     | E. Tapio (unpublished)\(^4\), [46, 229] |
| Apple chlorotic leaf spot virus| Malus sylvestris                      | unknown      | Leinmetty 1988, [30] |
| Aronia ring spot virus         | Aronia melanocarpa                    | unknown      | Bremer 1984 |
| Arabis mosaic virus            | rhubarb                               | Xiphinema sp. | Heinonen 1978, [16] |
| Barley yellow dwarf virus      | cereals and grasses                   |              | Bremer 1965, 1978, 1981, [32] |
| Bean common mosaic virus       | french bean                           | aphids F, E  | Jamalainen 1957, Tapio 1970, [73, 337] |
| Bean yellow mosaic virus       | red and alsike clover, pea, fababeen | Aphids       | Jamalainen 1957, Tapio 1964, 1970, [40] |
| Beet soilborne virus           | sugarbeet                             | Polymyxa betae | Bremer and Heikinheimo 1980, Lemmetty et al. 1997 |
| Black currant reversion virus  | Ribes spp.                            |              | Bremer 1973, 1974a, [3, 180] |
| Brome mosaic virus             | cereals, timothy grass, wheat, Agrostis tenuis, Agropyron repens |              |           |
| Carnation etched ring virus    | carnation                             | Myzus persicae | Bremer and Lahdenperä 1981, [182] |
| Carnation mottle virus         | carnation                             | M. persicae | Bremer 1978, [7] |
| Carnation necrotic fleck virus | carnation                             | unknown      | Bremer and Lahdenperä 1981, [136] |
| Carnation ringspot virus       | carnation                             | nematodes    | Bremer and Lahdenperä 1981, [21] |
| Carnation vein mottle virus    | carnation                             | aphids       | Bremer and Lahdenperä 1981, [78] |
| Cherry leaf roll virus         | Sambucus spp., chrysanthemum, tomato | Xiphinema sp. E | Cooper and Edwards 1980, [80] |
| Chrysanthemum aspermy virus    |                                          | M. persicae | Tapio 1963b, Bremer and Lahdenperä 1981 |
| Chrysanthemum virus B          | chrysanthemum                         | aphids       | Tapio 1963b, Bremer and Lahdenperä 1981, [110] |
| Cucumber green mottle virus    | cucumber                              | unknown      | Linnasalmi 1966, [154] |
| Cucumber mosaic virus          | cucumber, tomato, black currant,      |              |           |
|                               | Stellaria media, Mentha gentilis,     |              | Rainio 1941, Linnasalmi 1966, Linnasalmi ja Murtohauta 1966, Bremer 1983, Leinmetty 1985, Tegel 1987, [1, 213] |
|                               | Phlox paniculata                      |              | Kokkola 1992 |
| Garlic latent virus            | garlic                                | aphids       | Bremer 1990, Kokkola 1992, [240] |
| Leek yellow stripe virus       | shallot, garlic                       | aphids       | Lahdenperä 1981, [9] |
| Lettuce mosaic virus           | lettuce                               | aphids       | Kanervo et al. 1957, Ikäheimo 1961, Ikäheimo and Raatikainen 1961, 1963, [217] |
| Oat sterile dwarf virus        | oat                                   |              |           |

continues
| Virus                      | Host species         | Transmission              | By vectors<sup>a</sup> | Through seeds<sup>b</sup> | Reference<sup>c</sup> |
|---------------------------|----------------------|---------------------------|-------------------------|--------------------------|------------------------|
| Onion yellow dwarf virus  | shallot, garlic      | Finland                   | nr                      | aphids                  | Jamalanen 1957, Bremer 1990, Kokkola 1992, [158] |
| Potato leaf roll virus    | potato               |                           |                         |                          | Kurppa 1983, Uusitalo 1985, [36, 291] |
| Potato mop-top virus      | potato               |                           |                         |                          |                       |
| Potato virus A            | potato               |                           |                         |                          |                       |
| Potato virus M            | potato               |                           |                         |                          |                       |
| Potato virus S            | potato               |                           |                         |                          |                       |
| Potato virus X            | potato, tomato       |                           |                         |                          |                       |
| Raspberry bushy dwarf virus | *Rubus arcticus*     |                           | nr                      | unknown                 | E                     |
| Raspberry ringspot virus  | *Ribes* spp, plants and soil in plant nurseries<sup>d</sup> |                           |                         |                          |                       |
| Raspberry vein chlorosis virus | *Rubus* spp.     |                           |                         |                          |                       |
| Shallot latent virus      | shallot, garlic      |                           | nr                      | aphids                  | Bremer 1990, Kokkola 1992, [250] |
| Strawberry latent         | *Asitble x arendstii*, *Paeonia officinalis*, *Phlox* spp. |                           |                         |                          | Bremer 1985, [126] |
| Tobacco mosaic virus<sup>6</sup> | tomato, rhubarb, plants and soil in plant nurseries<sup>e</sup> |                           | nr                      | no vector               | Linnasalmi 1964, Heinonen 1978, Tapio 1985, [151] |
| Tobacco necrosis virus    | cucumber, tulip, plants and soil in plant nurseries<sup>e</sup> |                           |                         |                          |                       |
| Tobacco rattle virus      | potato, plants and soil in plant nurseries<sup>e</sup> |                           |                         |                          |                       |
| Tomato black ring virus   | black currant, plants and soil in plant nurseries<sup>e</sup> |                           |                         |                          |                       |
| Tomato spotted wilt virus | tomato, *Dahlia*, cineraria, chrysanthemum |                           |                         |                          |                       |
| Turnip mosaic virus       | rhubarb              |                           |                         |                          |                       |
| Wheat striate mosaic virus | oat                  |                           |                         |                          |                       |

<sup>a</sup>Vectors of Finnish origin experimentally shown to transmit Finnish virus isolates are indicated. The group of vectors known to transmit the virus elsewhere is mentioned if the vector in Finland is not identified. "No vector" means that the virus is mechanically transmitted only. "Unknown" means that the virus probably has a vector but it has not been identified. nr, not reported.

<sup>b</sup>Seed-transmissibility is indicated only if it is considered to be important for dispersal of the virus in the field. F, in Finland; E, elsewhere; (?), transmission of cucumber mosaic virus probably occurs via seeds of *Stellaria media* (Lemmety 1985).

<sup>c</sup>References to reports in which isolation, host range and vectors of Finnish isolates of the virus were described first. Numbers in parentheses correspond to the numbers of viruses in the series of C.M.I./A.A.B. Descriptions of Plant Viruses (Kew, UK).

<sup>d</sup>The Finnish isolates of alfalfa mosaic virus were identified in 1971 as previously described for isolates from other Scandinavian countries (Tapio 1970).

<sup>e</sup>A few strains isolated from tomato plants and originally identified as tobacco mosaic virus are currently considered to be strains of tomato mosaic virus (Linnasalmi 1972).

<sup>f</sup>Many plant species were infected (Tapio 1972b, 1985), but for brevity they are not listed here.
Table 2. Tentatively identified viruses and virus-like diseases observed in crops grown in Finland.

| Virus or disease                  | Crop               | Reference               |
|-----------------------------------|--------------------|-------------------------|
| Apple flat limb disease           | apple              | Jamalainen 1964         |
| Apple green crinkle disease       | apple              | Jamalainen 1964         |
| Apple rubbery wood disease        | apple              | Jamalainen 1964         |
| Apple star crack disease          | apple              | Jamalainen 1964         |
| Apple stem grooving disease       | apple              | Jamalainen 1964         |
| Beet mild yellowing virus         | sugarbeet          | E. Tapio, unpublished   |
| Beet mosaic virus                 | sugarbeet, *Chenopodium* spp. | E. Tapio, unpublished   |
| Beet yellows virus                | sugarbeet          | E. Tapio, unpublished   |
| Fuchsia latent virus              | *Fuchsia* spp.     | K. Bremer, unpublished  |
| Garlic mosaic virus               | garlic             | Bremer 1983             |
| Infectious variegation disease    | *Ribes* spp.       | Bremer 1983             |
| Pelargonium leaf curl virus       | *Pelargonium* spp. | E. Tapio, unpublished   |
| Phleum green stripe disease       | timothy grass      | Nuorteva 1962, Heikinheimo and Raatikainen 1976 |
| Potato aucuba mosaic virus         | potato             | Kurtto 1969             |
| Raspberry vein banding disease    | *Rubus* spp.       | Tapio 1961              |
| Raspberry yellows/yellow mosaic disease | *Rubus* spp. | Tapio 1961 |
| Red raspberry mosaic/raspberry leaf mottle disease | raspberry | Tapio 1961 |
| Red clover mottle virus           | red clover         | E. Tapio, unpublished   |
| Soil-borne wheat mosaic virus     | rye                | Bremer and Vestberg 1986 |
| Strawberry crinkle virus          | strawberry         | E. Tapio and K. Bremer, unpublished |
| Strawberry mild yellow edge virus | strawberry         | E. Tapio, unpublished   |
| Tomato ringspot virus             | *Phlox paniculata* | Tegel 1987              |
| Vein banding disease              | *Ribes* spp.       | K. Bremer, unpublished  |

by fields during the summer (Heikinheimo 1959). Aphids of the genus *Chaetosiphon* (Bremer and Pethman 1978) and nematodes of the genus *Xiphinema* (Tapio 1972b, 1985, Kari Tiilikka, pers. comm.) are important virus vectors elsewhere but have not been found in Finland. Seed-transmitted viruses (Table 1) may also be transmitted by pollen (Matthews 1991), but adequate tests are not always carried out.

Table 2 lists viruses that have been only tentatively identified, mainly on the basis of symptoms observed in crop plants. In some cases, test plant responses or a positive reaction in serological tests with virus-specific antiserum have been reported. Some of the viruses could probably be included in either Table 2 or Table 1. Inclusion in Table 2, however, is usually based on the original author’s suspicions concerning the identity of the virus; identity of the viruses and even confirmation of the viral nature of some of the diseases listed in Table 2 awaits more definite determination. Nevertheless, we felt that we should include these data in this review, because in so doing we could point to crops and viruses that may deserve more detailed investigation by virologists in Finland.

**Significance of plant virus diseases in Finland**

The occurrence of plant virus diseases in Finland has been known for over 60 years (Liro
1930, Rainio 1941, Brummer 1946, Jamalainen 1943, 1946). However, it was only 40 years ago that the economic damage caused by viruses in crop plants was more fully recognized and efforts to identify and control plant viruses were launched on a broader front, first at the Agricultural Research Centre of Finland, Tikkurila (Jamalainen 1952, 1957), and then at the University of Helsinki, Viikki. For the next 30 years, plant virologists were mainly concerned with virus identification and the development of control methods. This work involved tight collaboration with the entomologists. During that time, a few foreign scientists spent a few months in Finland participating in the identification of viruses in potato (A.B.R. Beemster, The Netherlands, 1955), cereals and grasses (E. Banttari, USA, 1966-67) and woody plants (J.I. Cooper, UK, in the 1970s and 1980s). During this decade, M. Saarma (Estonia) and his research group have contributed to research mainly of a theoretical nature on plant viruses in Finland.

The significance of virus diseases has declined in many crops in Finland during the past 40 years due to the development of schemes for producing virus-free planting materials, the better standards of hygiene in the greenhouse production, changes in cropping systems to reduce vector populations, introduction of procedures to predict and control the outbreak of virus epidemics, and improvements in cultivar resistance to viruses. Inspection of imported plants for viruses by the plant quarantine authorities has significantly decreased the occurrence of viruses in many horticultural and ornamental plants, the natural transmission of plant viruses to Finland being largely limited due to the country’s isolation from other agricultural areas in Europe by the Baltic Sea. Only a few persistently transmitted viruses are known to be occasionally carried to Finland over the sea by wind-borne aphids (Kurppa 1983, Kurppa S. 1989a). Virus transmission from the east is probably limited because the land there is mainly occupied by forests and the prevailing winds during the growing season are from the south and west.

Viruses in cereals and grasses

The severe disease that affected oats growing at the coast of the Gulf of Bothnia in the 1950s (Jamalainen 1957) was shown to be caused by oat sterile dwarf virus (OSDV) transmitted by leafhoppers in a persistent manner. Wheat stripe mosaic virus, also detected in the diseased oat crops, was transmitted by the same vectors as OSDV but occurred in fewer plants and was less damaging (Ikäheim 1960, 1961, Ikäheimo and Raatikainen 1961, 1963). The epidemic in oats drew the attention of agriculturalists to viruses in cereals and grasses in Finland. Although the disease caused by OSDV was reported in many parts of Finland (Jamalainen 1957), the epidemic was most severe at the western coast, possibly due to the higher vectoring capacity of local leafhopper populations (Bremer 1974b). At the same time, epidemics caused by OSDV were reported on the other side of the Gulf of Bothnia in Sweden (Lindsten 1961), and also in the Soviet Union and the US (Slykhu 1967). In Finland, OSDV was brought under control by changing the cropping system. Grass was abandoned as an undercrop of oat, which reduced the numbers of leafhopper nymphs that could overwinter and transmit OSDV to new oat crops during the next growing season (Ikäheimo 1962, Jamalainen and Murtomaa 1966, Raatikainen 1967). Since then, OSDV has not caused any significant problems in Finland.

Other viruses have also been detected in cereals and grasses (Table 1), of which a few await more definite identification (Table 2). Barley yellow dwarf virus (BYDV) causes economic losses in oats, barley and wheat (Bremer 1965, Korhonen 1981, Peltonen 1988). Epidemics in cereals thought to be caused by BYDV occurred in 1926, 1947 and 1954 (Jamalainen 1957), and epidemics known to be caused by BYDV in 1959 (Ikäheim 1960), 1973, 1975 and 1988 (Kurppa S. 1989b). Many perennial grasses are natural hosts of BYDV (Korhonen 1981, Kurppa A. et al. 1989) and the aphids (Heikinheimo 1959, Rautapää 1970) that persistently transmit BYDV.
(Ikäheimo 1960, Bremer 1965). Epidemics of BYDV therefore coincide with outbreaks of aphids, notably *Rhopalosiphum padi* (Kurppa S. 1989a, 1989b). Long-distance wind-borne migration of viruliferous *R. padi* from the south and southeast was a significant factor in the build-up of the epidemic caused by BYDV in 1988 (Kurppa S. 1989a).

Epidemics caused by BYDV can be forecast. The numbers of living eggs of *R. padi* are recorded in the winter host *Prunus padus* in the spring, and the development of aphid populations in grasses is monitored following migration from the winter host early in the summer. To prevent economic losses due to BYDV infection, migration of *R. padi* from grasses to cereals is monitored and chemical sprays are applied to kill the aphids in the cereal crop when a threshold value (one aphid found in one seedling out of five) is reached (Kurppa S. 1989a, 1989b). Long-distance migration of aphids can be observed with radar (Puhakka et al. 1986).

**Viruses in potato**

The occurrence of viruses in potato was recognized in the 1940s, and viruses were tentatively identified based on symptoms (Brummer 1946). The first viruses to be detected using serological tests were the potato viruses X and S (Aura 1957). Since then, several viruses have been detected and studied in the potato in Finland (Table 1). As potatoes are vegetatively propagated, many cultivars were found to be 100% infected by viruses (Aura 1957, Seppänen 1972). The yields of some cultivars declined faster than those of others following virus infection (Pohjakallio et al. 1961a, Kurtto 1969, Seppänen 1972) and a few susceptible cultivars were abandoned from use. The deleterious effects of viruses on potato quality were also recognized, and breeding for virus resistance was emphasized (Varis 1970).

Professional farmers control potato viruses mainly by using virus-free seed potatoes (Tapio 1972a), of which the highest quality classes are produced by the Seed Potato Center established in Tynävä in 1976 (Pietarinne and Seppänen 1981) and by contract farmers in the protected seed potato production zone in the same area. Many potato cultivars currently grown in Finland are susceptible to aphid-transmissible viruses such as potato virus Y (PVY) (Valkonen and Palouhuhta 1996) and potatoes grown in home gardens are often heavily infected with viruses. Potato crops are therefore frequently affected in the field with viruses non-persistently transmitted by aphids, particularly in southern Finland. In field experiments carried out on a farm in Renko (southern Finland), 26% and 38% of the initially healthy crop of potato cv. Rekord was infected with PVY after the first and second year, respectively (Tiilikala 1987). The yield losses per hectare were equivalent to 48 000 Fmk (current value) at the second year (Tiilikala 1987).

The capacity of different aphid species to transmit potato viruses in the field has not been studied in Finland, but the abundance of *R. padi* and *Aphis frangulae-nasturtii* in potato fields (Kurppa and Rajala 1986) and their ability to transmit the potato viruses Y and M under experimental conditions (Tapio 1980) suggest that they may be important vector species. Large numbers of *Aphis fabae* and *Cavariella theobaldi* have also been reproted in potato fields (Kurppa and Rajala 1986, Tiilikalla 1987) but their capacity to transmit potato viruses in Finland is not yet known. Sprays with mineral oils can diminish the transmission of PVY by aphids in potato crops, whereas sprays with insecticides reduce the number of aphids but not the transmission of PVY (Tiilikala 1987).

Potato leaf roll virus (PLRV) is the most important potato virus in many countries, but it has been detected only intermittently in Finland and is not economically damaging (Kurppa 1983). It is probably transmitted over the Baltic sea by wind-borne aphids (Kurppa 1983). Although a few aphid species that occur in potato fields in Finland can transmit PLRV (Usitalo 1985), the most efficient vector species, *M. persicae*, is not known to overwinter outdoors here (Heikinhei-
Viruses in berry plants, fruit trees and ornamental plants

The viruses detected in berry plants in Finland are listed in Table 1 and have been reviewed elsewhere (Tapio 1963a, Bremer 1987). Recently, raspberry bushy dwarf virus was shown to be prevalent in arctic bramble (Rubus arcticus) in eastern and southeastern Finland (Kokko et al. 1996). A virus resembling nepoviruses has been isolated from the reversion-diseased black currants (Lemmetty et al. 1997). Back-inoculation tests to healthy plants (Anne Lemmetty, pers. comm.) suggest that this virus may be the primary causal agent of the reversion disease (Bremer and Heikinheimo 1980).

Apple is the only fruit tree that is widely grown and therefore economically significant in Finland. Virus disease-like symptoms have been reported in apple trees and may be attributable to infection by several different viruses (Table 2; Jamalainen 1964); only apple chlorotic leaf spot virus has, however, been identified (Lemmetty 1988).

In the past, virus infections were common in imported chrysanthemum (Tapio 1963b) and carnation (Bremer 1978, Bremer and Lahdenperä 1981) grown in the greenhouse (Table 1). As the diagnostic tools used in plant quarantine improved, these viruses became less common in the cultivations. Many ornamental plant species grown outdoors are infected by soil-borne viruses transmitted by nematodes or fungi (Tapio 1972b, 1985, Bremer 1985, Keskinen 1991) (Table 1, 2). The Phlox spp. seem to be infected with the largest number of viruses (Tapio 1972b, 1985, Bremer 1985, Tegel 1987).

Major achievements in efforts to improve the quality and yield of berries and fruit in Finland were the schemes set up for producing healthy stocks of berry plants, fruit trees and ornamental plants at the Agricultural Research Centre of Finland (Bremer and Ylimäki 1978) and the foundation of the Healthy Plant Center in 1976, now located in Laukaa (Uosukainen and Kurppa 1988). Before the healthy plant production scheme for raspberries was introduced, 95% of the raspberry plants in the 20 plant nurseries inspected by Tapio (1961) were virus-infected. Later, it was shown that the yields of raspberries produced using virus-free plants were six times bigger than those of plants naturally infected with viruses (Bremer 1980).

A few viruses that infect berry and ornamental plants in Finland are difficult to eradicate from farms and gardens because sources of the viruses exist in the wild. Almost anywhere in Finland cultivated raspberries can be infected with viruses transmitted by aphids from virus-infected wild raspberries (Tapio 1961, 1964). Strawberries are frequently infected with aphid-transmitted viruses in the field, possibly because aphids of the genus Chaetosiphon, which are the most important vectors of strawberry viruses elsewhere, do not occur in Finland (Bremer and Pethman 1978). Viruliferous nematodes (Tricho- dorus spp., Longidorus spp.) and fungi (Olpid ium brassicae) may exist in plant nurseries, gardens and parks where ornamental or other perennial plants have been grown for a long time (Tapio 1972b, 1985). Therefore, transport of soil from nurseries and gardens may present a risk of virus dissemination.
Viruses in vegetable crops

The aphid-transmitted cucumber mosaic virus (CMV) was early associated with a mosaic disease of cucumbers grown in the greenhouse (Rainio 1941). However, neither CMV nor the seed-transmitted cucumber green mottle mosaic virus (CGMVM), which were found in ten and two, respectively, of the 263 crops inspected by Linnasalmi (1966), have become economically damaging to any crop in Finland.

The studies of Linnasalmi (1964) showed that 62% of the 387 tomato crops inspected were infected with viruses in 1961–63. Most of the diseased plants had mottle symptoms and were infected with tobacco mosaic virus (TMV), whereas 10% had streak symptoms and were infected with TMV (6–8%) or mixedly infected with TMV and potato virus X (PVX) (2–4%) (Linnasalmi 1964, Linnasalmi and Murtomaa 1966). TMV and PVX are readily transmitted mechanically but no insect vectors are known. Therefore, once the two viruses had been identified as the cause of the tomato mosaic and streak diseases, they could be controlled by improved hygiene. TMV and PVX are no longer significant in tomato crops.

Tomato spotted wilt virus (TSWV) was recently introduced to a few greenhouses, probably in infected, imported ornamental plants (Lemmetty 1991b). TSWV has a very broad host range, causes severe yield losses in many ornamental plants and horticultural crops, and is transmitted by two species of thrips (Frankliniella occidentalis and Thrips tabaci) that occur as pests in greenhouses in Finland (Lemmetty and Lindqvist 1993). TSWV is subject to special quarantine and control measures in Finland. If the virus is detected, the infected crop is destroyed and the greenhouse cleaned according to special instructions. Therefore, TSWV is not established in Finland, but the risk of reintroduction from other countries in imported plants remains and is continuously monitored by Finnish plant quarantine authorities (Anne Lemmetty, pers. comm.).

Until recently, vegetatively propagated onions of the aggregatum group (Allium cepa) and garlic were heavily virus-infected in Finland (Jamalainen 1952, 1957, Bremer 1990, Kokkola 1992). Many viruses have been identified in both crops (Table 1) and several unidentified viruses have also been observed (Bremer 1990, Kokkola 1992, Table 2). The viruses were recently eradicated from a few local clones of onion and garlic (Bremer 1990, Kokkola 1992) and the virus-free clones are maintained at and available from the Seed Potato Center.

Viruses continue to be detected time to time in vegetable crops in Finland (Tables 1, 2), but with exception of the viruses occurring in vegetatively propagated crops of potato, onion and garlic, as discussed above, economically significant losses no longer occur.

Virus in other crops

Viruses in legumes were extensively studied in Finland and other Scandinavian countries 30 years ago (Tapio 1970). Many viruses and virus strains were detected (Table 1), particularly in the experimental fields of plant breeders. A large number of these viruses caused a severe disease in infected legume plants, but were not prevalent in the legume crops in the farmers’ fields and therefore not economically damaging.

Foliar symptoms resembling those caused by aphid-transmissible viruses have occasionally been observed in sugar beets and fodder beets (Table 2). Wind-borne aphids may sometimes carry the semi-persistently transmitted beet yellows virus (BYV) over the sea to southwestern Finland. This assumption is supported by the occurrence of symptoms resembling those caused by BYV in beets in Finland in years when epidemics caused by BYV occur in southern Sweden (E. Tapio, unpublished). Beet soil-borne virus has been detected in the roots of sugar beets collected from several farms in Finland (Bremer et al. 1990).
No virus has been reported in any brassicas in Finland. Turnip mosaic virus that occurs in brassicas elsewhere has been detected only in rhubarb in Finland (Heinonen 1978).

Some of the viruses detected many years ago (Table 1, 2) have not been restudied recently in Finland. If the host range of a virus is restricted to the crop plant in which it has been detected, the virus may eventually be eradicated when new, virus-resistant cultivars will be introduced to cultivation. Further, if the virus has no vector or other means of dispersal in the environment in which it is introduced, it may be eradicated when the originally infected plant will be harvested or will die. However, no virus listed here is known to have ceased to exist in Finland. A few viruses may not have been detected in Finland because only the main crops and/or crops with severe disease symptoms have been inspected, the minor crops, crops with no obvious disease symptoms and wild plants having remained largely uninspected. Therefore, when new crop species and cropping systems are introduced in the future, new virus diseases caused by viruses and vectors that are currently unknown or considered non-important may appear in Finland.

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References

Aura, K. 1957. Of potato virus diseases in Finland. The Journal of the Scientific Agricultural Society of Finland 29: 103-110.

Baulcombe, D. 1994. Novel strategies for engineering virus resistance in plants. Current Opinion in Biotechnology 5: 117-124.

Bremer, K. 1964. Agropyron mosaic virus in Finland. Annales Agriculturae Fenniae 3: 324-333.

- 1965. Characteristics of the barley yellow dwarf virus in Finland. Annales Agriculturae Fenniae 4: 105-120.

- 1973. The brome grass mosaic virus as a cause of a cereal disease in Finland. Annales Agriculturae Fenniae 12: 207-214.

- 1974a. Occurrence of the brome grass mosaic and agropyron mosaic viruses in Finland in 1971-1973. Annales Agriculturae Fenniae 13: 1-4.

- 1974b. Virus diseases of Graminea-plants in Finland and Turkey. Annales Agriculturae Fenniae 13: 125-148.

- 1978. The carnation mottle virus in Finnish carnations. Annales Agriculturae Fenniae 17: 36-44.

- 1980. Hyviä satova jalvelellä taimilla (Good yields obtained using healthy raspberries). Puutarha 83: 526-527, 578. (In Finnish).

- 1983. Viral diseases occurring on Ribes species in Finland. Annales Agriculturae Fenniae 22: 104-109.

- 1984. Ring spot of Aronia melanocarpa, a disease caused by an isometric virus transmissible via sap and seed. Annales Agriculturae Fenniae 23: 176-182.

- 1985. Strawberry latent ring spot virus in ornamental plants in Finland. Annales Agriculturae Fenniae 24: 101-102.

- 1987. Virus diseases of berry plants in Finland. Journal of Agricultural Science in Finland 59: 161-168.

- 1990. Production of virus-free plants of vegetatively propagated onion Allium cepa L. Annales Agriculturae Fenniae 29: 1-7.

- & Heikinheimo, O. 1980. Problems of the reversion disease of Ribes in Finland. Acta Horticulturae 95: 87-91.

- . Hiltunen, L. & Valkonen, J. 1990. Survey of soil-borne virus diseases of sugar beet in Finland and Estonia. Proceedings of the 1st Symposium of the International Working Group on Plant Viruses with Fungal Vectors. p. 17-20.

- & Lahdenperä, M.L. 1980. A disease of out-doot cucumbers caused by the tobacco necrosis virus in Finland. Annales Agriculturae Fenniae 19: 5-8.

- & Lahdenperä M.L. 1981. Virus diseases in carnation and chrysanthemum cuttings imported into Finland. Annales Agriculturae Fenniae 20: 214-228.

- . Lehto, K. & Kurkela, T. 1991. Diseases caused by viruses and mycoplasmas in forest trees. Bulletin of the Finnish Forest Research Institute No. 382. 15 p.

- & Pethman, M. 1978. Occurrence of virus diseases in Finnish strawberry fields. Annales Agriculturae Fenniae 17: 38-41.

- & Vestberg, M. 1986. Two soil-borne viruses and their possible fungal vectors in Secale cereale in Finland. Annales Agriculturae Fenniae 25: 31-35.

- & Ylimäki, A. 1978. A certificate system to produce and distribute virus tested propagation material from berry plants in Finland. Annales Agriculturae Fenniae 17: 42-44.

Broekhuizen, S. 1969. (ed.). Atlas of cereal growing areas in Europe. Vol. 2. PUDOC, Wageningen, The Netherlands. 157 p.
Brummer, V. 1946. Tutkimuksia tärkeimmistä Tammistossa esiintyneistä perunavirroeiseista (Investigations on the most important potato viruses occurring in Tammisto). Hankkijan kasvinjalostusliitoksen Siemenjulkaisu. p. 176–185. (In Finnish).

Cooper, J.I. & Edwards, M.L. 1980. Cherry leaf roll virus in Juglans regia in the United Kingdom. Forestry 53: 41–50.

Hassi, A. 1991. Miten eri lajikkeet kestävät perunan mope-top virusta (Resistance of different potato cultivars to mope-top virus). Koetoiminta ja käytäntö 48: 40. (In Finnish).

Heikinheimo, O. 1959. On the occurrence of virus vector aphids in Finland. Publications of the Finland State Agricultural Research Board 178: 20–40.

& Raatikainen, M. 1976. Megadellaphis sordidula (StIDi) (Hom., Delphacidae) as a vector of Phleum green stripe virus. Annales Agriculturae Fenniae 15: 34–55.

Heinonen, M. 1978. Rapaperin virustaudeista Suomessa (On virus diseases of rhubarb in Finland). M.Sc. thesis. Department of Plant Pathology, University of Helsinki. 52 p. (In Finnish).

Ikäheimo, K. 1960. Two cereal virus diseases in Finland. The Journal of the Scientific Agricultural Society in Finland 32: 62–70.

1961. A virus disease of oats in Finland similar to oat sterile-dwarf disease. The Journal of the Scientific Agricultural Society in Finland 33: 81–87.

1962. Virus diseases of cereals in Finland. Maatalous ja Koetoiminta 16: 121–128.

& Raatikainen, M. 1961. Calligyppona obscurella (Boh.), a new vector of the wheat striate mosaic and oat sterile dwarf viruses. The Journal of Agricultural Science in Finland 33: 146–152.

& Raatikainen, M. 1963. Dicranotropis hamata (Boh.) (Hom., Araeopidae) as a vector of cereal viruses in Finland. Annales Agriculturae Fenniae 2: 153–158.

Jamalainen, E.A. 1943. Tomaatin virustaudeista (On virus diseases of tomato). Suomen Puutarhaviljelijän Liiton Julkaisuja. No. 30. 6 p. (In Finnish).

1946. The significance of potato virus disease in Finland. Journal of the Scientific Agricultural Society of Finland 18: 134–146.

1952. On factors hampering onion production and on measures for promoting onion cultivation. Reports of the Finnish State Agricultural Research Board No. 225. 45 p.

1957. On plant virus diseases and viruslike diseases in Finland. Publications of the Finnish State Agricultural Research Board No. 158. 58 p.

1964. Om fruktträdens virussjukdomar. Trädgårdsnytt 13–14/64.

& Murtomaa, A. 1966. Control of cereal virus diseases by cultural practices in Finland. Maatalous ja Koetoiminta 20: 159–166.

Kanervo, V., Heikinheimo, O., Raatikainen, M. & Tinnilä, A. 1957. The leafhopper Delphacodes pellucida (F.) (Hom. Auchenorryncha) as the cause and distributor of the damage to oats in Finland. Publications of the Finnish State Agricultural Research Board No. 160. 56 p.

Keskinen, M. 1991. Jalopionin virustestaus ja solukkoviljely (Virus indexing and tissue culture of Peonia x Lactiflora hybrids). M.Sc. thesis. Department of Plant Pathology, University of Helsinki. 66 p. (In Finnish).

Kokko, H.I., Lemmety, A., Haimi, P. & Kärenlampi, S. 1996. New host for raspberry bushy dwarf virus: arctic bramble. European Journal of Plant Pathology 102: 713–717.

Kokkola, M. 1992. Valkosipulin virustauid Suomessa ja virukstuttimien istutuksen toiminnan solukkoviljelyn avulla (Virus diseases of garlic in Finland and the production of virus-free clones through tissue culture). M.S. Thesis, Department of Plant Biology, Section of Plant Pathology, University of Helsinki. 129 p. (In Finnish).

Korhonen, K. 1981. Ohran kääpiökasvuvirus (BYDV), sen esiintymisen eri heinälaajella Pikku alueella sekä virussaastunnan vaikutus kauralajikkeisiin (Barley yellow dwarf virus (BYDV). Its occurrence in grasses at Viikki, and the effects of virus infection on some cultivars of oat). M.S. Thesis, Department of Plant Pathology, University of Helsinki. 69 p. (In Finnish).

Kurppa, A. 1983. Potato viruses in Finland and their identification. The Journal of the Scientific Agricultural Society in Finland 55: 183–301.

1989. The distribution and incidence of potato mop top virus in Finland as determined in 1987 and on the variation of disease symptoms in infected tubers. Annales Agriculturae Fenniae 28: 285–295.

–, Hassi, A. & Kurppa, S. 1989. Importance of perennial grasses, and winter cereals as hosts of barley yellow dwarf virus (BYDV) related to fluctuations of vector aphid population. Annales Agriculturae Fenniae 28: 309–315.

Kurppa, S. 1989a. Predicting outbreaks of Rhopalosiphum padi in Finland. Annales Agriculturae Fenniae 28: 333–347.

1989b. Damage and control of Rhopalosiphum padi in Finland during the outbreak in 1988. Annales Agriculturae Fenniae 28: 349–370.

– & Rajala, P. 1986. Occurrence of winged aphids on potato plants and pressure for potato virus Y transmission in Finland. Annales Agriculturae Fenniae 25: 199–214.

Kurto, J. 1969. Perunan virustauiden oireista sekä niiden vaikutuksesta muokulastoihin (Virus disease symptoms in potato and their effects on tuber yields). M.S. Thesis, Department of Plant Pathology, University of Helsinki. 67 p. (In Finnish).

Lahdenperä, M.L. 1981. Salaatin mosaiikki – monioireinen virustaalti (Lettuce mosaic – a virus disease with manifold symptoms). Puutarha 4/91: 178–179. (In Finnish).

Laurila, E. 1995. Puutarhatalouden viisi vuosikymmentä (Fifty years of horticulture). Puutarhalitto. 354 p. (In Finnish).

Lemmety, A. 1985. Kurkun mosaiikkiviruksen tartuntalähteeit Pikki koekentätäuleella (Sources of cucumber mosaic virus at the experimental fields of Viikki). M.S. Thesis, Department of Plant Pathology, University of Helsinki. 60 p. (In Finnish).
1988. Isolation and purification of apple chlorotic leaf spot virus and its occurrence in Finnish orchards. *Acta Horticulturae* 235: 177–180.

1991a. Tulppaanin kasvuhäiriön syynä on olla virus (Virus as a possible cause of disturbed growth of tulip). *Puutarha-Uutiset* 48/91: 20.

1991b. First reported occurrence of tomato spotted wilt virus in greenhouse crops in Finland. *Växtskyddsnotiser* 55: 7–9.

Latvala, S., Jones, A.T., Susi, P., McGavin, W.J. & Lehto, K. 1997. Purification and properties of a new virus from black currant, its affinities with nepoviruses, and its close association with black currant reversion disease. *Phytopathology* 87: 404–413.

& Lindqvist, I. 1993. *Thrips tabaci* (Lind.) (Thysanoptera, Thripidae), another vector for tomato spotted wilt virus in Finland. *Agricultural Science in Finland* 2: 189–194.

Lindsten, K. 1961. Studies on virus diseases of cereals in Sweden. *Kungliga Landbruksögklans Annaler* 27: 137–271.

& Tapio, E. 1986. Jordborna växtviroser – en förbisedd grupp av sjukdomar? *Växtskyddsnotiser* 50: 83–84.

Linnasalmi, A. 1964. The characteristics of some isolates of tobacco mosaic virus and potato virus X causing streak on tomato. *Annales Agriculturae Fenniae* 3: 224–234.

1966. Virus diseases of cucumber in Finland and characteristics of their causal agents cucumber mosaic and cucumber green mottle mosaic viruses. *Annales Agriculturae Fenniae* 5: 305–323.

1972. Tomaatin mosaiikkiviruksen (TMV) biologisen torjunnan nykyiset mahdollisuudet (Current means for biological control of tomato mosaic virus (TMV)). *Puutarha-Uutiset* 44/72: 3–4. (In Finnish).

& Murtooma, A. 1966. Virus diseases of tomato in Finland. I. Occurrence and causal agents of the diseases. *Annales Agriculturae Fenniae* 5: 345–354.

Liro, J.L. 1930. Über die Mosaikkrankheit der *Prunella vulgaris* L. *Annales Societatis Zoologici Botanici Fennici* "Vanamo" 11: 143–149.

Markkula, I. 1993. (ed.). Ajankohtaisia kasvinsuojelujohjeita (Current guide to plant protection). *Kasvinsuojeluseura ry:n Julkaisuja* No. 85. Ykkös-Offset Oy, Vaasa, Finland.168 p. (In Finnish).

Matthews, R.E.F. 1991. *Plant virology*. 3rd ed. Academic Press, San Diego, USA. 835 p.

Mehto, M. 1991. *Perunan X-virukselle resistentin Pito-lajikseen aikaansaaminen viruksen vaippaproteiinigenin siirrolla* (Generation of potato virus X-resistant plants of potato cultivar Pito through genetic transformation with the viral coat protein gene). M.S. Thesis, Department of Genetics, University of Oulu, Finland. 77 p. (In Finnish).

Mukula, J. & Rantanen, O. 1987. Climatic risks to the yield and quality of field crops in Finland. I. Basic facts about Finnish field crop production. *Annales Agriculturae Fenniae* 26: 1–18.

Nuorteva, P. 1962. Studies on the causes of the phytotoxicogenicity of *Calligypona pellucida* (F.) (Hom., Aracopidae). *Annales Zoologici Societas Vanamo* 23: 1–58.

OECD 1996. Consensus document on general information concerning the biosafety of crop plants made virus resistant through coat protein gene-mediated protection. *Series on Harmonization of Regulatory Oversight in Biotechnology* No. 5. Organisation for Economic co-operation and Development, Paris, France. 54 p.

Pehu, T.M., Mäki-Valkama, T.K., Valkonen, J.P.T., Koivu, K.T., Lehto, K.M. & Pehu, E.P. 1995. Potato plants transformed with a potato virus Y P1 gene sequence are resistant to PVY<sup>o</sup>. *American Potato Journal* 72: 523–532.

Peltonen, P. 1988. *Kauran lakjakesoesta vaikutus BYDV-kestävyyteen* (The effects of cultivar mixtures of oat on resistance to BYDV). M.S. Thesis, Department of Plant Pathology, University of Helsinki. 71 p. (In Finnish).

Pietarinen, E. & Seppänen, E. 1981. Start of seed potato production in Finland. *Annales Agriculturae Fenniae* 20: 184–187.

Pohjakallio, O., Karhuvaara, L. & Antila, S. 1961a. The effect of potato rugose on the yield of some potato varieties. *The Journal of the Scientific Agricultural Society in Finland* 33: 89–100.

Salonen, A. & Antila, S. 1961b. Über die Entwicklung von Sommergetreide in Feldversuchen ausgeführt auf den Versuchsgärten der Universität Helsinki, Viik (60°10') und Muddusniemi (69°5'). *Zeitschrift der Landwirtschafts-wissenschaftlichen Gesellschaft in Finnland* 33: 65–80.

Puhakka, T., Koistinen, J. & Smith, P.K. 1986. Doppler radar observation of a sea-breeze front. In: *The 23rd Conference on Radar Meteorology and Conference on Cloud Physics, American Meteorological Society Reprints*. p. 196–201.

Raatikainen, M. 1967. Bionomics, enemies and population dynamics of *Javessella pellucida* (F.) (Hom., Delphacidae). *Annales Agriculturae Fenniae* 6, Supplement 2. 149 p.

Raininko, K. 1964. The pea mosaic virus at the experimental farms, Viikki and Muddusniemi. *The Journal of the Scientific Agricultural Society in Finland* 36: 113–119.

Rainio, A.J. 1941. Untersuchungen über *Cucumis-Virus* 1, Erreger der Kräuselkrankheit auf Gurkenpflanzen. *Publications of the Finnish State Agricultural Research Board* No. 109. 24 p.

Rautapää, J. 1970. Preference of cereal aphids for various cereal varieties and species of *Graminia*, *Juncacea* and *Cyperacea*. *Annales Agriculturae Fenniae* 9: 267–277.

Robinson, D.J. 1996. Environmental risk assessment of releases of transgenic plants containing virus-derived inserts. *Transgenic Research* 5: 359–362.

Roivainen, H. 1947. *Eriophyid News* from Finland. *Acta Entomologica Fennica* No. 3, 51 p.

Scholthof, H.B., Scholthof, K.B.G. & Jackson, A.O. 1996. Plant virus gene vectors for transient expression of foreign proteins in plants. *Annual Review of Phytopathology* 34: 299–323.

Seppänen, E. 1972. The occurrence of virus diseases of potatoes in Finland in 1964–66. *Annales Agriculturae Fenniae* 3: 89–90.
Fenniae 11: 407–416.
Seppänen, P., Puska, R., Honkanen, J., Tuulkina, L.G., Fedorkin, O., Morozov, Yu. & Atabekov, J.G. 1997. Movement protein-derived resistance to triple gene block-containing plant viruses. Journal of General Virology 78: 1241–1246.
Sylkhuus, J.T. 1967. Virus diseases of cereals. Review of Applied Mycology 46: 401–429.
Tapio, E. 1961. Virus diseases of raspberry. Publications of the Finnish State Agricultural Research Board No. 184. 21 p.
– 1963a. Virus diseases on berries. Maatalous ja Koetoiminta 17: 242–251.
– 1963b. Sjukdömar på k瑞santermer. Trädgårdsnätt 17: 80–81.
– 1964. Virus diseases of leguminous plants. Maatalous ja Koetoiminta 18: 202–212.
– 1970. Virus diseases of legumes in Finland and in the Scandinavian countries. Annales Agriculturae Fenniae 9: 1–97.
– 1972a. Virus-free clones on the potato varieties Pito and Tammiston Akainen. Annales Agriculturae Fenniae 11: 115–118.
– 1972b. The appearance of soil-borne viruses in Finnish plant nurseries. The Journal of the Scientific Agricultural Society in Finland 44: 83–92.
– 1985. The appearance of soil-borne viruses in Finnish plant nurseries II. Journal of Agricultural Science in Finland 157: 167–181.
Tapio, M.L. 1980. Perunan Y ja M virussten siirtyminen kirvojen välityksellä sekä PVY:n kulkeutumisnopeus perunassa (Transmission of potato virus Y and M by aphids and the rate of movement of PVY in potato plants). M.S. Thesis, Department of Plant Pathology, University of Helsinki. 56 p. (In Finnish).
Tegel, J. 1987. Suomen taimitarhoissa viileltävien sysleimujen (Phlox paniculata L.) virootisuuksia (Virus infections in Phlox paniculata L. in Finnish plant nurseries). M.S. Thesis, Department of Plant Pathology, University of Helsinki. 45 p. (In Finnish).
Thresh, J.M. 1981. The role of weeds and wild plants in the epidemiology of plant virus diseases. In: Thresh, J.M. (ed.). Pests, pathogens and vegetation. Pitman Books, London, UK. p. 53–70.
Tiilikala, K. 1987. Perunan Y-viroosin torjunta mineraaliöljyllä (Control of potato virus Y using mineral oil). M.S. Thesis, Department of Plant Pathology, University of Helsinki. 22 p. (In Finnish).
Truve, E., Aaspolu, A., Honkanen, J., Puska, R., Mehto, M., Hassi, A., Teeri, T.H., Kelve, M., Seppänen, P. & Saarma, M. 1993. Transgenic potato plants expressing mammalian 2’–5’ oligo(adenylate synthetase are protected from potato virus X infection under field conditions. Bio/Technology 11: 1048–1052.
Yosukainen, M. & Kurppa, A. 1988. Production of healthy planting material. Annales Agriculturae Fenniae 27: 209–218.
Usitalo, A. 1985. Perunan kierrelehtivirus (PLRV) – viruksen leviämisen ja perunan PLRV-infektiotaiteisuus (Transmissibility of potato leaf roll virus, and susceptibility of potato cultivars to infection). M.S. Thesis, Department of Plant Pathology, University of Helsinki. 71 p. (In Finnish).
Valkonen, J. 1993. (ed.). Virus- ja viroidinimistö (Nomenclature of viruses and viroids). Kasvisuojeluseuran Julkaisuja No. 88. 16 p.
Valkonen, J.P.T. & Palohuhta, J.P. 1996. Resistance to potato virus A and potato virus Y in potato cultivars grown in Finland. Agricultural and Food Science in Finland 5: 57–62.
Vappula, N.A. 1962. Suomen viljelykasvien tuhoeläinjisto (Animal pests in crop plants in Finland). Annales Agriculturae Fenniae 1, Supplement 1. 275 p. (In Finnish).
Varis, E. 1970. Variation in the quality of table potato and the factors influencing it in Finland. Acta Agraria Fennica 118: 1–99.
Maatalous- ja puutarhakasveissa havaitut virukset ja niiden merkitys Suomessa

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Intensiivinen kasvivirustutkimus aloitti Suomessa vasta n. 40 vuotta sitten, vaikka virusten tarttumista viljelykasveista on dokumentoitu jonoa jo vuoden 60 vuoden ajalta. Suomen maanviljelyssä tapahtui suurrikkaat virustautioiden pohjana, jotka mukavasti virtaa maanviljelyssä ja heikennä merkittävänä viruksien määrän. Tiedot viruksista ja niiden torjunta- ja hallinnointimenetelmistä ovat hyvin erittäin monimutkaisia ja niiden hallinta edellyttää monen vuoden kestävää tekoälyä. Tässä artikkelissa kerrotaan viruksien ja niiden hallinnon Suomen maanviljelyssä.

Viljely kasvien ja heinien virustautumisen lisäksi onkin myös muita kasvi- ja heinäkasveja, joilla on ollut virustautumisaika. Tässä artikkelissa kerrotaan viruksien ja niiden hallinnon muilla kasveilla, jotka ovat erityisesti yleisiä Suomen maanviljelyssä.

Perunan- ja tomaattivirustautuminen on myös merkittävä aihe Suomen maanviljelyssä. Perunanperunan virustautuminen on tärkeä aihe Suomen maanviljelyssä, ja sen hallinta edellyttää monen vuoden tekoälyä ja monen vuoden kokeilua. Tässä artikkelissa kerrotaan perunanperunan virustautumisen vuorokauden hallinta Suomen maanviljelyssä.

Perunanperunan tuotanto on perustettu Suomen maanviljelyssä jo 1970-luvulla, ja sen hallinta edellyttää monen vuoden tekoälyä ja monen vuoden kokeilua. Tässä artikkelissa kerrotaan perunanperunan tuotantohallinnon Suomen maanviljelyssä.

Perunanperunan virustautuminen on tärkeä aihe Suomen maanviljelyssä, ja sen hallinta edellyttää monen vuoden tekoälyä ja monen vuoden kokeilua. Tässä artikkelissa kerrotaan perunanperunan tuotantohallinnon Suomen maanviljelyssä.

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