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Yellows of glasshouse vegetables, transmitted by Trialeurodes vaporariorum

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Abstract

The infectious yellows disease of glasshouse lettuce, endive and cucumber is further described and now also reported from ornamental pumpkin and the weed *Epilobium* sp. growing in an infested glasshouse, and from chicory witloof grown in the open near that glasshouse. In the Netherlands it was of major importance in cucumber and lettuce from 1978 to 1980, but has rapidly declined since then because of intensive whitefly control and better overall hygiene.

The pathogen could neither be transmitted mechanically nor with aphids and via seed of infected lettuce plants, and no virus particles could be detected neither in crude sap with the electron microscope nor in any other way. However, infectivity could easily be demonstrated in transmission tests with the greenhouse whitefly, *Trialeurodes vaporariorum.* Attempts to transmit the pathogen in *Lapsana communis* with *Aleurodes proletella* failed. The pathogen could also be transmitted by grafting in *Nicotiana glutinosa.*

In addition to the 6 species that were found naturally infected, 15 other species (belonging to 7 families) out of 27 tested were susceptible. All of these but 2 reacted with characteristic symptoms.

The pathogen is similar to if not identical with beet pseudo-yellows 'virus' first described in California and later also reported in France, Italy and Tasmania. It may be of much wider distribution and of considerable yet incompletely assessed economic importance. Its nature remains obscure.

Additional keywords: Aleurodes proletella, whitefly transmission, beet pseudo-yellows virus, wild hosts.

Introduction

In 1978 a new and damaging yellows disease was observed in glasshouse-grown lettuce *(Lactuca sativa),* endive *(Cichorium endivia)* and cucumber *(Cucumis sativus)* (Maaswinkel et al., 1979; Bos et al., 1980; Van Dorst et al., 1980a-e). In lettuce and endive the symptoms were identical with those caused by the aphid-borne beet western yellows virus (BWYV) in outdoor crops (Ashby et al., 1979), which had earlier been reported in Europe on lettuce for Britain (Russell and Duffus, 1970) and France (Lecoq, 1977). The glasshouse disease was also reported to occur in two widely

separated parts of France and to be prevalent there in glass and plastic greenhouses in the Provence (Lot et al., 1980).

Both in France and in the Netherlands the disease could not be transmitted with aphids, but with the greenhouse whitefly, *Trialeurodes vaporariorum* (Lot et al., 1980; Van Dorst et al., 1980a). In the Netherlands a first severe outbreak of this glasshouse pest occurred in 1971 (Woets, 1973). It is now prevalent in glasshouses and has a wide host range (Bink et al., 1980), but is particularly damaging on eggplant, tomato and cucumber.

In France and the Netherlands the pathogen was tentatively identified as the beet pseudo-yellows virus (BPYV) (Lot et al., 1980; Van Dorst et al., 1980a). This virus had been described for its biological properties in California by Duffus (1965, 1975) as a contaminant in his glasshouse experiments on BWYV and from a few wild plants in the open, including *Taraxacum officinale.* It was more recently found in the latter species in scattered locations throughout Hobart, Tasmania (Duffus and Johnstone, 1981). The two types of yellows disease of lettuce caused by BWYV and BPYV, respectively, have also been mentioned to occur in Campania, Italy (Ragozzino and Piccirillo, 1982).

This paper describes the disease in crop species naturally infected in the Netherlands and reports on our further research on the pathogen, particularly its natural and artificial host range, to establish its identity and to better judge its actual and potential importance.

The disease

The disorder has been observed in many glasshouses in and outside the glasshouse district of South Holland. In a few instances up to 75% of the lettuce plants were diseased and the same held for cucumber crops. Infected plants may be scattered throughout the crop and often healthy and severely diseased plants occur side by side. In recent years disease incidence is strikingly declining.

In lettuce the disease has been observed in many cultivars. Characteristic features of the malady in lettuce, starting some three weeks after planting, are interveinal chlorosis, slight downward curling and stiffness or sometimes brittleness of the older leaves. The chlorosis is often restricted to those parts of the leaves that are exposed to the light (Fig. 1). Such symptoms are hard if not impossible to distinguish from those of magnesium deficiency. As a whole affected plants remain smaller, but mostly become unmarketable when several of the outer leaves have to be removed because of yellowing.

Endive plants were infrequently infected. Symptoms in them resemble those of lettuce, but plants are more severely stunted (Fig. 2).

In cucumber the disease occurred in many cultivars. The striking symptom is chlorosis or often somewhat irrugular yellowing (Fig. 3), thus tending towards a *Bemisia*-transmitted golden mosaic or *Abutilon*-like variegation (Bird and Maramorosch, 1978). The yellowing may later proceed up to the youngest leaves, but was never observed on fruits. Affected plants age prematurely and are much less productive.

During 1980 a small plot of chicory witloof *(C. intybus)* grown just outside an in-

Fig. 1. Natural infection of glasshouse lettuce, cv. Ravel.

Fig. 1. Natuurlijke infectie van kassla, cv. Ravel.

Fig. 2. Natural infection of glasshouse endive with severe growth reduction. Right: healthy plant.

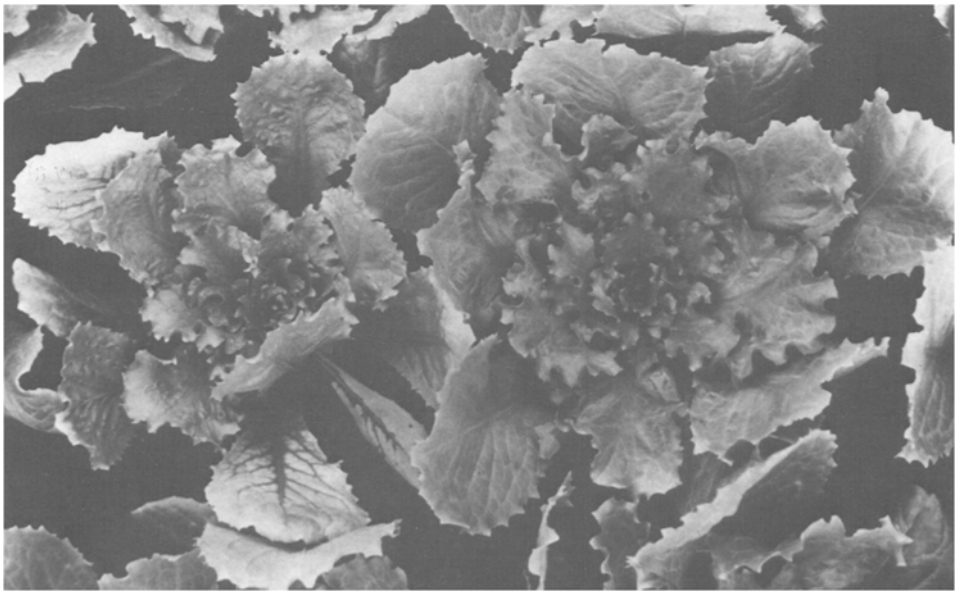

Fig. 2. Natuurlijke infectie van kasandijvie met ernstige groeireductie. Rechts: gezonde plant.

Fig. 3. Systemic irregular chlorosis in cucumber leaf 50 days after plant inoculation with whiteflies.

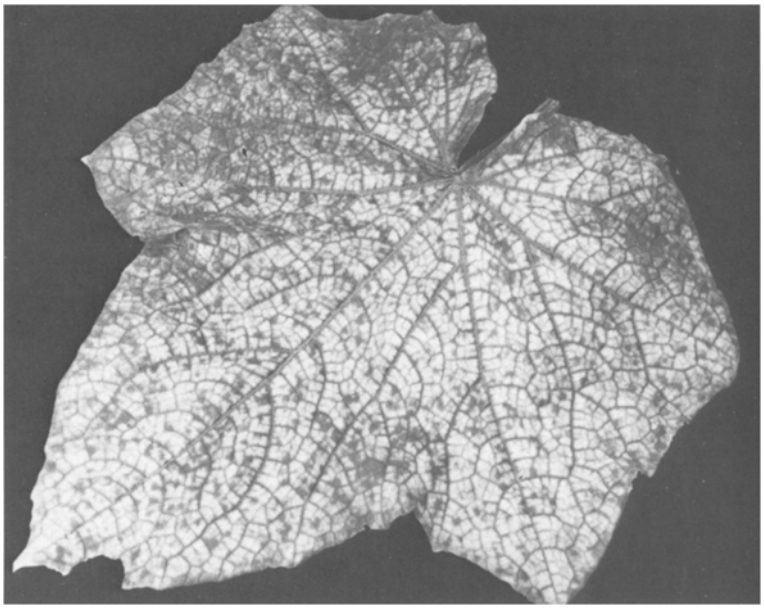

Fig. 3. Systemische onregelmatige chlorose in komkommerblad 50 dagen na inoculatie van de plant met wittevlieg.

fested cucumber glasshouse was found to contain several plants with golden yellow blotches on older leaves and to be infested with greenhouse whiteflies.

Material and methods

Most research was done with isolates of the pathogen from lettuce and cucumber from various sources. The main isolate used for host-range tests was kept for a long time in bolting lettuce plants.

Part of the work (initial transmission experiments and identification attempts) was done at Wageningen. Most of the host-range tests were done at Naaldwijk. Nearly all experiments with lettuce were with cv. Ravel and those with cucumber with cvs Corona and Sporu.

Efforts to transmit virus in sap were in the conventional way by grinding leaf material in water or buffer solution and inoculating test plants, dusted with carborundum (500 mesh), with the forefinger or cottonwool. In a special experiment whole leaves, main veins and roots were used separately as a source of virus to compare material with different proportions of phloem tissue. These materials were ground in a mortar in 0.1 M HEPES buffer (4-(hydroxyethyl) piperazine-1-ethanesulfonic acid) (Jacob, 1976) containing 0.01 M sodium DIECA, 15% sucrose and 11% Na-L-glutaminate 1:5 w/v) as virus stabilizers and with and without charcoal to remove in-

hibitors. Inoculation was onto the lower leaf surface after dusting with carborundum (80 mesh and 120 mesh) and celite, respectively. Inoculations were onto *Nicotiana glutinosa, N. clevelandii* and *Cucumis sativus,* 2, 2 and 6 plants, respectively.

For seed-transmission tests seed was harvested from diseased lettuce plants inoculated when young, and seedlings were examined for symptoms 2 months after sowing.

One graft-transmission experiment was done with *N. glutinosa.* A short sprout of a diseased plant was grafted in a leaf axil onto the stem of a healthy plant or the reverse.

Aphid-transmission tests were done with *Myzus persicae* by feeding them for 2 days on diseased plants, thereafter transferring them to test plants, 10 or more aphids per plant, where they were left for 3 days before they were killed with an aphicide. One experiment was with a great number of unidentified aphids taken from naturally infected plants of lettuce and endive.

Greenhouse whiteflies used for transmission were sampled in disease-free glasshouses and mostly reared in cages on tomato plants. The insects were fed for 1 day and sometimes 2 days on diseased plants, whereafter diseased leaves on which they were feeding were transferred to cages with healthy plants. Lateron whiteflies were transferred individually after having been temporarily immobilized by placing the caged food plants at 4 °C (Yassin and Elnur, 1970). They were left on test plants, 20 per plant, for 1 to 2 days and then removed with an insect exhaustor or killed with permethrin.

In large-scale host-range tests and diagnostic examinations of diseased samples, *N. clevelandii* was mostly used as indicator plant (Fig. 5) because it is easy to grow and reacts reliably and rapidly. Of each possible host species 4 plants were inoculated and 2 to 4 plants served as controls.

For electron microscopy crude-sap preparations were made by chopping plant material directly in 1% phosphotungstic acid, pH 6.5, or 1% ammonium molybdate pH 7.0, or first in distilled water followed by staining on the grid.

Results

Repeated mechanical-transmission experiments, either performed in the normal way or with special additives, were all unsuccessful. Experiments to transmit virus with *M. persicae* from five samples of diseased lettuce and of diseased endive to *Capsella bursa-pastoris, Claytonia perfoliata, Crambe abyssinica,* chicory witloof, endive and lettuce all failed. No seed transmission could be observed in 624 lettuce plants cv. Ravel and 672 plants cv. Renate grown from seed of thoroughly diseased plants inoculated when young. The disease could be readily transmitted in *N. glutinosa* by grafting in 6 out of 9 plants grafted. First symptoms appeared in 17 days.

First transmissions with *T. vaporariorum* were achieved from lettuce and cucumber in December 1979 (Van Dorst et al., 1980a). Characteristic symptoms, identical to those in naturally infected plants, developed on lettuce plants (four different cultivars) in 10 days after inoculation (Fig. 4). Similar symptoms developed in *N. clevelandii* (Fig. 5), also starting as early as 10 days after inoculation, and in endive. In *N. glutinosa* the symptoms were more irregular (Fig. 6) and golden yellow. *C. perfoliata* showed reddening rather than chlorosis. In most plants leaf chlorosis was associated

Fig. 4. Lettuce plant, cv. Ravel, with characteristic blotchy yellowing 10 days after the appearance of the first symptoms after inoculation with greenhouse whiteflies at 14 °C. Right, healthy control plant.

Fig. 4. Kasplant van sla, cv. Ravel, met de karakteristieke vlekkerige vergeling 10 dagen na het verschijnen van de eerste symptomen na inoculatie met kaswittevlieg bij 14 °C. Rechts, gezonde controleplant.

Fig. 5. *Nicotiana clevelandii* with yellows symptoms three weeks after whitefly inoculation. During winter, growth reduction usually is much more severe. Left, healthy control.

Fig. 5. Nicotiana clevelandii met vergelingssymptomen drie weken na wittevlieginoculatie. Tijdens de winter is de groeiremming meestal veel ernstiger. Links, gezonde controle.

Fig. 6. *Nicotiana glutinosa* with yellows symptoms ca 90 days after grafting with *N. glutinosa*. Left, ungrafted control plant normally ageing.

Fig. 6. Nicotiana glutinosa met vergelingssymptomen ongeveer 90 dagen na enting met N. glutinosa. Links, niet geënte controleplant die normaal veroudert.

with slight leaf rolling and thickening and reduction in plant vigour and size. Symptoms never developed in plants of lettuce and of *N. clevelandii* exposed to whiteflies (up to 40 per plant) that had not previously fed upon diseased plants.

No differences were observed in host ranges and symptoms between isolates from different origins, such as from cucumber, lettuce, chicory witloof or endive, on cucumber, lettuce and other species. Hence, most host-range tests were later done with one isolate from lettuce.

The results of host-range tests are summarized in Table 1. Emphasis was on testing important crop species of the glasshouse area as well as a number of weed species. Five cultivated and one wild plant species have been found naturally infected and bearing symptoms. Out of an additional 27 species submitted to infection, 15 species were found to be susceptible. All but two of them (dandelion and celeriac) reacted with symptoms.

In addition to the species found naturally infected, two more cultivated glasshouse crops, viz. melon and the gherkin types of *C. sativus,* have been found to be susceptible although gherkin is less sensitive than cucumber. Two other garden vegetables which may be grown near glasshouses, viz. celeriac and parsley, were also found to be susceptible. A number of other economically important glasshouse vegetables often grown together with or near cucumber and lettuce crops, such as sweet pepper, common bean, eggplant and tomato, and ornamental crops, such as carnation, chrysanthemum, gerbera and rose, turned out to be immune. However, host reaction may depend on cultivar, as in *N. tabacum* with only one out of three cultivars immune and in *Apium graveolens* with celery (var. *dulce)* immune and celeriac (var. *rapaceum)* attaining symptomless infection. From plants of *Gerbera jamesonii,* with chlorosis highly suggestive of infection, no transmission could be achieved, neither could plants of this species become infected after inoculation with whiteflies.

Some weeds of glasshouses or their vicinities appeared to be susceptible to the pathogen, such as dandelion, groundsel, St. Mary's thistle, nipplewort, shepherds purse and sowthistle. One species, *Epilobium* sp., with a striking leaf-reddening has twice been found naturally infected.

Crambe abyssinica was tested several times because of its characteristic reaction to BWYV. However, the species was unacceptable to the whiteflies as a food plant.

Aleurodes proletella, a whitefly species often occurring in the Netherlands on outdoor *Chelidonium majus* (Papaveraceae) and also on *Galinsoga parviflora* and *Lapsana communis* (Compositae) and on cabbage *(Brassica oleracea,* Cruciferae), on which it may be abundant in other countries (Bink et al., 1980), was also tested as a possible vector. Plants of *L. communis,* with clear symptoms some weeks after inoculation with viruliferous greenhouse whitefly and proven to be infected by back-inoculation with this whitefly to *N. clevelandii,* were used as a source of infection for *A. proletella* by feeding 55 whiteflies on each of 4 plants for 2 days. Subsequent inoculation feeding on healthy plants of *L. communis* with 45 insects per plant did not lead to infection as judged by observation for symptoms and back-inoculation with *T. vaporariorum* to *N. clevelandii.* In a second experiment results were identical.

Discussion

The observations on the occurrence and incidence of the disease in lettuce in the

Table 1. Results of host-range studies.

Plant species	Infection**		Susceptibility according to Duffus (1965, 1975)***
	natural	artificial	
Compositae			
Chrysanthemum morifolium (chrysanthemum) 'Morning Sun'		−/−	
Cichorium endivia (endive)	+/+		+
intybus chicory witloof)	+/+		
Gerbera jamesonii 'Appelbloesem'		−/−	
Lactuca sativa (lettuce) 'Ravel'	+/+	+/+	+
**Lapsana communis* (nipplewort)		+/+	
**Senecio vulgaris* (groundsel)		+/+	+
**Silybum marianum* (St. Mary's thistle)		+/+	
**Sonchus oleraceus* (sowthistle)		+/+	+
**Taraxacum officinale* (dandelion)		−/+	+
Cucurbitaceae			
Cucumis melo (melon) 'Ha'on'		+/+	+
sativus (cucumber) 'Corona'	+/+	+/+	+
'Sporu'		+/+	
(gherkin) 'Dura'		+/+	
'Levo'		+/+	
Cucurbita ficifolia		−/−	
pepo (ornamental pumpkin)	+/+		−
(courgette) 'Elite'		−/−	
Solanaceae			
Capsicum annuum (sweet pepper) 'Rumba'		−/−	
'Bruinsma Wonder'		−/−	
Lycopersicon esculentum (tomato) 'Sonatine'		−/−	−
'Moneymaker'		−/−	
Nicotiana clevelandii		+/+	+
glutinosa		+/+	+
megalosiphon		−/−	
rustica		+/+	
tabacum (tobacco) 'Samsun'		−/−	+
'White Burley'		+/+	
'Xanthi'		+/+	
Solanum melongena (eggplant, aubergine) 'Adona'		−/−	
'Radja'		−/−	
Umbelliferae			
Apium graveolens var. *dulce* (celery) 'Amsterdamse Fijne Donkergroene'		−/−	
var. *rapaceum* (celeriac) 'Albatros'		−/+	
Petroselinum crispum (parsley) 'Gewone Snij'		+/+	
'Gekrulde'		+/+	
Various species			
Beta vulgaris (beet) 'Corona'		−/−	+
**Capsella bursa-pastoris* (shepherd's purse)		+/+	+
Chenopodium amaranticolor		+/+	+
**Claytonia perfoliata* (winter purslane)		+	+
Dianthus caryophyllus (carnation) 'Scania'		−/−	
'Silvery Pink'		−/−	
**Epilobium* sp.	+/+		
Phaseolus vulgaris (common bean) 'Rolando'		−/−	−
Rosa hybr. (rose) 'Motrea'		−/−	

* Wild species.
** Results of visual observation for symptoms over results of back-inoculation with whiteflies.
*** No cultivar names mentioned.

Tabel 1. Resultaten van waardplantonderzoek.

Netherlands (Van Dorst et al., 1980a; and present report) appear to be identical to those in France (Lot et al., 1980). Our experiments with whiteflies not previously fed upon diseased plants have shown that the disease does not result from insect toxemia. Infectivity of the disease and natural spread by the greenhouse whitefly are now beyond doubt.

Our results of whitefly-transmission tests and host-range studies (Table 1) closely agree with those of Duffus (1965, 1975) for BPYV, the only discrepancy being a difference in reaction of beet and ornamental pumpkin. Such a difference, however, may well be due to a difference in cultivars used since cultivars, as of tobacco, may differ considerably in their reaction to the pathogen. Hence, the incitant of the European whitefly-transmitted disease is similar to if not identical with BPYV in California. Studies on the pathogen – vector relationships by Duffus (1965, 1975) point to a persistent or semi-persistent manner of transmission (acquisition and inoculation in 1-h feeding periods, latency less than 6 h, if any, and persistence not exceeding 6 days).

These results explain the negative outcome of efforts at Naaldwijk (Dr J.P.N.L. Roorda van Eysinga, personal communication, 1980) to demonstrate magnesium deficiency by soil and plant analysis and to achieve plant recovery by magnesium dressings. They also explain our unsuccessful aphid-transmission tests as well as the negative results of attempts (Dr H. Huttinga, personal communication, 1980) to isolate a virus from thoroughly diseased whitefly-inoculated plants of cucumber and *N. clevelandii* with techniques successful for the aphid-borne luteoviruses BWYV (Ashby et al., 1979) and pea leafroll virus (Ashby and Huttinga, 1979). Lack of seed transmission as observed in our tests is characteristic of a phloem-limited pathogen (virus) which is not mechanically transmissible.

Endeavours so far to visualize a virus, either in crude plant sap (our own experiments) or after tentative ultrathin sectioning (Miss E. van Balen, personal communication, 1980) have also failed. These results agree with those obtained in France with the virus from lettuce (Lot et al., 1980). The virus nature of the disease incitant therefore remains uncertain.

Results obtained in the Netherlands with isolates from different crops, mainly lettuce and cucumber, are identical. Thus in this country the whitefly-transmitted yellows diseases of different crops are obviously caused by one and the same pathogen, probably identical to BPYV described in California and to that reported in lettuce in France (Lot et al., 1980). However, it seems to be different from the virus causing cucumber yellows in Japan (Yamashita et al., 1979) and a similar virus causing a severe yellows disease of glasshouse-grown muskmelon in the Provence (France) (Lot et al., 1983). Both diseases are also transmitted by the greenhouse whitefly, but were reported to be limited to Cucurbitaceae and to have flexuous particles of 1000 nm length, observed in crude sap and ultrathin sections of phloem cells. With these diseases first characteristic symptoms are pinpoint chlorotic spots on young leaves instead of interveinal chlorosis on lower leaves as with BPYV.

The diseases and their incitants mentioned so far differ from cucumber yellow vein and its virus which is easily transmitted in sap (Cohen and Nitzany, 1960), by the tobacco whitefly, *Bemisia tabaci,* in the semi-persistent manner (Harpaz and Cohen, 1965), its rod-like shape (740-800 × 15-18 nm) and being composed of dsDNA and a single protein component (Sela et al., 1980). This virus has some features in common

with pumpkin yellow vein mosaic virus of field pumpkin, vegetable marrow and squashes in India, which is also transmitted by *B. tabaci* in the semi-persistent manner to several Cucurbitaceae, but also to some other species and not in sap (Varma, 1955; Capoor and Ahmad, 1975).

The picture is still far from complete. Severe epidemics of virus and virus-like diseases transmitted by *B. tabaci* have recently been reported in the desert production areas of California and Arizona during 1981 and 1982 (Duffus and Flock, 1982). Three major agents were involved, each causing a typical disease. Lettuce infectious yellows from lettuce and sugarbeet was reported to be associated with 1000-2000 nm long rod-shaped particles. The other two are typical *Bemisia*-borne leafcurl viruses as of cotton leaf crumple (Dickson et al., 1954; Erwin and Meyer, 1961) and squash leafcurl, the latter being restricted to Cucurbitaceae (Flock and Mayhew, 1981).

The whitefly-transmitted yellows diseases seem to be of great potential and actual economic importance. They may already be widespread but still be overlooked in many places or mistaken for poor growth due to other causes including mineral deficiency. The symptoms of whitefly-transmitted yellows diseases resemble those caused by persistent aphid-transmitted luteoviruses and several semi-persistent closteroviruses which are all totally or mainly bound to phloem tissue. There they primarily cause phloem degeneration including necrosis. This, in turn, leads to transport disturbances, starch accumulation in leaves, poor root development, poor nutrient uptake and more or less progressive debilitation of plants. These diseases are therefore hard to diagnose symptomatologically.

The whitefly-transmitted yellows diseases seem to have come to the fore more recently with recent introduction of the vectors in new areas, as of *T. vaporariorum* in Japan (Yamashita et al., 1979), or with the increase in whitefly population densities by changes in hygiene or crop cultivation, as of *B. tabaci* in California and Arizona (Duffus and Flock, 1982).

Yellows of glasshouse vegetables is able to affect several plant species, which may each contribute to the infection pressure in the infested area. It may easily be spread from one glasshouse or area to another in vegetative plant propagation material because of its wide host range and sometimes symptomless infection. Although mainly a pathogen of protected crops, it may also temporarily occur in or originate from crops grown in the open (as in chicory witloof near an infested glasshouse in the Netherlands) or from wild plants, as rarely in dandelion and *Conium maculatum* in California (Duffus, 1965, 1975), or widespread in dandelion in Hobart, Tasmania (Duffus and Johnstone, 1981).

Control could be by choosing resistant cultivars or by breeding for resistance, but information on resistance among cultivars of lettuce and cucumber is till lacking. Hygiene measures to reduce whitefly populations should have high priority. Mature crops should be timely removed and escape of whiteflies from them be prevented. Such measures of better crop hygiene and intensive whitefly control resulting from our reports to growers (Maaswinkel et al., 1979; Van Dorst et al., 1980b, c, d, e) and to officials (Bos et al., 1980; Bos, 1980) may well have led to the drastic decline in disease incidence in Dutch lettuce and cucumber crops during 1981 and 1982.

Acknowledgments

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Samenvatting

Vergeling van kasgroenten, overgebracht door Trialeurodes vaporariorum

De vergelingsziekte van in kassen geteelde sla, andijvie en komkommer wordt verder beschreven en nu ook gerapporteerd van sierkalebas geteeld in, en van witlof geteeld naast een kas met aangetaste gewassen. Ook werd de ziekteverwekker aangetoond in roodbladige planten van een *Epilobium*-soort groeiende in een kas waarin de ziekte voorkwam. In Nederland is het een (potentieel) schadelijke ziekte in komkommer en sla, maar de mate van voorkomen neemt al weer sterk af door intensievere wittevliegbestrijding en betere algehele hygiëne.

De ziekte is vooral gekenmerkt door tussennervige vergelingsverschijnselen, die aan een gebreksziekte doen denken en meestal in de oudere bladeren van aangetaste planten voorkomen en door een lichte bladkrulling, vooral bij komkommer, en stugheid van het blad. De planten blijven kleiner (vooral bij andijvie) en zijn niet verkoopbaar door verlies van te veel buitenblad (zoals bij sla) of produceren veel minder vruchten (zoals bij komkommer). De symptomen in kassla zijn niet te onderscheiden van die van het door bladluizen in vollegrondssla verspreide slavergelingsvirus ('beet western yellows virus') en van magnesiumgebrek.

De verwekker van de onderhavige vergelingsziekte kon niet met sap, noch met bladluizen of via zaad van zieke sla worden overgebracht. Besmettelijkheid van de ziekte kon echter gemakkelijk worden aangetoond in overbrengingsproeven met de kaswittevlieg, *Trialeurodes vaporariorum*. In sla en *Nicotiana clevelandii* kunnen de eerste symptomen reeds 10 dagen na inoculatie worden waargenomen. In *N. glutinosa* kon de ziekteverwekker worden overgebracht door enting. De afwijking kon niet worden gekarakteriseerd als een insektentoxemie.

Met genoemde vector werden 27 soorten kasgewassen en onkruiden getoetst op vatbaarheid. Behalve de 5 reeds genoemde natuurlijk geïnfecteerde gewassoorten en één onkruidsoort bleken 15 andere soorten, behorend tot 7 families, vatbaar. Alle behalve knolselderij en paardebloem reageerden met karakteristieke symptomen. *N. clevelandii* werd meestal gebruikt als indicatorplant voor het opsporen van infectie door terugtoetsing met wittevlieg. In *N. glutinosa* ontstond een grove goudgele bontheid. Het lukte niet om bij *Lapsana communis* de ziekte over te brengen met de koolwittevlieg *Aleurodes proletella*.

In ruw sap en in ultradunne coupes van zieke planten konden geen virusdeeltjes worden waargenomen, noch konden deze worden afgezonderd uit sap van zieke planten met methoden die succesvol waren voor door bladluizen overgebrachte vergelingsvirussen. De virusaard der verwekker is dan ook nog niet bewezen.

De ziekteverwekker lijkt sterk op, of is identiek aan het reeds in 1965 in Californië uit kasplanten en van enkele buiten groeiende onkruiden beschreven 'beet pseudo-yellows virus'. Het werd daarom in 1980 door ons het pseudo-slavergelingsvirus

genoemd. Hoogstwaarschijnlijk dezelfde verwekker werd in 1980 ook in Frankrijk gerapporteerd in kassla, in 1982 in Italië in sla en in 1981 in Hobart, Tasmanië, in buiten voorkomende paardebloem. De komkommervergelingsziekte in Japan en de meloenevergelingsziekte in Frankrijk, beide eveneens door de kaswittevlieg overgebracht, lijken te worden veroorzaakt door een ander, draadvormig virus dat in zijn aantastingsvermogen beperkt is tot cucurbitaceeën. In Californië en Arizona brak onlangs een ernstige epidemie uit in sla en suikerbiet van een waarschijnlijk weer andere infectieuze slavergeling die wordt verspreid door *Bemisia tabaci.*

Al deze vergelingsziekten kunnen gemakkelijk over het hoofd worden gezien of worden aangezien voor een gebreksziekte of zuiver fysiologische afwijking. Ze komen waarschijnlijk veel meer voor dan wordt vermoed.

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