ABSTRACTS OF PAPERS PRESENTED AT THE 8TH CONGRESS OF THE PHYTOPATHOLOGICAL SOCIETY OF ISRAEL

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A: NEW DISEASES IN ISRAEL AND PROPAGATION MATERIAL AS A SOURCE OF DISEASE SPREAD

PHYTOPHTHORA CINNAMOMI RANDS

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Phytophthora cinnamomi is one of the most widespread and destructive plant pathogens, with nearly 1000 hosts. With the discovery of this fungus in Israel, *P. cinnamomi* now constitutes a major problem in all of the major avocado-producing areas of the world. The A2 mating type is the common type worldwide, with the A1 type very limited in hosts and in geographical distribution. The origin of *P. cinnamomi* is still a matter of speculation.

Information was presented on many aspects of our research in California on this pathogen, including origin of the fungus, isolation, variability, effect of environmental factors on growth and pathogenesis, sporulation, and various aspects of control, especially use of fungicides and resistant rootstocks. Principal systemic organic fungicides under extensive investigation are fosetyl Al (Aliette), metalaxyl (Ridomil) and etridiazole (Terrazole). These fungicides are primarily applied to the soil, in various formulations and by various methods, although foliar applications of fosetyl Al are used as well for control of *Phytophthora* root rot. An extensive program of collecting and testing for resistant rootstocks has been underway in California for over 30 years, resulting in several compatible rootstocks (*Persea americana* and other species of *Persea*) with appreciable resistance to *P. cinnamomi,* including Duke 6, Duke 7, Huntalas, G6 and G755. *(L)*

AVOCADO ROOT ROT IN ISRAEL

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Avocado root rot was discovered recently for the first time in Israel in an 8-year-old avocado grove in the Sharon area. An additional seven infected groves were detected later, all in the same vicinity. All soils in the infected groves were calcium-free soils with drainage problems. The patho-

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L = lecture sessions; *P* = poster (market place) sessions.

gen *Phytophthora cinnamomi* was isolated from feeder roots of diseased trees and identified as the A2 mating type. A nationwide nursery survey, based on a random-sampling system, revealed seven contaminated nurseries, that disseminated the pathogen with the planting material to new sites. Two distinct morphological types of the pathogen were identified: one common to the infected nurseries only, and the other restricted to the groves. The nursery type isolates produce smaller and fewer hyphal swellings and chlamydospores and release zoospores in water without precooling treatment. In artificial inoculation tests, distinct differences in virulence were found among the various isolates. The nursery isolates were always much less virulent than the grove ones. Due to the appearance of the disease in Israel, the avocado industry in the country entered a new era. Control measures must be taken to prevent introduction of the pathogen into new groves, and preventive measures must be practiced in the nurseries and packing houses. *(L)*

ON NEW DISEASES AND "NEW" DISEASES OF PLANTS IN ISRAEL

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When damaging diseases of cultivated crops are first noticed, they are often automatically and erroneously considered to be new to the country. Although some causal agents might indeed be recent introductions, which found conditions and a crop host favorable for their development, many others have been "hiding" unnoticed on wild plants or cultivated crops. Due to edaphic or agrotechnical changes which stimulate outbreaks on current crops, or to new susceptible crop hosts, they come to our attention.

During the past year, we found (i) eight pathogenic fungi or bacteria hitherto unknown in Israel, and (ii) new hosts for pathogens already recorded here. Some are threats to crops; all or almost all are not likely to have been introduced recently: (i) *Basidiophora entospora* (downy mildew) on *Erigeron canadensis* at four locations, at only one of which cultivated *Callistephus* (China aster) was also stricken. *Helicobasidium purpureum* (teleomorph only), as a saprophyte on dead twigs of forest trees at two locations; it is an important pathogen of numerous plants overseas ("Violet root rot" – *Rhizoctonia crocorum*). *Peronospora* sp. on *Papaver brachyatum* (introduced experimental medicinal crop). Four diseases on wild legumes on uncultivated land (8 x 8 m), Rehovot: *Peronospora* spp. on *Ornithopus* and *Ononis; Leptotrochila medicaginis* (=*Pseudopeziza jonesii*), causing yellow leaf blotch of alfalfa, on *Medicago; Pseudopeziza trifolii* on *Trifolium berytheum,* found again elsewhere on the same species of clover; *Pseudomonas syringae* f. *pisi,* causing bacterial blight on cultivated peas at two locations, on two pea varieties.

(ii) On cultivated *Coriandrum: Oidiopsis taurica.* On cultivated introduced *Hedysarum (H. coronarium): Oidium* sp. On cultivated *Glycyrrhiza glabra* (licorice): *Uromyces glycyrrhizae.* Five disease organisms on *Brassica napus* (introduced experimental crop of rape): *Albugo candida, Peronospora parasitica, Alternaria brassicae, Xanthomonas campestris, Oidium* sp.

As it took no effort to find these diseases, there must be many more extant here. This points to the need for constant awareness to the danger that such pathogen reservoirs exist, and hence for systematic, rather than haphazard, searches to bring them to light. *(L)*

NEW BACTERIAL DISEASES IN ISRAEL

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Several bacterial diseases were recently detected for the first time in Israel. Some of them were introduced into the country through stem cuttings, tubers and seeds.

Blackleg disease of potato

Strains of *Erwinia chrysanthemi* were recently isolated from rotting potato stems and tubers. The pathogen was detected in the imported potato cultivars 'Spunta' and 'Désirée'. *E. chrysanthemi* was only recently recognized as a pathogen of potato and may be potentially more destructive than *Erwinia carotovora* subsp. *carotovora* and subsp. *atroseptica,* because *E. chrysanthemi* strains tolerate high soil temperature and are able to survive in soil for a long period under semi-arid conditions.

Pith necrosis of tomato

Tomato pith necrosis was detected in greenhouses and fields for the first time in Israel in 1981. The symptoms of infection were pith necrosis, stem lesions and stem collapse and in some instances severe losses occurred. The disease was found on several imported hybrid tomato cultivars and spread to local hybrid cultivars. Based on physiological and biochemical pathogenicity tests, the pathogen was identified as *Pseudomonas corrugata.* It was consistently isolated from various parts of the plant, including stem, petiole and fruit pedicle; it was also isolated from several seed lots of hybrid cultivars. This is the first indication that *Ps. corrugata* is seedborne.

Cavity spots of carrots

Cavity spots are causing considerable damage to carrots in Israel. Evidence indicates that pectolytic bacteria of the anaerobic genus *Clostridium* are consistently involved in incidences of the disease.

Stalk and leaf necrosis of onion

A new foliage disease of onion, particularly in the onion seed production area, was detected for the first time in Israel. The disease is characterized by rapid necrosis of seed, stalk and leaves; a bacterial pathogen was consistently isolated from infected stalk and leaves and was identified as a strain of *Erwinia herbicola.*

Bacterial blight of pelargonium

Bacterial blight and leaf spot disease of pelargonium was detected in a few propagation nurseries. The disease caused severe losses. From the infected plants and cuttings a bacterial pathogen was isolated and identified as *Xanthomonas pelargoni.* There is evidence that the pathogen was introduced into the country in stem cuttings derived from meristem cultures. *(L)*

ESTABLISHMENT OF THE CROWN AND ROOT ROT PATHOGEN OF TOMATO IN THE NEGEV REGION

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Crown and root rot of tomatoes, caused by *Fusarium oxysporum* f. sp. *radicis-lycopersici,* was first found in Israel in early 1981. The disease was first recorded in tomatoes growing in

unheated glasshouses. In 1982 and 1983 it was found also in outdoor plantings, in the Arava region of Israel. The damage in 1983 was widespread and severe, perhaps due to the lower than average winter temperatures.

Examination of commercial seed lots of imported seed showed that the organism was present in seed of two of the cultivars used in our greenhouses. The pathogen was recovered from seed 4 and 5 years old. We believe that the organism was introduced into this country in this manner and established itself in the Negev region.

Means to control the pathogen under glasshouse conditions include fumigation with methyl bromide at a rate of 75 g/m^2. Methyl bromide fumigation at this rate has not been successful in the outdoor plantings. Only a 60-cm-wide strip is fumigated, the remaining portion of the bed not being treated; thus, rapid re-infestation from the untreated area may be the cause of the poor results obtained.

Our isolates seem to be identical, with regard to pathogenicity, to those reported from other countries. This, and the seedborne nature of dissemination, suggests that a common source may have been the cause for the rapid and far-reaching spread of the pathogen. *(L)*

PENETRATION OF *MACROPHOMINA PHASEOLINA* INTO MELON FRUIT AND THE ROLE OF SEEDBORNE INOCULUM IN SOIL INFESTATION

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The fungus *Macrophomina phaseolina* causes a "charcoal rot" in many plant species. In the northern Negev of Israel it has been found to be the major pathogenic agent in collapse of mature melon plants. The finding of the disease in virgin soils and other field observations suggested that the pathogen was seedborne.

Artificial inoculations of melon fruit, conducted under controlled conditions, induced symptoms as observed under field conditions, eventually leading to colonization of the fruit by the fungus and formation of microsclerotia. Field observations also showed that in many cases the first symptoms of the disease on the fruit appeared at the area of the peduncle and progressed inward. Isolation studies showed that seed from such fruit bore the pathogen externally and internally.

Infested seed was sown in pots and kept in a greenhouse (winter) and a screenhouse (summer). Isolations from roots grown from such seeds yielded 80-90% recovery. Repeated sowings in soil, where the above plants are grown, lead to low emergence and a high percentage (up to 98%) of collapse of the plants. The latter was especially evident in summer sowings. Our studies show a new avenue of fruit infection and the importance of seed as a primary source of inoculum. *(L)*

SEEDBORNE *ALTERNARIA MACROSPORA*: TRANSMISSION AND PENETRATION INTO *GOSSYPIUM BARBADENSE* (CV. PIMA) COTTON SEEDS

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The fungus *Alternaria macrospora* Zimm., which causes leaf and boll spot in cotton, was detected for the first time in 1981 in locally grown commercial seed lots of *Gossypium barbadense* (cv. 'Pima'). The fungus was not found, however, in seed lots of *G. hirsutum* (cv. 'Acala').

The pathogenicity of the isolated fungus was determined by inoculation tests on the cotyledons of the cotton seedlings. The fungus seed – plant transmission was demonstrated in growing-on tests, under controlled conditions. The location of the fungus in the seed and its way of penetration into the seed tissues were studied. It was found that most of the bolls spotted by *A. macrospora* also carried infected seeds. The infection rate of fuzzy, mechanically delinted seeds ranged between 14% and 70% in different boll samples. In the major part of these seeds the fungus was located on the seed surface only; chemical delinting decreased the infection rate considerably. In the delinted seeds the fungus was observed mainly in the chalazal end of the seed. The location of the fungus in the different parts of the seed was determined by planting the different components. The fungus was isolated from the seed coat, chalazal cup and embryo tissue.

In conclusion, it seems that the fungus penetrates from the infected boll to the seed surface. Under certain conditions, in the chalazal end of the seed, the fungus succeeds in reaching the embryo tissue *via* the seed coat and chalazal cup. Our findings indicate that infected seeds can become a source for spreading *A. macrospora* in cotton fields. *(L)*

TRANSMISSION OF *VERTICILLIUM DAHLIAE* IN POTATO TUBERS

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Verticillium wilt of potatoes caused by *V. dahliae* is borne in the tubers. Under local conditions infection occurs in the spring crop, a portion of whose yield is used in the autumn sowing.

Damage is expressed in yield loss and field infestation. In order to reduce the spread of the fungus by tuber-borne inoculum, fields with 5% plant infection were not certified for seed. With susceptible cultivars such as 'Up-to-Date', this practice proved to be efficient, but with the introduction of tolerant cultivars difficulties were encountered in certifying fields based on visual symptom expression.

A 4-year research program was carried out to study the relation between haulm symptoms and tuber infection, and the role of seedborne inoculum in infection of the haulm and daughter tubers. The following conclusions were reached on the basis of our results: *(a)* A test which included 73 cultivars grown in infested soil demonstrated that there was no correlation between symptom expression on the foliage and daughter tuber infection. *(b)* There are large variations in daughter tuber infection from year to year. *(c)* Examination of several cultivars in commercial fields showed that there was no correlation between foliar symptoms and daughter tuber infection. However, there was a positive correlation between infected seed tubers – as shown by isolation of the pathogen or serological means – and infection of the haulms. The results suggest that certification be based on tuber infection. *(L)*

B: CHEMICAL AND INTEGRATED CONTROL OF PLANT PATHOGENS

ALTERNATIVE FUNGICIDES FOR THE CONTROL OF POWDERY MILDEW IN CUCUMBERS

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Failure in the control of powdery mildew *(Sphaerotheca fuliginea)* in cucumbers in the Nazareth area was observed during the 1981 season. There was a suspicion that the fungus had become resistant to the conventional fungicides. The following trials were performed in the spring of 1982:

Trial No. 1: The treatments, applied once a week, were: Afugan (pyrazophos) 30% E.C., 500 ml/ha; Rubigan (fenarimol) 12% E.C., 300 ml/ha alternating with Afugan, 500 ml/ha; and control. The alternating treatment gave the best control.

Trial No. 2: The treatments were: Tilt, 1-[2-(2,4-dichlorophenyl)-4-propyl-1,3-dioxolan-2-ylmethyl]-1H-1,2,4-triazole, 25% E.C., 250 g/ha; Rubigan + Plondrel (ditalimfos) 50% E.C., 300+600 g/ha; Tilt, 0.02% and 0.03%; and control. Best disease control was achieved with Tilt, but some stunting and deformation of the plants was observed.

Trial No. 3: The treatments were: Baytan (triadimenol) 15% E.C., 250 g/ha; Baytan, 25% W.P., 250 g/ha; Bayleton (triadimefon) 25% W.P., 250 g/ha; Plondrel, 700 g/ha alternating with Rubigan 300 ml/ha; and control. The alternating treatment was the most effective. Bayleton was not effective in this trial; and Baytan E.C. was more effective than Baytan W.P.

Trial No. 4: The treatments were: Baytan E.C., 250 g/ha; Calixin (tridemorph) 75% E.C., 400 g/ha; Denmart (Marit; buthiobate) 10% E.C., 1000 ml/ha; Fungaflor (imazalil) 20% E.C., 500 ml/ha alternating with Rubigan, 300 ml/ha; and control. The most effective treatment was Calixin, and the alternating treatment also gave effective control. *(L)*

CROP LOSS AND PARTIAL CHEMICAL CONTROL OF BACTERIAL SCAB OF PEPPER CAUSED BY *XANTHOMONAS CAMPESTRIS* PV. *VESICATORIA*

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Bacterial scab of pepper appears in the field with typical symptoms but also causes damage in symptomless plants with an endophytic population of 10^6 bacteria/g tissue inside the plant. Damage of commercial significance could be caused by: (i) visible symptoms on the fruits, preventing marketing; (ii) decrease in the number of fruits on the plants. In severely diseased crops, losses of 44% were detected. In inoculated fields with symptomless plants, yield was decreased by 24%; (iii) direct damage resulted from massive defoliation causing fruit exposure to the sun; in this case all fruits were severely damaged. Maximum yield damage was recorded when the pathogen attacked young seedlings (4-6 leaves). The crop loss was less severe (6%) when infection occurred in mature pepper plants.

Pepper plants artificially infested with *Xanthomonas campestris* pv. *vesicatoria* were sprayed with various compounds: Kocide 101 [77% $Cu(OH)_2$, Kocide Chem. Corp., Houston, Texas]; Coprox 50 [87% $3Cu(OH)_2 . CuCl_2$, Makhteshim, Be'er Sheva]; $CuSO_4$ + Biofilm surfactant (Chemitivon, Tivon); Bordeaux mixture; Captan 50% W.P. (Makhteshim); Manebgan (maneb 50% W.P., Agan Ltd., Ashdod); and Manzidan (mancozeb 80% W.P., Makhteshim). The compounds tested reduced the rate of disease development only slightly. Kocide was found to be the most effective compound. An increased Kocide dose (up to 0.6%) enhanced disease control but was phytotoxic to young plants. The most efficient control of bacterial scab was obtained by spraying 0.5% Kocide immediately prior to or after infestation and close to irrigation periods. *(L)*

CONTROL OF DELIMITED SHELL SPOTS OF PEANUT PODS BY INTEGRATED SOIL TREATMENTS, AND BREEDING FOR RESISTANCE

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Shell spots of peanut pods with a distinct demarcation line are caused in heavy soils, under partially anaerobic conditions, by an as yet undetermined complex of biotic factors.

Treatments in one field trial were solarization in mid-summer and metham fungigation the following spring, followed by seeding of two peanut cultivars of different susceptibility. In another field trial solarization was employed, *inter alia,* on metham-treated soil in mid-summer and a susceptible peanut cultivar was seeded the next spring to test the effect of the treatments on disease level.

In the first trial, incidence of spot-affected cv. 'Shulamit' pods was reduced from 63% in the controls to 42% in the metham-treated plots and to 22% following solarization; solarization in summer plus fungigation in the following spring was no better than solarization alone. In the experimental cv. 'AZ-1', incidence of spotted pods was only 10% in the controls and 5% in all treatments.

In the second trial an obvious and significant synergism was achieved by metham fungigation and immediate solarization. Incidence of spotted pods was 91% in (water-irrigated) controls, 79% in the best metham treatment, 53% following solarization (on plots irrigated with water), and 20-30% in the combined treatment of solarization on fungigated soil. In the combined treatment no significant difference was found between prewetting the soil with either 400 or 900 l/ha of metham (37.2% a.i.) applied to a soil depth of 40 cm. *(L)*

THE BUILDUP OF FUNGAL SUBPOPULATIONS RESISTANT TO A SYSTEMIC FUNGICIDE UNDER VARIOUS FUNGICIDAL CONTROL STRATEGIES: A THEORETICAL MODEL

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The buildup of fungal subpopulations resistant to systemic fungicides is a well known problem in disease control. It has been suggested that the use of a systemic fungicide in a mixture with a second fungicide which has a different mode of action (usually a protectant), would delay the buildup of such resistant subpopulations. However, limited experimental data, if any, are available to support this suggestion. A mathematical model based on the logistic equation of growth was developed to assess the effect of various fungicidal control strategies, on the buildup of subpopulations resistant to systemic fungicides. The model is composed of a set of differential equations describing the growth of the two subpopulations (susceptible and resistant) and is based on the following assumptions:

1. The systemic fungicide is not mutagenic. A resistant subpopulation exists in nature.
2. There is no influx of inoculum from other fields.
3. The apparent infection rates (*sensu* Vanderplank) of the two subpopulations are equal in the absence of fungicides.
4. The efficacy of the protectant fungicide is equal against both the susceptible and the resistant subpopulation.

Simulation of the model shows that the rate of buildup of a resistant subpopulation following the use of fungicide mixtures (systemic *cum* protectant) or alternating treatments is de-

pendent on the completeness of fungicide coverage, the rate of fungicide decay, the degree of additive action between the two fungicides in a mixture, and the apparent infection rate.

Results show that overdominance (50%) of the resistant subpopulation may occur within 15 sprays of the systemic fungicide alone. *(L)*

RATIONALIZATION OF THE USE OF SYSTEMIC FUNGICIDES IN CONTROLLING FUNGAL PLANT DISEASES

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The buildup of fungal subpopulations resistant to systemic fungicides is a well known problem in disease control. Using a mathematical model based essentially on the Lotka Voltera equations of population growth, a series of control strategies were tested in order to find optimal ones with which both disease control and suppression of the resistant subpopulation will be maximal.

Epidemics were simulated at various apparent infection rates, and fungicidal treatments were simulated at various compositions of fungicidal mixtures (systemic and protectant) or at alternative treatments of fungicide mixtures and a protectant fungicide alone. Results showed that the higher the efficacy of the control by the systemic fungicide, the higher the rate of buildup of the resistant subpopulation. At apparent infection rates (*sensu* Vanderplank) lower than 0.1 and an additive effect between the two fungicides comprising the mixture higher than 0.6, the optimal control strategy is a *prophylactic* treatment with fungicide mixtures (the two at full strength) and a *responsive* treatment with a protectant fungicide alone. At apparent infection rates higher than 0.1 and an additive effect between the two fungicides comprising the mixture lower than 0.6, the optimal control strategy is a *prophylactic* treatment with a protectant fungicide and a *responsive* treatment with fungicide mixtures. Our results indicate that experimental data have to be collected as to the additive effect of fungicides in a mixture before theoretical considerations can be implemented. *(L)*

BUTHIOBATE, A FUNGICIDE FOR THE CONTROL OF POWDERY MILDEW

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Buthiobate (as Marit 10% EC) is a non-systemic fungicide developed in Japan, for the control of powdery mildew. It was tested in Israel in 1982 on various crops.

On cucumbers in greenhouses, an application rate of 1.0 liter formulated product/ha effectively controlled initial powdery mildew spots and prevented further infection. Four to six weekly sprays were applied at a volume of 500-1000 l/ha. In the open field, weekly sprays at an application rate of 1.5 liter formulated product/ha effectively controlled the disease.

In a trial to control powdery mildew in grapes cv. 'Sultanina', buthiobate was sprayed at concentrations of 0.1% and 0.15% formulated product using a volume of 1000 l/ha. Four biweekly sprays at either concentration gave satisfactory control.

In a greenhouse trial with roses cv. 'Baccara', three sprays were applied every 9 days at a volume of 2000 l/ha. Buthiobate at a concentration of 0.1% or 0.15% effectively controlled the powdery mildew.

The product was tested on various other crops with satisfactory results. In summary, buthiobate is suitable for the control of powdery mildew under the growing conditions in Israel, both in greenhouses and in the open field. The spray frequency depends on the disease and the host. *(L)*

TRIDEMORPH FOR CONTROL OF POWDERY MILDEW IN CUCURBITS

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Calixin, a systemic fungicide developed by BASF (Ludwigshafen, W. Germany), has been found to be very effective in the prevention and treatment of powdery mildew in cucurbits. Tridemorph (N-tridecyl-2,6-dimethyl-morpholine), the active ingredient of this fungicide, is absorbed by the leaf and translocated upward in the xylem tissue. In this way the fungicide is distributed in the parts of the plant above the point at which it is taken up. Calixin is translocated in the phloem to a slight extent only.

As a result of being taken up by the plant, Calixin is affected only slightly by weather conditions and therefore remains active longer than conventional contact fungicides. It has a protective and curative action; successful fungus control is therefore possible even when mild infection has already occurred.

Field trials performed with the 75% EC formulation indicated that an application of 400 ml/ha, every 7-10 days, was the most favorable one for controlling powdery mildew caused by *Sphaerotheca fuliginea* in squash, and cucumber cvs. 'Delila' and 'Shimshon'. Trials were limited to open areas, as application of the product causes adverse effects on treated crops in greenhouses.

In three field trials performed with cucumbers and squash, Calixin was compared with fenarimol (Rubigan) (300 ml/ha), which was a standard treatment, and with control plots. In the first trials, in cucumbers, it gave yield increases of 40% above the control plot and of 11% above the fenarimol treatment. In the second trial, in squash, the respective figures were 119% and 111%.

In the third trial, fenarimol failed to control powdery mildew in cucumbers, and consequently a 38% yield increase was obtained in plots treated with Calixin in comparison with fenarimol, and an 85% increase in comparison with control plots. *(P)*

CONTROL OF *SCLEROTINIA SCLEROTIORUM* BY SOIL DISINFESTATION WITH METHAM-SODIUM AND BY AERIAL APPLICATION OF BENOMYL

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The fungus *Sclerotinia sclerotiorum* causes severe damage to lettuce, eggplant and pepper in the cold season. A regular foliar spray application with benomyl is the recommended treatment against the fungus. Recently, severe damage caused by the fungus, a 50-70% loss in yield of these crops, was reported. We found that no development of resistance by the fungus to benomyl had occurred in those fields. In the fields that were severely damaged by the fungus, in addition to ascospores transported to the field, a local source of ascospores from germinating ascocarp-bearing sclerotia was observed.

When metham-sodium at 350 l/ha was applied through the sprinkler irrigation system 21-30 days before planting, sclerotia were killed to a depth of 15-20 cm. The combined treatment, soil disinfestation by metham-sodium with subsequent foliar applications of benomyl sprays, was necessary in fields previously infested with viable sclerotia of *S. sclerotiorum*, in order to reduce disease incidence and consequently disease severity and yield loss. Also, indications have been obtained in lettuce fields that it is possible to reduce the number of spray applications of benomyl without significantly increasing the disease incidence. *(L)*

OPTIMIZATION OF *VERTICILLIUM DAHLIAE* CONTROL BY METHAM-SODIUM IN LOESSIAL SOIL OF THE NEGEV AREA AND ITS EFFECT ON POTATO TUBER YIELDS

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Penetration of metham-sodium applied along with irrigation water into loessial soil in the field was studied by measuring the viability of microsclerotia (MS) of *Verticillium dahliae* placed in the soil at depths of 2, 10, 20, 30 and 40 cm. Equal quantities of metham-sodium were applied as concentrated or dilute solution, and as concentrated followed by a dilute solution (combined application). The dilute application was inferior to both the concentrated and the combined applications; more chemical was required to kill MS by the combined than by the concentrated application. With the latter mode, penetration of the chemical was maximal when the dose was dissolved in the first 5-10% of the irrigation water used. 800-1000 l/ha metham-sodium, applied to commercial fields by each of the methods mentioned, reduced disease incidence and significantly increased potato yields compared with controls irrigated with water only, or with 300 l metham-sodium/ha – treated plots. The highest increase in yield was obtained by the concentrated-application treatment of 800 l metham-sodium/ha, and reached in two cv. 'Désirée' fields 7.5 or 10 t/ha more than the control.

To evaluate the minimal fungicide dose which reduces the *V. dahliae* population in soil and results in optimal potato yields, three different doses – 400, 600 and 800 l/ha – were applied in equal total water volumes of the concentrated application. Potato yields were 24.75, 30.54, 36.20 and 34.79 t/ha in the control, 400, 600 and 800 l/ha treatments, respectively. Thus, the maximal potato yield per liter fungicide applied was obtained with 600 l/ha. *(P)*

SOOTY MOLD OF PEACHES IN ISRAEL

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Sooty mold of peaches appears as a black coating on the surface of fruit, but not on leaves or twigs. It is composed of dark mycelial threads and spores of three fungi: *Alternaria* sp., *Ulocladium* sp. and *Cladosporium* sp. The molds do not penetrate the peel tissue, but rather attack and decompose the fruit's hair by means of enzymes. These fungi are able to use the hair of peaches as a sole carbon source, as confirmed in an auxanogram test. The sooty mold attacks only the upper parts of the fruit, exposed to the sky. Fruits that are shielded by leaves and twigs are not affected.

As a first step to find means of controlling this disease, bioassays were performed on potato dextrose agar, with the following fungicides: *(1)* propineb, *(2)* fentin acetate, *(3)* captan, *(4)* maneb, *(5)* thiabendazole, *(6)* chlorothalonil, *(7)* iprodione, *(8)* ditalimfos, *(9)* fenarimol, *(10)* vinclozolin, *(11)* dicloran, *(12)* a 50% a.i. inorganic copper preparation based on 30% copper oxychloride, 10% maneb and 10% zineb, *(13)* dichlofluanid and *(14)* metomeclam (CO 6054; Drawifol). Of all the fungicides tested, *2, 7* and *9* showed the highest activity against the sooty mold fungi. At a concentration of 1 ppm, they inhibited only *Alternaria* by more than 50%; at the 10 ppm concentration, *2, 7* and *9* inhibited all the fungi tested by more than 50%, except for *Cladosporium,* which was inhibited by *7* at a rate of 38% only. At 100 ppm, *2, 7* and *9* inhibited all three fungi by more than 50%. *(L)*

ASCOCHYTA RABIEI-INFECTED SEEDS AS A SOURCE OF ASCOCHYTA BLIGHT IN CHICKPEA FIELDS AND ITS CONTROL BY SEED TREATMENT

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The fungus *Ascochyta rabiei* is a destructive pathogen limiting the emergence and regular growth of chickpea (*Cicer arietinum* L.). Chickpea seeds of the Spanish variety were collected from fields infected with *Ascochyta rabiei* (Pass.) Lab. These seeds were shown to be the cause of damage to the crop. Fungus-bearing seeds (95% of the total) reduced the percentage of germination and seed emergence.

The use of thiram as a seed treatment in field experiments significantly increased the percentage of emergence (600% as compared with non-treated seeds) but failed to prevent the development of *A. rabiei* on the seedlings. On the other hand thiabendazole, phenapronil and 'Drawigran plus' (fenfuram + thiabendazole + quintozene + imazalil) provided excellent protection against the systemic development of the fungus.

The combination of thiabendazole with thiram significantly increased the percentage of emergence and provided systemic protection against secondary foliar infection for a period of 60 days after sowing. In addition, the combined treatment of thiabendazole with thiram increased yield as compared with thiram or non-treated plots. *(P)*

CONTROL OF LOOSE SMUT IN WHEAT WITH SYSTEMIC FUNGICIDES

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During the winter growing seasons of 1981 and 1982, field experiments were conducted to investigate the effectiveness of the systemic fungicides triadimenol and furmecyclox [N-cyclohexyl-N-methoxy-2,5-dimethyl-3-furancarboxamide; Campogran (BAS 389)], in comparison with carboxin (Vitavax), as seed dressings for control of loose smut *(Ustilago tritici)* in wheat.

Triadimenol provided excellent control of loose smut. In 1981, application rates of 1, 1.5 and 2‰ resulted in 0 – 0.07% smutted spikes. These results were not correlated with the initial infection rates of the seed lots used (9% and 3.5%). In 1982, rates of 0.5, 0.75 and 1‰, applied to two seed lots with 1.5% initial infection, reduced the incidence of smutted heads to 0.01, 0.005 and 0%, respectively. Application of carboxin resulted in 0.26 and 0.27% diseased spikes in 1981, and in 0 – 0.015% in 1982. The effectiveness of triadimenol is thus similar to, or slightly better than, that of carboxin.

Application of 2‰ Campogran in 1981 gave 0.36 and 0.28% smutted heads in heavily and lightly infested seed lots, respectively. In 1982, disease rates between 0.059 and 0.088% were observed with two application rates. These results render Campogran unsatisfactory for use in seed production schemes.

Addition of a mercury compound (2-methoxyethylmercury chloride) did not influence the smut-controlling effect of either of the systemic fungicides, or improve emergence or yield. These results indicate that triadimenol may be suitable for use as a general seed dressing fungicide. *(P)*

C: *EPIDEMIOLOGY AND PHYSIOLOGICAL ASPECTS OF DISEASES CAUSED BY BACTERIA AND FUNGI*

SURVIVAL AND DISTRIBUTION OF *VERTICILLIUM DAHLIAE* IN THE PROFILE OF LOESSIAL SOIL IN THE NEGEV

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The pathogen *Verticillium dahliae* produces numerous microsclerotia (MS) on potato plants, more in autumn than in spring. Survival of the fungus was compared in soil in the laboratory and in the field by determining fungal populations periodically. In the laboratory a dry soil, naturally infested with *V. dahliae* MS, was stored at 20-28°C. In the field, diseased potato crop residues were disced into soil and the viability of the fungus was determined during several years when the crop rotation consisted of non-host plants only. In the laboratory, a sharp decrease (95%) in viability of MS was observed during the first 2 years; after 3.5 years only 1.5% of MS were viable and after 5 years no viable MS were detected. In the field, viability of the fungal population was maintained longer: 2 and 6 years after the incorporation, 50% and 8%, respectively, of the original population remained viable.

The distribution of the fungal population in the soil profile was tested in four soil depths: 0-10, 10-20, 20-30 and 30-40 cm. After potato harvest and disc incorporation of the residue, 98% of the fungal population found was in the first two soil layers (*i.e.*, 0-20 cm depth). During the years of the successive crop rotation of non-host plants, the proportion of the fungal population in the top layer decreased and the fungus was more equally distributed throughout the entire soil profile examined. *(P)*

INDUCTION OF, AND CROP LOSS DUE TO, CAVITY SPOT OF CARROTS

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Carrots were inoculated with 20 different aerobic and anaerobic bacterial species isolated from the rhizosphere and the surfaces of carrots; none of them induced cavity spot in carrots. Heat, cold, wilting and flooding stresses led to only a low level of induced cavity spot. A combination of at least 6 h flooding and temperatures higher than 27°C clearly induced cavity spots in carrots. Sugars, amino acids and minerals leaked from the carrot after the plant was subjected to flooding and heat. Longer growth periods after stress markedly increased cavity spots in the carrots. The soil types (sand, loess and heavy soil) and several carrot cultivars tested had no marked effect on spot formation. Increased N-fertilization slightly enhanced the "disease." Scanning electron microscopy revealed that after subjecting the carrots to heat and flooding very small cavities were formed under the epidermis and they were free of bacteria. After the epidermis collapsed there was massive multiplication of bacteria, concomitant with cavity appearance. Infected carrots showed moderate protease, pectinase and cellulase specific activities and strong peroxidase and polyphenoloxidase activities as compared with healthy carrots.

The following mechanism is suggested as a working hypothesis for induction of cavity spot of carrots. Physiological stresses cause microscopic damage to carrots and leakage of nutrients to the adjacent rhizosphere. Under these conditions non-specific bacteria developed which caused some limited degradation of the tissue. Their activity induces the defence mechanism of the plant that overcomes and stops the local infection; as a result, a black spot develops. Cavity spots reduce the marketing value of carrots.

In preliminary field experiments disease incidence in commercial fields rose to 80% of the carrots, mainly in summer sowings, whereas in autumn sowing disease incidence decreased to 50%. There was very high variability in the degree of economic damage observed in different fields, regions and growth periods, ranging from negligible (2-3%) to severe (40%). *(L)*

DELIMITED SHELL-SPOTS OF PEANUT PODS: FACTS AND HYPOTHESES

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The facts accumulated about the disease are as follows: (i) In the lignifying, yet fleshy, pod-shell first a small ulcer develops; in the final spot a dark-colored demarcation line forms around a lighter colored necrotic tissue. Such spots are abundant on pods developing under conditions of restricted soil aeration. Leguminous winter fallows increase spot incidence, whereas winter cereals for forage decrease them as compared with plowed fallow. (ii) Populations of *Rhizoglyphus* soil-acarina are present in pod-spot-affected fields; however, they are absent from similar soils which produce healthy pod-yields. The delimited shell-spots are scattered on the shell not randomly but in batches, as if they were produced by a moving animal. (iii) Soil sterilization prevents spot development. Solarization, general biocidal disinfection, zoocides, acaricides and insecticides significantly reduce spot incidence. Fungicides do not affect the abundance of spots. (iv) Fungi isolated from spots could not be shown to cause such spots on inoculation. A pectolytic *Clostridium* sp., the only microorganism isolated from initial ulcers, was inoculated to developing and lignifying pods, alone and in combination with infestation with *Rhizoglyphus* sp. Although *Clostridium* could be reisolated, typical lesions were rare. In young pods, mechanically induced wounds, without inoculation, healed quickly.

Our hypotheses about the etiology of the disease are: (i) At microsites of intimate contact between pod and soil, organic debris may undergo anaerobic breakdown and products may scorch a wound in the outer tissue of the unlignified pod. Exudates from the initial wound may attract bacteria and, subsequently, also microarthropods; acarina, by moving around in the vicinity of the primary wound, may scratch the integument of the pod and infest the scratches with microbes. (ii) In the phase of rapid development of the pod-shell, most wounds heal. However, when wounds are produced later, they heal slowly, and fungi invade and expand them. (iii) Presumably, acarina transmit a necrogenic virus. However, the dark ring bordering the spot may be specific not to the causal agent but to the reaction of the tissue which localizes the ulcer. *(P)*

COMPARISON OF ISOLATES OF THE FUNGUS *HENDERSONULA TORULOIDEA* PATHOGENIC TO APRICOT AND LEMON

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The fungus *Hendersonula toruloidea* causes dying-back of branches and death of apricot and lemon trees in Israel.

The fungus produces two types of asexual spores, arthrospores and pycnidiospores. In culture, isolates which had originated from apricot produced only arthrospores, as in the orchard, while lemon isolates produced pycnidiospores in nature as well as in culture. Treatments in the laboratory induced the fungus to produce spores of the type not found in the above-mentioned

isolates. These treatments included near–UV irradiation of apricot isolates with natural light for 8 months, which caused the isolate to produce characteristic pycnidia and pycnidiospores; and growing lemon isolates on poisoned media, which caused the isolate to produce chains of characteristic arthrospores.

Field trials showed that isolates were specifically pathogenic to the host species from which they were originally collected. Pathogenicity was not obtained when apricot isolates were inoculated on lemon trees and *vice versa.*

The two original isolates also differed in their temperature preferences. The apricot one preferred 35°C, while the lemon isolate grew better at slightly lower temperatures. Furthermore, the latter isolate had a woolly growth form, whereas the apricot one had a flat growth pattern. *(L)*

MONOSPORASCUS EUTYPOIDES – A NEW THERMOPHILIC CAUSE OF COLLAPSE OF MELON PLANTS IN AN ARID AREA OF ISRAEL

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Collapse of melon plants continues to be an important factor damaging this crop in Israel. The study to determine its cause was recently extended to the Jordan Valley and Arava regions, two extremely arid, hot areas.

The role of the loculoascomycete *Monosporascus eutypoides* in a collapse of melon plants was evaluated. Field trials and an inoculation experiment showed that the organism was a primary pathogen in these two extremely hot and arid areas of Israel. The fungus caused a root rot that led to early collapse of the plants. Fumigation of soil with methyl bromide delayed symptom expression and prevented collapse of the plants, whereas soil solarization failed to prevent infection and collapse. There was a clear correlation between the degree of root colonization by the fungus, and the onset and degree of collapse of the plants. The pathogenicity of the fungus was demonstrated by inoculation studies.

The degree of collapse as affected by soil infestation at two temperature regimes (30/20°C, and 25/20°C, day/night) was examined. Symptoms appeared earlier at the higher temperature regime and their expression was accelerated in contrast to those appearing on the plants kept at the lower temperature regime. *(L)*

STUDIES OF THE BIOLOGY OF GARLIC RUST, CAUSED BY *PUCCINIA ALLII*

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The garlic rust disease is caused by the fungus *Puccinia allii* (DC) Rud. All its stages appear on *Allium* plants. Teliospores collected in the Lakhish area of Israel during the spring of 1982 were able to germinate in the summer and autumn seasons of that year. With these teliospores we succeeded in infesting skinned cloves and green leaves of several cultivated garlic varieties and of *A. ampeloprasum.* The fungus attacks a few wild species of the genus *Allium;* the main one attacked in Israel is the widespread *A. ampeloprasum.* Teliospores that were derived from *A. ampeloprasum* attacked cultivated species and *vice versa.* Under natural conditions the fungus appears on *A. ampeloprasum* approximately one month before it attacks cultivated garlic, and we have proved that the fungus spreads from the wild species to the cultivated one. At the beginning

of the season (January-February) pycnia and aecia appear on *A. ampeloprasum*, and later on uredia appear. The urediospores are spread by the wind to the cultivated fields; in a few fields also pycnia and aecia were found on cultivated garlic. Onion seedlings *(Allium cepa)* were susceptible to germinating teliospores originating from either cultivated or wild *Allium*. *(L)*

THE ULTRASTRUCTURE AND GERMINATION OF SCLEROTIA OF *BOTRYTIS ALLII*, THE CAUSAL AGENT OF THE GRAY-MOLD DISEASE IN ONIONS

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The structure of mature sclerotia of *Botrytis allii* was studied by light and scanning electron microscopy. The mature sclerotium has two distinct layers: a narrow rind consisting of rounded rather thick-walled empty cells in which a black pigment accumulates, and a large central medulla of filamentous hyphae which are loosely arranged in a gelatinous matrix. The mode of germination of the sclerotia is sporogenic, and it was found that the conidiophore emerging from the ruptured rind is of medullary origin. *(P)*

INOCULUM SOURCE AND DISEASE DEVELOPMENT OF *ALTERNARIA* LEAF SPOT OF COTTON

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Alternaria macrospora has been known as a pathogen on cotton in Israel since the 1950's. The high quality cv. 'Pima' is especially susceptible and epidemics decrease yield by about 25%. The pathogen was present in plant debris collected from previously diseased cotton fields. Spores formed on 0.5-3% of the debris incubated under moist conditions and probably serve as primary inoculum sources in situations where crop rotation is not practiced. Initial infections are likely to be formed on cotyledons. The incidence of infection on cotyledons was five times higher than on true leaves on 3-week-old plants inoculated under controlled conditions. Cotyledon-susceptibility increased with age until the plants were 30 days old, and decreased thereafter. True leaf susceptibility remained constant and decreased only in plants older than 50 days. Infected leaves typically abscissed and the shedding was positively correlated with disease severity.

Inoculum production in the field was examined by collecting spores from infected leaves. More spores were produced on attached leaves with large lesions than with small ones. Spores were also formed on detached leaves; they can be a source of secondary inoculum, adding to the inoculum pressure in the disease epidemic. *(L)*

MACROPHOMINA PHASEOLINA IN PINE NURSERIES

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Mortality of pine seedlings in forest nurseries has recently become widespread; it occurs in young seedlings close to the start of lignification. Disease symptoms are yellowing of the needles,

followed by wilting and death of the seedlings. The fungus *Macrophomina phaseolina* was isolated from roots of 40-75% of all infested seedlings. It was recovered from roots of *Pinus pinea, P. canariensis, P. maritima, P. brutia* and *P. halepensis* in JNF nurseries. The frequency of *M. phaseolina* in roots was correlated with the percentage of dead pine seedlings in the nurseries.

Other soil fungi isolated from infected roots were *Fusarium* spp. In inoculation studies in growth chambers the isolate *M. phaseolina* was pathogenic, while the *Fusarium* spp. isolates showed a low level of pathogenesis. *(P)*

WOOD-ROTTING FUNGI OF ISRAEL

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Lignicolous fungi have been neglected in Israel until recently. However, during the years 1975-1982, many higher lignicolous Basidiomycotina fungi were collected in coniferous and deciduous woods of northern and central Israel. Among them, the groups of Aphyllophorales, Tremellales, Dacrymycetales, Auriculariales and Agaricales fungi were amply represented in both species and genera. Most of the fungi in this list are found on dead, fallen or standing trees, stumps or dead branches. These organisms play an essential part in forming the quantity of dead organic material which recycles carbon back into the atmosphere. Some of the fungi decay the heartwood in living trees and shrubs, weakening the plant structurally and contributing to its eventual decline and death. The collection, which is far from complete, includes about 2000 specimens, which gives about 120 new species for Israel. The following wood-rotting fungi species are the most common in Israel: *Peniophora meridionalis, P. lycii* gr., *Meruliopsis corium, Coriolopsis gallica, Phlebiopsis roumeguerii, Phanerochaete tuberculata, Lopharia spadicea, Steccherinum fimbriatum, Asterostroma muscicolum, Laeticorticium polygonioides* and *Stereum hirsutum.* *(L)*

WHEAT POWDERY MILDEW – A SPORADIC DISEASE IN ISRAEL

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From surveys conducted, observations made and information gathered on the incidence of wheat powdery mildew in recent years, it was concluded that the disease occurs, to varying extents, in Israel every year.

The disease, caused by *Erysiphe graminis tritici,* was observed in varietal test plots and occasionally in commercial fields. Now and then it appeared spontaneously in greenhouses, where wheat is grown for research studies. It is more prevalent in the northern regions of the country, while in the central and southern areas it is quite rare. Cultivars and lines of both durum (*e.g.* 'Inbar') and common wheat (especially 'Shafir' and 'Miriam') were diseased under field conditions. Powdery mildew developed mainly in fields with dense stands, on all parts of the plant, including flag leaves and ears, mainly of secondary stems.

Single-pustule cultures, which were prepared from isolates collected from different varieties and locations, were tested under greenhouse conditions. According to their behavior on a set of the local wheat cultivars and lines, it is obvious that all the isolates collected from common wheats were capable of infecting each of the tested varieties. On the other hand, one can distinguish two groups among the isolates collected from durum wheats: one consisting of isolates which behave

similarly to the common wheat isolates, and one consisting of isolates which are restricted in their virulence to the durum wheat varieties. In spite of the homogeneous behavior, on the local varieties, of the isolates belonging to the same group, their behavior on a set of differential varieties from abroad is quite variable; they thus represent different physiological races. Cultivars like 'Lakhish' and 'Barkai', which under field conditions in Israel were never observed to be infected by powdery mildew, proved to be susceptible to the disease even at a mature age under greenhouse conditions.

In Israel, *Erysiphe graminis tritici* produces fertile cleistothecia – which apparently serve as the primary source of inoculum – in the beginning of the winter. This points to the possible role of the perfect stage in preserving local variability in pathogenicity and in recombining virulence capabilities.

Among the powdery mildews prevalent on wild grasses, only isolates from *Triticum dicoccoides* were capable of infecting wheat, mainly durum varieties. *(L)*

THE EFFECT OF LEAF RUST AND SEPTORIA ON WHEAT YIELDS

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Disease level in a plant is the only visual parameter measurable throughout the growing season. Yield level, at the end of the season, is the parameter by which the efficacy and the economy of disease control measures can be determined, *post factum*. In many crops and diseases yield losses will increase with the rise in disease level.

Results of 13 years of experimentation in the control of foliar diseases of wheat do not fit the above generalization. The impression was received that a maximum yield level is reached at a certain optimal disease level. Experiments were conducted in 1980/81 and 1981/82 in a region stricken with *Septoria tritici* and also in one stricken with leaf rust. Disease progress curves were drawn and yields were harvested. Various disease levels were obtained when using different thresholds for the initiation and termination of chemical control. In one of the experiments single plants were used for disease follow-up and yield determination. The relationship between yield and disease was analyzed. The disease parameters used were disease level of the flag leaves, disease level of the upper two leaves, or the area enclosed by the curves of the graphic presentation of the disease progress [area under the disease progress curves (AUDPC)]. The correlation coefficient for a linear relationship ($y = a-bx$) was in the range of 0.206 to 0.639 and was not significant. For a parabolic relationship ($y = c+bx-ax^2$) the coefficient was in the range of 0.663 to 0.998 and significant in all cases tested.

These results lend support to previous impressions and justify the recommended control schedules. These schedules aim at arriving at an optimal disease level by determining the disease threshold for the initiation of chemical control, and the plant stage threshold for the termination of chemical control. *(L)*

VARIATION IN *HORDEUM SPONTANEUM – ERYSIPHE GRAMINIS* ECOSYSTEMS

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Utilization of disease-resistant single wild plants in breeding of related cultivated crops is commonplace. Recently, attempts have been made to elucidate the defense structures in indigenous wild populations which impair the stability of the host-pathogen interaction. Extrapolation of such

information to agroecosystems is envisioned. This study explores the defense structures against powdery mildew *(Hordeum spontaneum)* pathosystems in Israel.

One hundred plants sampled by the transect method in 17 populations were planted in a field nursery inoculated with cultures collected throughout the country. Infection types and infection severity were recorded periodically. Progenies of the tested plants were tested in successive years. It was ascertained that the defense patterns comprise slow-mildewing plants and components displaying hypersensitivity in various proportions, influenced by the ecologic conditions of the original plant habitat. These patterns have remained stable over the years.

Seedlings of four populations were inoculated in the greenhouse with 35 fungus isolates collected from: (i) the place of origin of the specific barley population, (ii) various regions of Israel, and (iii) Germany. In host-parasite couplets originating from the same site, the interactions were compatible. In contrast, inoculation with German cultures produced hypersensitivity and an incompatible interaction.

Distinct variation in infection types was recorded in plants inoculated with cultures from various regions in Israel. *(L)*

OCCURRENCE OF SEXUAL FRUITING BODIES OF *SPHAEROTHECA FULIGINEA* ON POWDERY MILDEW-INFECTED MUSKMELONS

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Cleistothecia of the fungus *Sphaerotheca fuliginea* (Schlecht. ex Fr.) Poll., a causal agent of powdery mildew in cucurbits, were found in January 1983 on mildewed 3-month-old muskmelon (*Cucumis melo* L.) plants growing in a heated greenhouse (15-45°C). Brownish-black cleistothecia were formed in groups on the lower surface of older leaves, on lower internodes of stems, and on juvenile leaves of side branches growing from lower internodes of the stem; occasionally they were seen on upper leaf surfaces. The cleistothecia were round (73-98 μm), had a single ascus with an as yet undetermined number of ascospores, and bore hypha-like appendages. They were found on the following muskmelon cultivars growing in the greenhouse: 'Ananas-Yokneam', 'Hemed', 'Gil'ad', and (US) P.I. 164323, as well as on *Lagenaria vulgaris*. Based on the susceptibility-resistance of American cultivars PMR 45, PMR 5, PMR 6, and Edisto 46, we concluded that race 1 of *S. fuliginea* prevailed in the greenhouse.

Potted 2-3-leaf stage cucumber and muskmelon plants placed in the greenhouse became heavily mildewed within a week and showed cleistothecial production within another week, on still greenish leaves exclusively.

Sequential inoculations conducted with two-leaf-stage melon plants (cv. 'Ananas-Yokneam') in growth chambers (20±2°C, 12 h light/day) resulted in a gradual decline of cleistothecia production, with no cleistothecia formed at the sixth inoculation test.

This is the second report on the production of cleistothecia of *S. fuliginea* in cucurbits in Israel (the first was by Reiss in 1947, from the Jordan Valley). *(P)*

THE ROLE AND METABOLIC FATE OF GLUCOSE DURING OOSPORE GERMINATION OF THE FUNGUS *PYTHIUM APHANIDERMATUM*

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Bimorphic development of activated oospores (treated sequentially by desiccation, high temperature, and $KMnO_4$) was investigated during germination in a defined liquid medium containing inorganic salts and lecithin (S+L). Oospores incubated in S+L developed indirectly with unbranched germ tube elongation and release of motile zoospores; when incubated in S+L to which glucose was added (at concentrations of 0.1 mM or higher), oospores developed directly, with highly branched germ tube elongation and no zoospore release. Using ^{14}C-glucose it was found that glucose uptake was maximal after germ tube emergence. Following the uptake of all of the exogenously available glucose, no decline in the incorporated radioactivity levels could be detected during incubation. Approximately 75% of the radioactivity taken up during direct germination was located in the wall fraction of germlings and $\sim$20% was located in the $HClO_4$-soluble cytoplasmic fraction. Ultrastructural examinations revealed that substantial wall thickening (up to 700 nm) occurred in hyphal walls of directly germinating oospores, whereas thinner hyphal walls (100-200 nm) occurred in hyphae of indirectly germinating oospores. The results of this study indicate that the process of wall synthesis has a prominent role in the control of bimorphic oospore germination. *(P)*

SLOW-RUSTING TYPE OF RESISTANCE TO STEM RUST DISEASE IN *AVENA STERILIS*: IMPORTANCE, STABILITY AND MECHANISMS CONTROLLING THE PHENOMENON

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The paucity of genes conditioning low reaction to oat stem rust and the ephemeral nature of this protection in cultivated oats, stimulated the search for slow-rusting resistance in populations of *Avena sterilis* L., the wild ancestor of cultivated oats, which has co-evolved with its pathogens over millenia.

The geographic distribution and stability of slow rusting were studied *(a)* on plants from 30 populations sampled by the transect method and *(b)* on single plants selected for low disease severity in field nurseries, by assessing disease severity and reaction class.

In greenhouse tests the mechanisms of host penetration, receptivity and urediospore productivity were studied. The tests involved uniform inoculation of one-leaf seedlings, and of flag leaf sheaths of adult plants, with stem rust race 6F = 72. The work proved that (i) slow-rusting type of resistance is the most important factor in the defense of *A. sterilis* in nature; (ii) slow rusting is a stable form of resistance in many lines and in their progenies; (iii) slow rusting effectively protects uniform plots, as demonstrated by disease severity and rate of urediospore productivity; and (iv) the following mechanisms condition slow rusting: reduced appressoria formation and rate of penetration, reduced receptivity of the host, and reduced urediospore productivity. *(L)*

COMPETITION BETWEEN METALAXYL-RESISTANT AND -SENSITIVE STRAINS OF *PSEUDOPERONOSPORA CUBENSIS* ON CUCUMBER PLANTS

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Pseudoperonospora cubensis strains resistant to metalaxyl predominated in Israel during 1980 in both plastic greenhouses and open fields. Predominance of the mild-type sensitive strains did not return before mid-1981, about half a year after the use of metalaxyl in cucurbits was discontinued. The fitness of metalaxyl-resistant and -sensitive strains of *P. cubensis* was compared in the absence of metalaxyl selection pressure by: *(a)* single strain inoculations; *(b)* passing mixed (1:1, 1:6, and 1:20 resistant:sensitive in initial sporangial suspension inoculum) strains through two inoculation cycles on intact cucumber cotyledons in growth chambers; and *(c)* exposing cucumbers growing in plastic greenhouses to both strains (at a ratio of 1:1 or 1:4). With single strain inoculation, strains were equally infective to cucumbers. In mixed strain inoculations in growth chambers, after one sporulation cycle (two successive inoculations), the original 1:1, 1:6 and 1:20 ratios of resistant:sensitive components changed to 1:0. In mixed strain inoculations in plastic houses, the original 1:1 and 1:4 ratios (resistant:sensitive) changed to almost 1:0 after 12-17 and 23 days, respectively.

These results explain the occurrence, and sometimes the overdominance, of resistant strains of *P. cubensis*. It is assumed that resistant strains were built up in treated plants in sufficient quantities to compete favorably with sensitive strains in the absence of the fungicide. The use of metalaxyl was discontinued in 1981, as a result of which the frequency of resistant strains gradually declined. The return of the sensitive wild-type strain clearly shows that they are better adapted to nature than resistant strains, but the latter are highly competitive when they reach a certain proportion in the population. *(L)*

FREQUENCY AND PERSISTENCE OF *VENTURIA INAEQUALIS* BIOTYPES RESISTANT TO BENOMYL IN AN APPLE ORCHARD

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Leaves and fruits infected with apple scab were found in the late spring of 1981 in a 4-year-old apple orchard on the Golan Heights. In order to detect resistance to benomyl in *Venturia inaequalis* (Cke.) Wint., 2000 scab lesions were sampled from four 30-tree rows of cv. 'Starking'. The initial test for resistance in the pathogen population was performed on benomyl-amended medium (PDA + 0.5 μg/ml). Spore germination was obtained from 75% of the scab lesions tested, and from these it was determined that 2.3% (33 out of 1447) of the pathogen population was resistant to benomyl. The source of the leaves infected with benomyl-resistant *V. inaequalis* was found to be a few trees scattered in two rows of the plot.

Single-spore cultures from 14 resistant scab lesions were used to determine the degree of benomyl resistance *in vitro*. According to the ability of the isolates to grow on media supplemented with varying benomyl concentrations (0, 0.5, 5, 50 μg/ml), three levels of resistance were determined: moderately resistant (MR) isolates grew at 5 μg/ml but not at 50 μg/ml; highly resistant (HR) isolates grew at 50 μg/ml more slowly than at 5 μg/ml; and isolates with very high resistance (VHR) grew at 50 μg/ml as freely as at 5 μg/ml.

Although alternate spray applications of benomyl and captan effectively controlled scab during the following season (1982), a few infected leaves were detected in November 1982. The frequency of benomyl-resistant isolates in the second season increased to 63% (61 out of 97

lesions). Out of 512 single-spore cultures from 55 resistant lesions, examined to evaluate the frequency of isolates with different levels of resistance, 12.7% were MR, 34.6% were HR and 52.7% were VHR. From these results it can be concluded that *(a)* biotypes of *V. inaequalis* resistant to benomyl were able to survive and persist although the disease had been controlled by alternate spray applications of benomyl and captan, and *(b)* under the regime of fungicide treatment applied in this orchard, the fitness of each of the resistant mutants and the sensitive wild type was similar.*(L)*

D: CONTROL BY NONCONVENTIONAL METHODS AND BY BREEDING FOR RESISTANCE

REDUCTION OF *SCLEROTIUM ROLFSII* DISEASE INCIDENCE BY GROWING ONION BEFORE THE SUSCEPTIBLE CROP

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Field observations in central Israel had raised the possibility of reducing the incidence of *Sclerotium rolfsii* in susceptible crops in fields where the previous crop was onion. A survey of peanut and tomato fields naturally infested with the pathogen verified this phenomenon.

Soil samples were taken during the growth period of onion and peanut in field experiments, in order to examine inoculum potential. Reduction of inoculum potential was found to be higher at the end of the onion growth season and during peanut growth, as compared with disease potential at the beginning of the onion growth season.

Growing peanuts in plots where onion (cv. 'Grano Bahir') had been grown during the winter reduced *S. rolfsii*-diseased plants by 64%. Yield increases of 14-52% were obtained, compared with plots where onion was not grown. It is suggested that growth of onion during winter may provide protection against *S. rolfsii* in susceptible crops, *e.g.* beans, pepper and tomatoes.

The fungicidal effect of onion under field conditions was restricted to onion cv. 'Grano Bahir'; *e.g.* cv. 'Grano Makdim' does not reduce disease incidence. Laboratory experiments showed that bulb and root extracts had an effect on growth of *S. rolfsii* in culture and on sclerotial germination. *(P)*

STUDIES OF THE HYPERPARASITE *AMPELOMYCES QUISQUALIS* AND PRELIMINARY TRIALS ON BIOLOGICAL CONTROL OF POWDERY MILDEW

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Isolates of the hyperparasite *Ampelomyces quisqualis* isolated from parasitized powdery mildew on *Catha edulis* were tested for their growth ability, production of pycnidia, sporulation and parasitism on the mildew; the most effective isolates were used in the trials. The optimum temperature for development of the hyperparasite was 22±2° C. Tests showed that the best medium for growth and sporulation was 4% malt extract agar + 0.2% DL asparagine. Rapid reproduction was achieved by spreading a spore suspension on this medium: after 2½ weeks high yields of spores were obtained. *A. quisqualis* has a wide host range and parasitized powdery mildews on cucumber, melon, sugar beet, carrot, apple, mulberry, pepper and zinnia. Its half-time (t_{50}) in culture was determined as 25 days.

The effect of several fungicides, insecticides and acaricides on the hyperparasite was tested. The fungicides chlorthalonil, aluminum tris (ethyl phosphonate), triforine, triadimefon, and

tridemorph; and the insecticides and acaricides phosphamidon, aldicarb and cyhexatin have no, or an inconsequential, effect on the hyperparasite's development and viability. The other pesticides tested prevented or damaged its viability. Mycelia of the hyperparasite did not infect powdery mildew; thus, inoculations should be done by spores.

Greenhouse and field trials were carried out on the biological control of cucumber powdery mildew. The optimal parameters necessary for successful control are: 22±2°C; moisture (moist-chamber) for 18 to 20 hours after the inoculation; and hyperparasite spore concentration of the suspension for inoculation of the mildew: $1x10^5$ to $1x10^6$. In the field trial substantial infection by the hyperparasite was achieved on dewy nights or when plants were covered with plastic for 14 hours after inoculation. Biological control of cucumber powdery mildew is more effective when treatments are applied every 7 rather than 10 days. The untreated control plants were killed by the mildew 2 weeks earlier than the plants treated with the hyperparasite. Prolongation of the cucumber plants' life at the end of cropping enables extension of the yielding period and is thus of economic importance to the grower. *(L)*

REDUCTION OF PYTHIUM SEED ROT BY GERMINATION PRIOR TO PLANTING AND BY *ENTEROBACTER CLOACAE*

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Fluid drilling of germinated seeds is a method developed to improve seedling establishment and to increase the rate and uniformity of crop emergence. The advantage of this method is that seeds are germinated under ideal conditions before sowing, thus eliminating the variable effect of the uncontrolled seedbed environment on germination. We have studied the effect of pregermination on Pythium seed rot.

Cucumber and pea seeds were germinated in aerated water until radicle emergence. When germinated seeds were planted in *Pythium*-infested soils, disease incidence was greatly reduced relative to seeds that did not receive the germination treatment. When germinated seeds were planted in the presence of dead seeds or nongerminated pea seeds, more seeds rotted than when germinated seeds were planted in their absence. During seed germination in aerated water, large amounts of bacteria grow in the water and on the seed surface. Seeds germinated under aseptic conditions were more susceptible to *Pythium* than seeds germinated under nonaseptic conditions. Dry seeds of cucumber, peas and beets treated with bacteria from germinated seeds were protected from rot. *Enterobacter cloacae,* isolated from germinated cucumber seeds, prevented rot of dry seeds of all three crops. *In vitro, E. cloacae* formed sheaths of bacterial cells around hyphae of *P. ultimum,* and lysis of the enclosed hyphae resulted. There was no evidence of production of any diffusible antibiotic to *P. ultimum* by *E. cloacae.* *(L)*

INTEGRATED CONTROL OF *RHIZOCTONIA SOLANI* AND *PYTHIUM APHANIDERMATUM*

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Two isolates of *Trichoderma harzianum* were found to be tolerant to methyl bromide at concentrations of up to 20,000 ppm (v/v) under laboratory conditions. The phytopathogenic

fungi *Rhizoctonia solani* and *Pythium aphanidermatum* were susceptible to methyl bromide already at 9000 ppm (v/v). Exposure to methyl bromide in sublethal concentrations had no effect on the antagonistic properties of the two *T. harzianum* isolates. Soil fumigation with methyl bromide at the recommended dose of 500 kg/ha did not reduce the *Trichoderma* population in soil and thus allowed rapid colonization of *Trichoderma* in the soil.

A combination of *T. harzianum* and reduced doses of methyl bromide (200 kg/ha) significantly reduced disease incidence of *R. solani* in bean seedlings in comparison with the untreated control. Similar control was achieved with the recommended dose of methyl bromide. A combination of *T. harzianum* and methyl bromide at a reduced dose under field conditions had a significant synergistic effect on carrot seedling damping-off caused by *R. solani* and had the same effect on growth, yield and disease control as did the recommended dose.

It was found that *T. harzianum* was able to prevent re-infestation of fumigated soil. *(L)*

BIOLOGICAL CONTROL OF *ASPERGILLUS NIGER* AND THE INFLUENCE OF *TRICHODERMA HARZIANUM* ON PLANT GROWTH

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Biological control of *Aspergillus niger* in peanuts was carried out with *Trichoderma harzianum*. Non-disinfected peanut seeds were planted in uninfected soil under greenhouse conditions. Seed coating with conidia of *Trichoderma*, combined with soil application of the fungus, reduced disease incidence by 48%. Disease incidence caused by *A. niger* in peanut fields was reduced by 43% and 60% by seed coating and soil treatment with *Trichoderma*, respectively. Up to 14% yield increase was obtained at the end of the growth period. *T. harzianum* was found to reduce seedborne *A. niger* in peanuts.

Trichoderma harzianum enhanced plant growth in the absence of soilborne plant pathogens. This effect was shown on cucumber, tomato, pepper, bean, peanut, etc. *Trichoderma* was mixed with soil as a wheat bran + peat preparation, conidial suspension, or used as a seed coating. Plant germination was 2 – 7 days earlier, the plants were up to 100% taller, the dry weight was 40% greater, leaf area increased by up to 150%, and the plants blossomed earlier.

When roots from plants treated with *Trichoderma* were plated on a selective medium, after external disinfection with sodium hypochlorite (NaOCl), mycelium of *Trichoderma* was found to emerge from the roots. *(L)*

APPLICATION OF *TRICHODERMA HARZIANUM* AS A BIOCONTROL AGENT FOR DAMPING-OFF IN VEGETABLES

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A new isolate of *Trichoderma harzianum* Rifai. was found to be highly effective in controlling *Pythium aphanidermatum* (Edson.) Fitz. The antagonistic fungus, grown on a wheat bran/peat mixture, was incorporated into infested soils. Broadcast application of the *Trichoderma* preparation in sandy loam soil, artificially infested with *P. aphanidermatum* (10^6 oospores/kg soil), controlled pre- and post-emergence damping-off in peas, cucumbers, tomatoes and beans and led to up to 91% disease reduction. The biocontrol agent was also applied as a conidial sus-

pension (10^9 conidia/ml) for seed coating. This application method was found to be similar in effectiveness to the broadcast application in controlling the pathogen. Experiments that were carried out in a peat – vermiculite rooting mixture, naturally infested with *P. aphanidermatum*, showed that both the wheat bran/peat preparation and the seed coating technique controlled damping-off throughout the rooting period of tomato, cucumber and pepper seedlings.

An extracellular culture filtrate of *T. harzianum* added to a synthetic medium inhibited linear growth of *P. aphanidermatum* by 87%. The growth rate of *P. aphanidermatum* on a synthetic medium on which *T. harzianum* had been grown previously, was inhibited by 89.8%. A comparison between *T. hamatum* (Bon.) Bain and *T. harzianum* revealed that the latter excreted substances that were more inhibitory to *P. aphanidermatum.* *(L)*

A CONTINUOUS PLASTIC FILM COVERING AND WELDING MACHINE FOR SOIL SOLARIZATION

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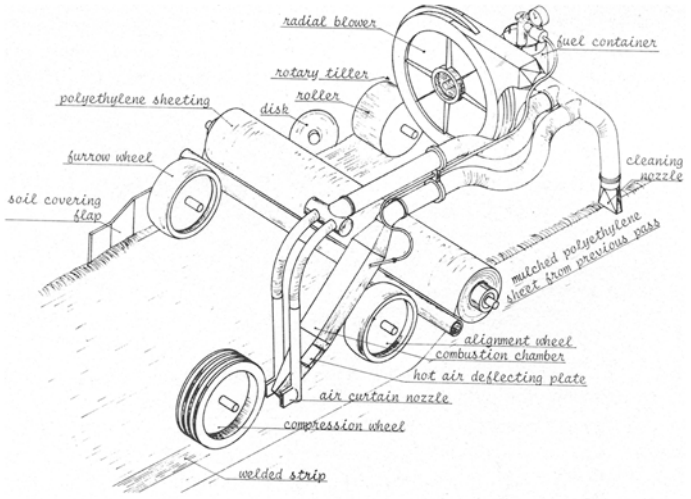
The term soil solarization describes a method which is essentially a pasteurization process. The widespread use of this method, by which a large number of soilborne pathogens and also weeds are controlled with only minimal interference with the soil's biological balance, was partially limited by the lack of a fully mechanized system for the application and welding of the plastic cover. Solarization treatment is conducted when ambient day temperatures are higher than 20° C. The treatment consists of covering pre-cultivated fields, after they have been irrigated to a depth of ∿50 cm, with transparent polyethylene sheets for a period of not less than 4 weeks.

The machinery used hitherto was based on strip covering, leaving untreated soil areas between the treated sections. Gluing, such as practised in methyl bromide cover-sealing, was found to be unsuitable when the sealing requirement was for longer than 3-4 days.

A machine which is capable of both spreading and welding a continuous plastic cover over a field was therefore developed. This machine buries one edge of the 2.5-meter-wide plastic sheet in



The mulching and welding system

the soil, while welding the opposite edge to a previously buried section of sheet. The previously laid plastic section is cleaned by an air stream prior to welding to the second sheet. The plastic films are heated from the top downwards by a gas-flame-heated air stream which is confined to the sealing strip area by air curtains. A Teflon-coated and ribbed roller compresses and welds the heated films. A continuous wind-resistant cover is thereby formed.

Field tests have shown that this machine is capable of covering up to 1 ha/h in a continuous process and that fields covered with sheeting of 30-μ thickness have good climatalogical resistance over the required treatment time. *(P)*

CONTROL OF FOLIAR DISEASES WITH EPIDERMAL COATING MATERIALS

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The effect of several epidermal coating polymers on leaf diseases (Septoria leaf blotch of wheat; powdery mildew of barley and roses) was studied. The wheat field plots (16 m^2) were inoculated with a pycniospore suspension (10^6/ml) of *Septoria tritici,* and the barley field plots were naturally infected by powdery mildew, *Hordeum vulgare.* The coating treatments were given at the flag leaf stage of growth, with a 2% polymer concentration in water (10 1/1000 m^2).

The commercial antitranspirants 'Wilt Pruf' and 'Vapor Gard' were the most effective polymers in controlling both diseases; Folicote and Nu-Film 17 were ineffective. The disease assessments were based on the infected area of the two upper leaves, when the leaves treated with the polymers reached an infection level up to 10%, compared with 80% in the untreated control. The grain yield of the polymer-treated plots was 20% greater than that of the untreated control.

The antitranspirants are considered as non-toxic materials and do not contaminate the environment. Controlling foliar diseases with epidermal coating polymers may be a promising and alternative system, and a deciding factor in their introduction into use. *(L)*

BREEDING FOR RESISTANCE IN POTATO TO *VERTICILLIUM DAHLIAE*

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The potato cultivars grown in Israel were bred in northern Europe. These cultivars are well adapted to the environment there, but only occasionally are they suitable for the hot climate in Israel. At present there is no potato cultivar that is very suitable for local conditions.

As part of a cooperative program with government researchers and commercial companies in several countries to breed cultivars more suitable for our environment, screening tests to determine *Verticillium dahliae* resistance or tolerance are undertaken in Israel. The material tested includes cultivars, advanced lines, seedlings, and di-haploids. The last mentioned are particularly useful in determining resistance/tolerance segregation in the parent line. The above materials are tested in the field in the spring season, under heavy infection pressure and also in fumigated soil.

The results have shown that there are a number of lines and parental material with high resistance to the pathogen. This material is being used to incorporate the resistance in potato cultivars, to be grown under local conditions.

Besides the information obtained as to resistance to the pathogen, other qualities are evaluated. Among these are length of growing period, total yield, distribution of yield according to tuber size, and tuber quality. Thus, a number of factors important to adapting cultivars or advanced lines to conditions such as ours, are examined in one test. *(L)*

PRELIMINARY OBSERVATIONS ON RESISTANCE OF *CUCUMIS MELO* TO *SPHAEROTHECA FULIGINEA* AND *PSEUDOPERONOSPORA CUBENSIS*

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The reaction of various melon cultivars, P.I. (U.S.) entries, and F_1 hybrids to powdery mildew (PM) and downy mildew (DM), was examined under field conditions and in greenhouses and growth chambers, during the years 1978-1983.

The Israeli cvs. 'Ananas-Yokneam', 'Hemed' and 'En Dor' were highly susceptible to DM at all growth stages, in both the field and greenhouse; the first two were also highly susceptible to PM. As regards American cultivars, 'Iroquois' was susceptible to both pathogens, 'Mainstream' was susceptible to DM but segregated in resistance to PM; 'Perlita-45', 'PMR 5', 'PMR 6', 'Edisto 47' and 'Cinco' were resistant to PM, and all except 'Cinco' were susceptible to DM.

The P.I. entries 123517, 177334, 136224, 164323, 164723, 164796, 200819 and 164797 were susceptible to PM, while 182954, 182953 and 234607 were highly resistant. The P.I. entries 164765, 212895 and 321005 segregated in resistance to PM. The P.I. entries 124112, 165449, 164323 and 124111 exhibited considerable resistance to DM in the field and slight susceptibility in growth chambers.

F_1 hybrids between some of the latter resistant P.I. entries and the susceptible Israeli cvs. 'Ananas-Yokneam', 'En Dor' and 'Hemed' were resistant to both PM and DM in the greenhouse and growth chamber inoculations.

In January 1983 abundant cleistothecia of *Sphaerotheca fuliginea* were found on susceptible plants growing in the greenhouse.

Our results indicate that resistance to both PM and DM could be transferred to Israeli cultivars from P.I. entries. *(P)*

E: PHYSIOLOGY OF THE INFECTED PLANT AND RESISTANCE OF PLANTS TO PATHOGENS

THE ROLE OF PHYTOALEXINS IN PLANT DEFENSE AGAINST PATHOGENS

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Phytoalexins have been shown to be produced in several plants in response to infection by incompatible pathogens. Detailed studies with a few host-pathogen interactions have indicated that phytoalexins are the major factor determining resistance. With gene-for-gene systems, pathogens have been shown to produce chemicals called elicitors that activate the plant phytoalexin response. At least two mechanisms may determine whether the host produces high amounts of phytoalexins and is resistant to an incompatible race, or produces low levels and is susceptible. These are: (i) pathogen elicitors from all races have similar activity, but only compatible races produce suppressor molecules that interfere with phytoalexin production; (ii) pathogen cell-surface carbohydrate elicitors exhibit differential activity, depending on the host-resistant genotype, such that they are more efficient in the resistant genotype. In addition, recent research from a few laboratories has indicated that pathogen elicitors may be released by host enzymes, may be processed by host tissues, and that certain pathogen-produced host-specific toxins possess elicitor activity. Thus, defense initiation may be a complex process with considerable variation, depending on the host-parasite interaction. *(L)*

ACCUMULATION OF FUNGITOXIC COMPOUNDS IN CITRUS SPECIES FOLLOWING INFECTION BY *PHYTOPHTHORA CITROPHTHORA*

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Root and collar rots of citrus caused by *Phytophthora* spp. are worldwide in occurrence and are among the major causes of loss of production.

Citrus species resistant to *Phytophthora citrophthora:* sour orange *(Citrus aurantium),* Trifoliata *(Poncirus trifoliata),* Macrophylla *(Citrus macrophylla);* and susceptible ones: Rough lemon *(Citrus limon),* Sweet orange *(Citrus sinensis),* Niva *(Citrus reticulata* x *Citrus sinensis),* were compared for production of a fungitoxic compound in the bark, following inoculation with this pathogen.

A fluorescent compound having an ultraviolet absorption spectrum with a maximum at 340 nm was induced in both the resistant and susceptible species. The concentration of the fluorescent compound increased rapidly in the resistant species 24 h following inoculation. Maximum concentration, 5000 ppm, was reached after 4 days. In the susceptible species, the maximum concentration was also reached 4 days following inoculation, but was no higher than 300 ppm.

A comparison between the concentration of the fluorescent compound and the size of the lesion on the bark showed a negative correlation: in the resistant species the length of the lesion was only 2-5 mm and in susceptible ones it was over 10 mm.

Bioassays demonstrated that the fluorescent compound showed activity, by inhibiting growth of *P. citrophthora* and *Verticillium dahliae* on potato dextrose agar for 48 h at 25°C, when the concentration exceeded 500 ppm. *(L)*

THE MECHANISM OF RESISTANCE OF *NICOTIANA GLUTINOSA* TO *ERYSIPHE CICHORACEARUM,* THE CAUSAL AGENT OF POWDERY MILDEW IN TOBACCO

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A high percentage of emergence of the first germ tube from conidia of *Erysiphe cichoracearum* occurs on both congenial and uncongenial leaves of *Nicotiana* species (as well as on agar medium), but the two other germ tubes, which are required for production of a fungal colony, develop on congenial leaf tissue only. To ascertain whether immunity of *N. glutinosa* results from the presence of prohibitins on the leaf surface, leaves were dewaxed with organic solvents, and the extract was applied to susceptible tobacco leaves. It was found that such extracts strongly suppressed mildew development on treated plants.

The compound responsible for the inhibition of powdery mildew was identified as a diterpene ($C_{20}H_{32}O_2$) with the structure 13(S)-hydroxylabda-8(20), 14-dien-2-one (2-ketoepimanool). When applied to the leaf surface of susceptible tobacco plants this diterpene strongly suppressed the emergence of conidial germ tubes 2 and 3 (but not of germ tube 1), and hence inhibited mildew development (ED = 1 $\mu g/cm^2$). The compound was not detected in *N. debneyii* or *N. tomentosiformis,* two other species immune to mildew, nor in three immune cultivars of *N. tabacum. (L)*

INDUCTION OF PLANT RESISTANCE TO *VERTICILLIUM DAHLIAE* BY PHENOLS

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Young tomato and eggplant seedlings in a nursery were irrigated with aqueous solutions of three types of phenols: catechol, hydroquinone and chlorogenic acid, at a concentration of 100 ppm. After 2 weeks treated and control plants were transplanted to pots containing soil infested with microsclerotia of *Verticillium dahliae* Kleb. The pots were held in a greenhouse at 22°-24°C for 5 weeks, during which time the number and height of diseased plants were recorded. After the 5-week period additional parameters were studied, *viz.*, dry weight of leaves and roots, number of nodes per plant, and total content of phenols per gram roots. Plants which had been irrigated with phenols had a maximum of 20% disease incidence, whereas 71% of the untreated control plants were diseased. The treated plants were almost twice as tall as the control (32 *vs.* 17 cm). There was an average of 5.1 g leaves and 0.7 g root per treated plant, compared with 2.6 g leaves and 0.4 g root per control plant. The total phenol content was 85 μg/g root in the untreated plants. It is considered that phenols have the potential to induce resistance. *(L)*

AN INDUCED RESISTANCE REACTION ACHIEVED BY UREA DERIVATIVES ON *MELOIDOGYNE JAVANICA* INFECTED TISSUE

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Urea (U), hydroxyurea (HU) and thiourea (TU), in various concentrations, were added to a chemically defined plant tissue culture medium on which *Meloidogyne javanica* was reared on excised tomato roots. Concentrations as low as 3 ppm HU or 12 ppm TU inhibited nematode maturation by 70-90% as determined 4 weeks after inoculation.

Observation by scanning electron microscope (SEM) revealed that the giant cells (coenocytes) in the parasitized tissue treated with HU and TU were poorly developed and usually devoid of cytoplasm. Gall weight was also inhibited by 50% in cultures treated with 3 and 6 ppm HU. However, exposure of juveniles of *M. javanica* and *Tylenchulus semipenetrans* or juveniles and adults of *Pratylenchus thornei* to increasing concentrations of HU and TU, at up to 100 ppm, was not lethal. Exposure of *M. javanica* juveniles to high concentrations of HU did not affect penetration into the root or normal development within it. The two urea derivatives still inhibited nematode maturation when the infected region of the root was not in direct contact with the chemicals. Therefore, we suggest that the urea derivatives examined inhibit nematode development by affecting the plant metabolism essential for coenocyte formation, similarly to the hypersensitive reaction in a naturally resistant plant. *(L)*

THE BIOLOGICAL ACTIVITY OF THE INHIBITOR OF VIRUS REPLICATION (IVR)

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The control of virus diseases by chemicals has so far not been successful. This is due to the close integration of the virus within the cell; those chemicals that inhibited virus replication were also harmful to the host plant. Another approach is to understand the natural resistance phenomena

known to exist in plants against viruses and to determine whether they are associated with natural antiviral substances that inhibit virus replication without detrimental effects to the plant tissue.

In this work the inhibitor of virus replication (IVR) released from resistant protoplasts was found to inhibit the replication of tobacco mosaic (TMV), cucumber mosaic (CMV) and potato virus X (PVX) in leaf discs. The inhibition rates ranged between 60% and 80% when the virus concentration was determined by infectivity or by ELISA.

IVR also inhibited replication of TMV applied through cut stems or by spray before or after inoculation. The inhibition rates ranged between 60% and 90%.

The effect of the two antimetabolites actinomycin D and chloramphenicol on IVR production and TMV replication was studied. Both materials markedly increased TMV replication in protoplasts of Samsun NN, a cultivar in which the infection in the intact plant is localized, when added up to 24 h after inoculation. No increase was observed when TMV-infected protoplasts of Samsun – a systemic responding cultivar, were incubated in the presence of these antimetabolites. On the other hand, cycloheximide depressed virus replication in the protoplasts from the two cultivars. *(L)*

ULTRASTRUCTURAL EVIDENCE FOR RECOGNITION BETWEEN PLANT AND BACTERIAL CELLS

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Historically, the study of pathogenesis during the last 35 years followed a pattern of tissue examination *(a)* just prior to symptom development, *(b)* 6-24 hours after inoculation, and most recently *(c)* moments after inoculation.

The recent trend has been to presume that the development of pathogenesis is determined moments or within minutes after contact or "recognition" between host cell and pathogen.

Terminology for the phenomenon includes *receptor* and *ligand* and more recently *cognor* (active partner) and *cognon* (passive partner, the entity that is recognized). In addition there is *molecular recognition* – which is instantaneous, probably controlled by *diffusion,* and by *cellular recognition,* which is metabolic. Cellular recognition may become evident only in hours and presupposes a second and/or a succession of reactions before becoming evident.

This presentation describes briefly the reacting surfaces of plant cell and bacterial cell in ultrastructure. In addition, we allude to the rate of reaction and precision of recognition. Finally, a series of electron micrographs are presented that portray recognition and reactions that are preludes to either pathogenesis or resistance. *(L)*

PATHOGEN PENETRATION AND BACTERIAL-PLANT PHYSIOLOGICAL PROCESSES IN BACTERIAL SPECK OF TOMATO

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Pseudomonas syringae pv. *tomato,* the causal agent of bacterial speck of tomato, possesses several mechanisms for penetration and pathogenesis in the tomato plant. In addition to its ability to penetrate through the natural openings of the leaf and through wounds, the pathogen has a limited active penetration ability. Cell-free extracts of the infected plant showed moderate cutinase and endo-polygalacturonase activities during the first 48 h of invasion both in susceptible and in resistant plants. Cutinase was found to be of bacterial origin, whereas endo-polygalacturonase

stemmed from both the bacterium and the pathogen-host interaction. Phenols extracted from resistant inoculated tomato plants inhibited endo-polygalacturonase activity.

The tomato plant's surface morphology (number of stomata, trichomes, cuticle and wax thickness) was not an important factor in enhancing or inhibiting the invasion. It was demonstrated that ammonia causes necrosis in bacterial speck of tomato. Enzyme activities responsible for ammonia production in diseased plants, such as protease and deaminative enzymes, were tested. Protease, which is a constitutive enzyme, participates in the disease syndrome at later infection stages. Activity was higher in inoculated susceptible plants than in resistant plants and isozymes originating from the host, the pathogen and the pathogenic interaction were found in extracts of diseased plants. A good regression coefficient was found between proteolytic activity and degree of disease severity in susceptible and resistant cultivars and in 21 tomato cultivars, lines and species, with a wide range of susceptibility and resistance to bacterial speck of tomato. Protease activity was located mainly near the still forming necrotic spot. As a result of proteolytic activity, free amino acids accumulated and soluble proteins decreased in the leaf. These newly formed amino acids were converted into ammonia *in vivo* by bacterial asparaginase and glutaminase. Disease severity could be enhanced by applying asparagine and glutamine to the leaves prior to inoculation. There was a decrease in the nitrogen content of diseased plants. *(L)*

CO_2 FIXATION IN CORN PLANTS INFECTED BY *EXSEROHILUM TURCICUM*

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Corn plants (cv. 'Jubilee') locally infected by *Exserohilum turcicum* were exposed to labeled carbon dioxide at 250 μEinstein $.m^{-2}$ $.sec^{-1}$ and 25°C for 1 min. Carbon fixation in the leaf tissue surrounding the infected sites was measured and compared with that in uninfected plants and in the surrounding leaf tissue of artificial lesions. Results show that carbon fixation by leaf tissue surrounding an infection site, expressed in chlorophyll units, is dependent on time lapsed from inoculation, and on the distance from the infection site. Carbon fixation in the leaf tissue surrounding the infection site was significantly higher than that in the control plants during the first 6 days after inoculation, equal during 7-10 days and declined to 56% as compared with the control plants after 13 days. The higher amount of incorporation was found at a distance of 1 cm from the infection site. No differences between the infected and the control plants were found at a distance greater than 5 cm from the infection site. The amount of chlorophyll in the leaf tissue surrounding the infection sites was 29% lower than in the control plants.

Results show that *E. turcicum* induces photosynthesis in the leaf tissue surrounding the infected sites. *(P)*

THE ROLE OF MYCORRHIZA IN PHOSPHORUS UPTAKE AND PLANT GROWTH

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During the last decade the role of mycorrhizal fungi in phosphorus uptake by higher plants has been elucidated in some detail.

In Israel, where fumigation eliminates these beneficial fungi, or where due to sparse desert vegetation little inoculum is present, the lack of these organisms has been noted frequently. Symptoms are expressed as severe stunting and a much lower phosphorus concentration in the

tissues. Among the crops affected are cotton, peanuts, onions, celery and pepper. Melon, eggplant, tomato and potato are seemingly unaffected. The high dependence of some crops on mycorrhizal infection seems to be correlated to the high phosphorus-sorbing capacities of most of our soils, due to their high $CaCO_3$ content – which can vary from 20-90%. Even at the low percent (20%) the above crops are severely stunted if no mycorrhiza are present.

Attempts to overcome the mycorrhizal deficiency by heavy applications of superphosphate, up to 3,000 kg/ha, were unsuccessful. However, when phosphoric acid, at rates of up to 40 ppm P, is added *via* fertigation through trickle systems, a highly susceptible plant species such as pepper responds very favorably.

Experiments conducted to evaluate the efficiency of mycorrhizal populations from various soils suggest that there are qualitative differences with regard to the ability of the populations to take up P. We found that populations from highly P-sorbing soils were much more effective with regard to P uptake and subsequent plant growth effects than populations from less sorbing soils. *(L)*

SPECIES AND QUANTITY OF VESICULAR-ARBUSCULAR MYCORRHIZAL FUNGI IN ISRAEL

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Soil samples were collected in October and November 1982 from fields planted with onion or pepper in all the regions of the country in which these crops are grown. Spores of vesicular-arbuscular mycorrhizal (VAM) fungi were extracted by wet sieving (37-1000 μm) and centrifuging in 50% sucrose. Spore populations were usually less than 0.05 spores/ml soil and too low for reliable identifications to be made. Infective propagule number estimated by a most probable number technique, was found to be 0-1.7 (median 0.2) propagules/ml.

To encourage fungus activity and spore production, melon plants were grown for 3-6 months in the sampled soil mixed with sterile sand (1:1). The melon roots were often colonized by VAM fungi and there were 0-13 (0.6) spores/ml of the soil + sand mix. Generally only one species was found per sample. *Glomus macrocarpum* var. *macrocarpum* was the most common species, followed by *G. mosseae* and *G. fasciculatum*. A few spores of other *Glomus* and *Acaulospora* spp. were occasionally present. There were no significant differences between the species or quantity of VAM fungi obtained from either crop or from the various geographic regions of the country. *(L)*

IMPROVEMENT OF THE MPN (MOST PROBABLE NUMBER) TEST FOR QUANTITATIVE ESTIMATION OF INOCULUM OF VESICULAR-ARBUSCULAR MYCORRHIZAL (VAM) FUNGI

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The bioassay used for determining the inoculum potential of soil cultures of the non-culturable fungi of vesicular-arbuscular mycorrhiza (VAM) was studied. The commonly used method consists of seeding a host plant into a soil dilution series and, using the percent of infected plants in each dilution, estimating the non-diluted inoculum level by most probable number (MPN) statistics. Initially, test plants were studied for their ability to become infected by VAM

fungi. Five crop species – wheat, tomato, pepper, onion and melon – were planted in artificially infested soil. Four weeks after seeding, the percent of roots infected with VAM-fungi was determined. Melon had the most infection and was chosen as the test plant. Several sources of soil inoculum were diluted with sterile sand in a ten-fold series, seeded with melon, and maintained in a greenhouse chamber at 25°C. Samples of ten plants were taken 3, 4, 5 and 6 weeks after seeding. Inoculum potential of the original inoculum of each culture, estimated by the MPN method, remained fairly constant between 3 and 5 weeks after seeding; this corresponded to the time the second true melon leaf was expanding and had fully expanded. Subsequently, the estimated MPN increased rapidly.

We suggest using a plant like melon, which germinates rapidly and becomes infected quickly, and conducting the MPN determination 3-4 weeks after seeding, when the inoculum estimations are least affected by the stage of host development. *(P)*

F: POSTHARVEST DISEASES

SOME ASPECTS OF THE MYCOTOXIN PROBLEM: AN ISRAELI VIEWPOINT

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Mycotoxins, secondary metabolites produced by fungi in foodstuffs, endanger the health of humans and animals. Most of the fungi producing mycotoxins are saprophytic species belonging to the genera *Aspergillus, Fusarium* and *Penicillium.* Since the discovery of aflatoxin some 20 years ago, more than 100 toxins have been isolated from fungi. Effects produced by these toxins are, *inter alia,* carcinogenic tumors in liver, kidney hypertrophy, skin lesions, emetic response, abortion and sterility. Outbreaks of disease in animals have been correlated with the presence of mycotoxins in foodstuffs; circumstantial evidence also exists of the involvement of mycotoxins in human diseases.

Aflatoxin is the most extensively studied mycotoxin, and its widespread occurrence in nature is well documented, whereas the presence of other mycotoxins occurring as natural contaminants was reported only in the last decade. Some countries have specific regulations stipulating the maximum permissible aflatoxin content in food or feedstuffs; this amount ranges from 0 to 20 ppb. In Israel, the presence of aflatoxin is unacceptable in food for human consumption. In routine tests carried out by the Department of Stored Products at the ARO in selected imported and exported foodstuffs, aflatoxin has been detected in Israeli grown peanuts and in imported corn.

Mycotoxin determination is time-consuming, expensive and not highly specific. The HPLC methods developed recently for mycotoxin analysis enable the detection of smaller amounts than by TLC. Serological methods for mycotoxin detection, although only in their early stages, appear to be promising principally because of their high specificity. In the search for mycotoxin detoxification, studies carried out using ammonia have shown positive results regarding aflatoxin detoxification. Although grains treated with ammonia are of lower grade, this does not prevent their use when they are destined for animal consumption. This treatment has not yet been investigated in Israel. There is also a need to study the effects of some other chemicals on aflatoxin, as well as their influence on some other mycotoxins. *(L)*

ACCUMULATION OF OCHRATOXIN A IN SCLEROTIA OF *ASPERGILLUS OCHRACEUS*

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The mycotoxin ochratoxin A can be produced by *Aspergillus ochraceus*, a mold commonly found in foodstuffs. The fungus may also form sclerotia which can persist under adverse conditions and pass through the food-processing procedures along with the inoculated grains. The possibility that sclerotia contain ochratoxin A was examined. One g sclerotia contained 1.25 μg ochratoxin A as compared with 16.5 μg detected in 1 g (dry weight) of mycelia. A similar quantity of toxin (16.5 μg) was found to be released into the medium in which mycelium was grown. This represents the first report on ochratoxin being detected in *A. ochraceus* sclerotia. The concentration of ochratoxin in sclerotia stored for 2, 6 or 12 months at either 4° or 26°C did not decrease. In a study of the effect of some chemicals on the destruction of ochratoxin, it was found that the concentration of the toxin in sclerotia was not influenced by their exposure for 48 h to 50 or 500 mg/l methyl bromide, or on examination 7 days after treating the sclerotia with concentrated ammonium hydroxide (2% or 5% v/w) or ammonium propionate (2% v/w 'Luprosil'). None of these three compounds decomposed the pure toxin after a similar period. Similarly, exposure of sclerotia to a mixture of methyl bromide + phosphine in a commercial fumigation of corn grains did not affect the ochratoxin level in the treated sclerotia. *(L)*

DEVELOPMENT OF FUNGI IN SOYBEAN SEEDS AND ITS RELATIONSHIP TO THE INCREASE IN FREE FATTY ACIDS DURING STORAGE

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Soybeans (grade II) imported to Israel from the United States were examined by scanning electron microscopy. Intact seeds were almost free of microorganisms, but profusely developing fungal mycelia were frequently observed in cracked coats and on damaged sites of broken beans. Bacteria were found only sporadically. Fungi penetrated the beans through cracks and through the micropyle. No penetration through the hilum or porelike structures could be observed. The penetrating fungi developed over the cotyledons, along the concavities between adjacent cells. Light microscope observations of sections of naturally infested beans showed little penetration into the cotyledons. However, sections of beans kept at high relative humidity (95%) at 26°C for 7 days, revealed profusely developing fungi colonizing both seed coat tissue and cotyledon.

In naturally occurring broken beans, free fatty acids (FFA) content was 0.45%, as compared with 0.3% in intact beans. After storing the beans for 2 months at 95% RH and 26°C, the amount of FFA in the broken beans reached 10.0%, *vs.* 2.0% in intact ones. Mold count of stored beans revealed 10^6 propagules/g in broken beans and 10^5/g in intact ones, *vs.* 10^2/g in both fractions before storage. CO_2 output in broken beans reached 208 mg CO_2/100 g dry matter/24 h *vs.* 45 mg in intact ones. Captan (2 g/100 g beans) added to seeds subsequently kept for 2 months at 95% RH and 26°C did not prevent fungal development and the FFA content of the treated seeds was similar to that of untreated seeds. *Aspergillus candidus* was the dominant fungus; *A. ruber, A. versicolor* and *Penicillium cyclopium* were found less frequently. All the isolated fungi showed lipolytic activity, and *A. candidus* was the most active. Autoclaved and nonautoclaved beans

inoculated with single isolates and incubated at 95% RH and 26°C for 2 months, developed high, similar levels of FFA, indicating that these fungi are involved in the FFA increase in soybeans during storage. *(L)*

FOSETYL-AL AS A POSTHARVEST TREATMENT AGAINST BROWN ROT IN CITRUS FRUITS

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Brown rot in citrus fruits is caused by *Phytophthora citrophthora* in the grove, in the packing house, during handling and during storage. The fungal mycelium developing on the peel surface of the infected fruits causes a contact inoculation of the healthy adjacent fruits in the packed box. Recently metalaxyl – a relatively new systemic compound – was investigated and found to be effective against brown rot as a postharvest treatment in the packing house. Concomitantly, we investigated the influence of another new systemic compound, fosetyl-Al, of which the results are given herein.

Fosetyl-Al in aqueous solution at concentrations between 5,000 and 10,000 ppm controlled the fungus already located in the fruit. The longer the time elapsed after inoculation, the less effective the treatment. Fosetyl-Al incorporated in the wax coating of the fruits was more effective than in aqueous solution, probably as a result of better absorption under conditions of higher humidity, but fosetyl-Al at higher concentration caused hardening of the wax. Fosetyl-Al controlled brown rot when inoculated at the stem end zone (vascular bundles) of the fruit. In treated healthy fruits, the compound had a good prophylactic effect against contact infection during storage. It was also found to have a fungicidal effect against other fungi pathogenic to citrus fruits, which was greater against mold and less against sour rot. It had a fungicidal effect in *in vitro* tests, but only at higher concentrations. *(L)*

IMPROVING DECAY CONTROL OF POSTHARVEST CITRUS MOLDS BY CHANGING THE MODE OF APPLICATION OF FUNGICIDES

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Postharvest treatment with fungicides on citrus fruit in the packing house was found to be more effective when the material was applied in water instead of in wax, the commonly used fungicide carrier. The biological activity of the fungicide thiabendazole (TBZ) gave similar decay control with 4g TBZ per ton of fruit when applied in water suspension, as with 7g TBZ per ton, the amount commonly used in the wax. Similar results were achieved with other fungicides.

This reduction in the amount of fungicides which are being applied to the fruit has the following three main advantages: (i) significant reduction of residues on the fresh fruit; (ii) improvement in the decay control of citrus molds; and (iii) saving of money by reducing the amount of fungicides which is needed to achieve decay control. *(L)*

INVOLVEMENT OF A PREFORMED ANTIFUNGAL COMPOUND IN THE LATENCY OF *COLLETOTRICHUM GLOEOSPORIOIDES* ON UNRIPE AVOCADO FRUITS

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Peel of unripe avocado fruits contained the preformed antifungal compound cis,cis 1-acetoxy-2-hydroxy-4-oxo-heneicosa-12,15-diene. Concentrations of the compound decreased during fruit ripening, coincident with the renewed development of previously latent peel infections by *Colletotrichum gloeosporioides*. The purified diene was observed to be oxidized *in vitro* by lipoxygenase extracted from avocado peel and by soybean lipoxygenase. The specific activity of lipoxygenase in peel extracts also increased by 80% during the climacteric stage, coincident with a rapid decrease of the concentration of the diene in fruit peel, and before symptoms of *C. gloeosporioides* infections were expressed.

Infiltration of fungus-inoculated fruits with α-tocopherol acetate before ripening led to a reduction of only 40-50% in the diene compound and fungus development in the peel was delayed.

The evidence supports the hypothesis that the preformed antifungal compound is the cause of *C. gloeosporioides* infections remaining latent in unripe avocado peel and that subsequent active infections result from the metabolism of the diene during ripening, which in turn may result from the activity of lipoxygenase. *(L)*

CONTROL OF GRAY MOLD IN STORED STRAWBERRIES BY PREHARVEST FUNGICIDAL SPRAYS

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The gray mold caused by *Botrytis cinerea* Pers., which is the main postharvest disease of strawberries, is initiated by infection of the young fruit in the field. Field sprays with iprodione or Drawifol (CO 6054; metomeclam; 1-(3,5-dichlorophenyl)-3-methoxymethyl)-pyrrolidine-2, 5-dione) applied once a week during 2 months of growth markedly decreased rot development in cv. 'Aliso' strawberries stored in export plastic baskets packaged in stretched PVC wrappers. Incidence of decay after 8 days in cold storage (2° C) and 2 additional days of shelf-life conditions (20° C) was 2% and 3% following iprodione and Drawifol treatments, respectively, as compared with 76% in the untreated fruit. Field treatments were still effective 2 weeks after the weekly sprays had been stopped.

The two fungicides markedly reduced *Botrytis* spore germination, mycelial growth, sporulation and sclerotia formation. In the presence of 1 ppm of iprodione or Drawifol in the culture medium, decreases of about 65% and 55%, respectively, in spore germination and of 88% and 95%, respectively, in mycelium growth were recorded after 6 days at 23° C. This concentration totally inhibited sporulation and sclerotia formation in culture. At sublethal concentrations the two chemicals caused a prolongation of the incubation period of the fungus, of up to 4-6 days at 23° C as compared with 24 h for the untreated cultures. The two compounds were effective also on *Botrytis* strains resistant to benzimidazole, the rate of mycelium growth-inhibition of the resistant strain being usually greater than that of the sensitive one. *(P)*

RESPIRATORY CO_2 RETARDS DECAY IN STORED BROCCOLI PACKAGED IN SEALED POLYETHYLENE BAGS

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Packing broccoli heads in sealed polyethylene bags (0.04 mm thick) kept the commodity green and fresh during 14 days of cold storage (0.5°C) and 3 additional days of shelf-life (20°C). Decay under these conditions was almost completely inhibited. The respiratory CO_2 level increased during the first 24 h of storage up to about 8%, after which it stabilized at 2-3%. Transferring the commodity to shelf-life conditions resulted in the elevation of the gas concentration to 8.5-13%. O_2 concentration decreased to about 16% at the end of cold storage and to 8.5-12.5% under shelf-life conditions. Wrapping the heads in PVC stretch film (control) resulted in a marked yellowing after only 24 h of shelf-life. The rate of decay under these conditions generally exceeded 50%, being caused mainly by *Alternaria alternata* and *Botrytis cinerea.*

A marked decrease in rot development in the discs of the broccoli flower buds, inoculated with *B. cinerea* spore suspension, was observed after being held in a 10% CO_2-enriched atmosphere. An atmosphere of 12% CO_2 caused a direct decrease of 25% and 15% in mycelial growth of *B. cinerea* and *A. alternata,* respectively.

The decrease in the O_2 level during storage was insufficient to have a direct effect on either host senescence or fungal development. The suppression of rot development was related mainly to the effect of CO_2 accumulated in the sealed bags, which delayed the senescence process of the commodity and maintained its natural resistance to decay. *(L)*

G: EPIDEMIOLOGY OF VIRUSES

GRAPEVINE STEM-PITTING DISEASE IN ISRAEL

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The grapevine stem-pitting disease (Legno riccio) was found in vineyards throughout Israel, with symptoms appearing on different rootstocks and on both table and wine varieties. The severity of the disease depends, in grafted grapes, on the combination of rootstock and scion, but severe cases of the disease have been found in varieties growing on their own roots. Typical symptoms consist of pitting and grooving on the surface of the wood and corresponding inversed relief in the bark. In some cases leaf symptoms such as mosaic and yellowing were seen. The disease causes reduction in yield quality of grapes and degeneration of the plants.

Investigation of the vineyards in the Hebron area showed that among the main varieties (not grafted) grown there, 'Zeini' was free of the disease, the incidence of disease in 'Dabuki' was about 40%, and in 'Beitumi' and 'Shami' nearly 100%. In the Samaria region, where grafted grapes were examined, the rootstock 110R was found to be fairly resistant in combination with 'Carignan', whereas 216-13 was highly sensitive and 41B less sensitive. The wine variety 'Petite Sirah' growing in Yizre'am was found to be infected, and was rooted out from the virus-free plot.

The mode of transmission of this disease is not yet known, nor has the causal agent been characterized. *(L)*

BEET WESTERN YELLOWS VIRUS IN ISRAEL

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Premature yellowing of sugar beet and lettuce has been noticed for many years in Israel. It was demonstrated for the first time in Israel that these plants are infected by beet western yellows virus (BWYV). The identification was based on aphid transmission to indicator plants, serology (double sandwich enzyme-linked immunosorbent assay) and immunosorbent electron microscopy, where isometric particles resembling BWYV virions were observed. Besides sugar beet, red beet and lettuce, BWYV could be identified in turnip, radish and mangold at incidences of 2%-61%. BWYV was also identified in the following weeds: shepherd's purse (58%), *Brassica kaber* var. *pinnatifida* (14%), *Raphanus raphanistrum* (32%), and *Senecio vulgaris* (8%).

Isolates of BWYV from Israel were not able to infect potato (cvs. 'Désirée', 'Blanca', 'Russett Burbank' and 'Cara'), *Datura stramonium, D. tatula,* tomato, *Petunia hybrida* or pepper (cvs. 'Maor' and 'Zahov Naharia'). However, in view of results that BWYV might be involved with the potato leaf roll disease, our seed potatoes from the Golan Heights are assayed regularly. As yet, no BWYV was found in these potatoes or in other plants in the Golan area. Among the indicator plants *Crambe abyssinica* seems to be the most reliable and a high correlation coefficient was found between infection revealed by symptoms to this host and infection indicated by serology. The correlation coefficient was much lower with the known indicators: shepherd's purse and *Physalis floridana.* *(L)*

BEET MOSAIC VIRUS IN ISRAEL

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Sugar beet plants exhibiting mosaic symptoms were observed in various regions of Israel; the yield in infected fields was reduced. The causal agent of the disease was identified using various methods: (i) Mechanical inoculation to a series of herbaceous plants, which reacted typically to beet mosaic virus on *Chenopodium amaranticolor, Beta vulgaris* (sugar beet, mangold) and *Gomphrena globosa.* (ii) Insect transmission trials were conducted with *Mysus persicae* and *Aphis gossypii.* Aphids were fed for different acquisition periods on infected sugar beet plants, and transferred to healthy sugar beet plants for an inoculation period. The virus was transmitted after 1 and 15 minutes of acquisition feeding and failed to be transmitted after 24 hours of acquisition feeding, which proved that it is a non-persistent virus. (iii) The causal agent was purified from infected sugar beet plants using a procedure described by Gruntzig and Fuchs, and the purified preparation was found to be infectious. Antiserum against the virus was prepared by injecting rabbits with this purified preparation. (iv) Electron microscopy of the purified preparation revealed elongated particles 800 nm in length and 15-18 nm in diameter. (v) Using double immunodiffusion tests with SDS (sodium dodecyl sulfate) and enzyme-linked immunosorbent assay (ELISA), purified preparations as well as crude sap from infected plants reacted positively with BMV antiserum (received from Germany). (vi) Immune electron microscopy performed according to Milne and Luisoni, using beet mosaic virus antiserum, decorated virus particles from purified preparations.

The causal agent of this disease was positively identified as beet mosaic virus based on host range, insect transmission, virus particles and serology, which were all in agreement with the data published on beet mosaic virus. *(P)*

STRAINS OF MAIZE DWARF MOSAIC VIRUS IN ISRAEL

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In a survey of sweet corn carried out in its common growing areas in Israel, two strains of maize dwarf mosaic virus (MDMV) were identified, and designated as MC and MD, respectively.

Both strains induce mosaic symptoms on corn and Johnson grass, the latter serving probably as a natural source for virus spread. Strain MC induces mosaic in some common sorghum cultivars, while in the same cultivars strain MD is responsible for the appearance of red lesions which coalesce, resulting in withering of the whole leaf and ultimately in death of the plant. Strain MD is a potential threat to sorghum cropping in Israel. The MD and MC strains reacted differently from the American strains on some differential hosts.

The serological relationships between the local strains and some foreign strains of MDMV were determined by SDS immunodiffusion test, enzyme-linked immunosorbent assay (ELISA) and immunosorbent electron microscopy. MC was found to be related but not identical to MD. Furthermore, the strains reacted differently with antisera of sorghum red stripe virus, MDMV-A and sugarcane mosaic virus strain H.

A reduction of 30% in ear yield was recorded in infected corn plants inoculated at the three-leaf stage with any of the strains. MD induced severe dwarfing as compared with MC, and MD-inoculated plants reached only 75% of the height of control plants. No significant reduction in ear yield was detected in corn plants inoculated at the seven- or eight-leaf stage.

Oil sprays were not effective in controlling the disease. However, soil mulching with transparent plastic sheets reduced inoculation levels in the field by 75%, thereby providing effective protection to the crop at the critical growth stage. *(L)*

TOBACCO STREAK AND STRAWBERRY MOTTLE VIRUSES IN STRAWBERRIES IN ISRAEL

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A recent survey of the viruses affecting strawberry cultivars in Israel revealed the presence of two viruses at one location where slow-developing, stunted plants were found. Necrotic shock symptoms were observed in the indicator *Fragaria vesca* var. *semperflorens* ('Alpine'), following grafting of leaves from infected field plants. Tobacco streak virus (TSV) was transmitted mechanically from plants with necrotic shock symptoms to a series of herbaceous test plants and caused typical symptoms of this virus. TSV was detected serologically by the enzyme-linked immunosorbent assay (ELISA), both in field plants and in indicator plants carrying the virus.

Strawberry mottle virus (SMV) caused typical leaf symptoms in *F. vesca* (clones UC-4 and UC-5) following grafting of leaves from infected plants, and was transmitted by the aphid *Chaetosiphon fragaefolii*. This major aphid vector of strawberry viruses was recently found in northern Israel on strawberry plants in the field. This is the first evidence that the aphid is present in Israel.

SMV is an aphid-borne virus known only in strawberries, whereas TSV is a pollen-borne virus known to infect a wide range of plants from different families and may represent a potentially serious problem to strawberries and other crops. This constitutes the first report of the occurrence of these two viruses in Israel. *(L)*

SEPARATION OF VIRAL PROTEINS FROM BULBOUS IRIS BY GEL ELECTROPHORESIS

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Commercial stocks of bulbous iris in Israel are infected with iris mild mosaic virus (IMMV); in addition, iris severe mosaic virus (ISMV) is very common. These are poty viruses found only in bulbous iris. In Israel two additional viruses were found in this plant: bean yellow mosaic virus (BYMV), a poty virus with a great variety of hosts, and narcissus latent virus (NLV) from the carlaviruses group, found also in narcissus cultivars and *Nerine* spp.

Identification of IMMV, ISMV and NLV is difficult because of the lack of specific test plants. These viruses and BYMV have particles of similar size as well as a coat protein subunit of 33,000 daltons for three of them. Therefore, a rapid method to identify the viruses in iris plants was sought, which eventually will facilitate the preparation of specific antisera. The identification procedure was based on the existence of specific cylindrical inclusions in poty virus-infected plants. Partial purification, based on organic phase separation and PEG (polyethylene glycol) adsorption, sedimented the cylindrical inclusions together with the viral particles and very few host proteins. The resulting polypeptides of SDS (sodium dodecyl sulfate) disruption were separated by gel electrophoresis on a 5-15% polyacrylamide gradient gel, containing 0.1% SDS. The different cylindrical inclusions were found to be composed of different size polypeptides: 69,000 daltons for IMMV, 71,000 daltons for ISMV, 73,000 daltons for BYMV and 44,000 daltons for NLV. These differences were consistent and sufficient to distinguish the various viruses infecting bulbous iris plants. *(L)*

TRISTEZA IN CITRUS GROVES IN ISRAEL: A REVIEW OF THE NATIONAL SURVEY AND ERADICATION PROGRAM

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In July 1969 a national survey for the detection and eradication of citrus tristeza virus was launched. From then until February 1983 about 2,200,000 citrus trees were sampled and analyses for the presence of tristeza virus were carried out by the ELISA procedure. Of the total number of trees examined, about 600,000 were in a census conducted repeatedly in infected plots, and around trees serving as a propagation source. The survey, based on sampling 60 trees per area of 5 ha, revealed some infected sites. Upon discovery of an infected site, a census is carried out, in which every tree in the infected plot is sampled. By February 1983 5,600 infected trees were discovered, most of them in 17 large sites. Five of these sites contained three-quarters of all infected trees found. Around these heavily infected sites, where the initially discovered infection level was > 15% of the tree population, the entire plot was uprooted. Two of these sites were discovered in 1981 and eradication was carried out as soon as virus infection was found. In 1982 and 1983, the number of infected trees at those sites was reduced.

Near Kefar Yona a large active site of infection was discovered in 1980; eradication, however, was not conducted properly, and tristeza was found to have spread to neighboring plots. In the Hibbat Ziyyon area eradication has been carried out since the initial discovery of infection in 1970, yet no epidemic outbreak of the disease occurred, indicating the efficiency of the program. We expect to find during the present year about 2,000 infected trees, mainly around known active sites.

The proper practice of eradication may be the only means to delay or prevent the outbreak of a tristeza epidemic, similar to the system in other citrus-growing countries. *(L)*

THE APPLICATION OF GENETIC ENGINEERING TECHNIQUES FOR DIAGNOSING CITRUS TRISTEZA VIRUS

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Citrus tristeza virus (CTV), which causes a serious disease of citrus plants, is a member of the closterovirus group, the virus particles being 2000 nm long and 10 to 12 nm wide. Using purified CTV preparations, a homogeneous single-stranded RNA with an estimated molecular weight of 6.5×10^6 to 7.0×10^6 was isolated.

Complementary DNA to citrus tristeza virus (CTV) genomic RNA sequences were synthesized *in vitro*, converted to double-stranded cDNA and inserted into the pBR322 plasmid of *E. coli*. Clones harboring viral sequences were detected by colony hybridization with a ^{32}P labelled viral RNA probe. Hybridization patterns to northern blots of viral RNA indicated the presence of three types of clones: (I) clones hybridizing with a distinct narrow band; (II) clones hybridizing with a broader band; and (III) clones hybridizing with several distinct bands. All the clones positively hybridized with the full length viral genomic RNA. Similar patterns were obtained respectively when these clones were hybridized to purified double-stranded RNA from CTV-infected plants.

Strains of CTV are numerous and vary considerably in their effects on citrus trees. Strain typing on the basis of biological tests is difficult and time-consuming. The availability of a molecular probe for CTV is expected to have practical application in diagnosing CTV strains by rapid biochemical tests, and it will enable elucidation of the molecular structure and diversity of the virus. *(L)*

DEMATOPHORA ROOT ROT ON AVOCADO TREES IN ISRAEL AND DEVELOPMENT OF A DIAGNOSTIC METHOD

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Dematophora disease or white root rot of avocado trees is caused by the fungus *Rosellinia necatrix* (anamorph: *Dematophora necatrix)*.

In the summer of 1980, the disease was found in the avocado orchard of Kibbutz Hanita. Severe damage was caused in this orchard, about 300 15-year-old trees being killed in an area of 1.1 ha. The following summer, the disease was found at five additional sites. The fungus attacks the roots of the trees, causing rot covered with white characteristic mycelium. Symptoms on the upper parts of the trees are yellowing of leaves, wilt and degeneration, leading to drying out and death of the trees.

Mexican and West Indian rootstocks and seedlings were tested by artificial inoculation with avocado isolates. All these rootstocks and seedlings were susceptible to the disease and were killed by the fungus.

In avocado trees diseased with *Dematophora*, viable mycelia of the fungus were found in infected roots at a depth of 100 cm from the soil surface.

A method for qualitative and quantitative isolation and identification of *Dematophora* from soil was developed, based on burying 1.8-cm-diam discs of fresh green avocado leaves, as traps for *Dematophora*. The discs were arranged in two layers in the soil in closed plastic containers. Soil moisture was adjusted to field capacity. The sealed containers were incubated at 25°C for 12 days, the discs then washed free of residues, and kept in a moist chamber for 2-3 days. The colonized discs developed a white characteristic mycelium and changed color to cream or light brown, while the non-colonized discs remained green or were dark brown. A good correlation (r=0.98) was found between the percentage of leaf discs colonized by the pathogen and the level of soil infestation. This allows use of the method for quantitative assessment, in addition to qualitative identification of the fungus. *(L)*

DEVELOPMENT OF A SENSITIVE METHOD FOR DETECTING ANGULAR LEAF-SPOT IN CUCUMBER CAUSED BY *PSEUDOMONAS SYRINGAE* PV. *LACHRYMANS*

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A new, sensitive method for the detection of low cell populations of *Pseudomonas syringae* pv. *lachrymans* and *P. syringae* pv. *tomato* in plant tissue, rhizosphere, soil and seeds was developed. Cultures of each of these two pathogens were grown on modified King-B broth medium containing Penicillin G. They were incubated for 48 h at 28°C on a shaking water bath. After incubation the cells were removed by centrifugation and the supernatant was kept and processed further. Separation of the water-soluble fluorescent pigment was done by extraction with an acetone-chloroform mixture. The aqueous phase containing the green fluorescent pigment gives a specific pattern of emission spectrum using a fluorimeter for each of the pathogens examined.

Estimation of cell number was done by using serial tenfold dilutions. The number of bacteria was estimated by the MPN (most probable number) procedure on modified King-B medium. The results indicate that by using this method it is possible to detect as few as ten cells per ml, in comparison with 10^2-10^5 cells per ml by conventional means, such as agar plating and serological methods. *(P)*

DEVELOPMENT OF A SERODIAGNOSTIC METHOD FOR GALL-FORMING BACTERIA IN GYPSOPHILA

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The bacterium *Erwinia herbicola*, which is the cause of gall formation in gypsophila, does not differ from saprophytic epiphytic bacteria. Several serological methods were examined for their capacity to differentiate between the pathogenic and saprophytic bacteria. Among these, one method was chosen which gave the best distinction and also enabled efficient diagnosis of a large number of samples.

A number of antisera prepared in rabbits against the bacterium *E. herbicola* were tested and found to be positive by the methods of Ouchterlony, agglutination and direct enzyme-linked immunosorbent assay (ELISA). Since the antibody titre in these tests and also the specificity of the reactions with non-pathogenic bacteria were unsatisfactory, the inhibition of indirect ELISA was tried. Wells in polystyrene plates were coated with extracts of *E. herbicola* treated with 90% phenol. The inhibition of antiserum binding to the *E. herbicola*-coated wells was tested with standard bacterial suspensions and also with unknown samples. For detection of the reaction,

goat antibodies to rabbit gamma-globulin conjugated with alkaline phosphatase were used. Inhibition of rabbit anti-*E. herbicola* serum by field isolates of pathogenic *E. herbicola* was found. This method enables detection of pathogenic bacteria also in mixed populations. *(P)*

VIRUS DISEASES IN ROSES

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Severe symptoms of deformations, dwarfness, drying and death are characteristic for a group of rose diseases known as "dieback" or "rose wilt." The diseases can be transferred in most cases to indicator plants and are suspected to be viral in nature. However, no specific causal factors have yet been isolated or characterized.

Another, very common group of viral rose diseases is called "rose mosaics." Diseased plants are either visually symptomless or bear multiform weak foliage symptoms. A complex of several well characterized viruses is associated with rose mosaics. Prunus necrotic ring spot virus (PNRSV) is the dominant component of this complex. Its detection in a rose plant indicates the presence of the disease.

Rose mosaic was identified in Israel in the early 1960s, at which time an eradication project was undertaken. Identification of PNRSV was performed by grafting dormant eyes from a suspected source to a rosaceous perennial indicator. Recently, an enzyme-linked immunosorbent assay (ELISA) technique was attempted in order to replace the expensive and laborious indexing by grafting inoculation.

The highly nonspecific reaction of crude rose extracts in ELISA tests was minimized by adsorbing the enzyme-conjugated antibody with healthy peach leaf extract. By this modification the sensitivity of ELISA was increased three- to fourfold and thus enabled rapid routine detection of infected plants. *(L)*

I. DISEASES OF FLOWERS

EFFECT OF TEMPERATURE ON THE LIFE CYCLE OF STATICE RUST CAUSED BY *UROMYCES SAVULESCUI*

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Statice rust caused by *Uromyces savulescui* is autoecious. Uredia, telia and pycnia were found on cultivated and wild *Limonium sinuata* (=*Statice sinuata*) in Israel. No classical aecia were noted. The life cycle seems to be determined by temperature. Rust starts in new crops or new growth of the perennial plant with pycnia, which are soon surrounded by teliopores which germinate readily. Further development in autumn and winter is mainly by pycnial and telial stages, with basidiospores as the dispersal units. During early spring, as temperatures rise, there is a shift toward uredospore production. From then on throughout summer, the uredial stage dominates. At the beginning of autumn teliospores are formed in the uredia and independent telia also appear. Statice rust may be considered as a bifunctional rust, operating as a microcyclic rust in winter and as a macrocyclic rust in summer. Inoculations under controlled conditions have shown that: (i) Basidiospore inoculations result in pycnia formation at temperatures up to 20°C; at 22°C and 25°C no infection occurs. (ii) Uredospore inoculations result in production of both uredia and telia at 5°, 10°, 13°, 15°, 18°, 20°, 22° and 25°C; at 5-15°C the telia dominated. *(P)*

CONTROL OF *BOTRYTIS CINEREA* IN ROSES

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Trials were performed for the control of *Botrytis cinerea* in greenhouse-grown roses during two winter seasons. One-year-old 'Gabriella' rose plants were given eight consecutive sprays from 15.XII.81 to 7.II.82, using a spray volume of 1500 l/ha. There were four replications (single row of 7 m) per treatment, which consisted of Rovral WP (50% iprodione) at a concentration of 0.1% (formulated product), Euparen WP (50% dichlofluanid) at 0.2% and 0.3%, and an untreated control. The infected branches were counted at weekly intervals until 25.II.82. Euparen reduced the number of infected branches, compared with that of the control, by 70% and 69% at 0.2% and 0.3%, respectively; Rovral reduced the infection by 65%.

Five consecutive sprays (from 17.II to 17.III.82) using a spray volume of 2000 l/ha, were applied to 'Golden Time' roses which were heavily infected with *Botrytis*. There were four replications (10 m^2 bed) of the following treatments: Euparen 0.2%, Rovral 0.1%, Drawifol WP (50% metomeclam), and an untreated control. The number of infected branches (counted on 18.III.82) was reduced in a similar manner by Euparen and Drawifol, *i.e.*, 78% and 81%, respectively; control with Rovral was inadequate (26%).

Results of the two trials show that the increase in resistance of *B. cinerea* to Rovral may be countered by the use of Euparen, a relatively old protectant fungicide. Euparen may be used until such time as a new fungicide with greater efficacy comes on the market. In addition, the new product, Drawifol, may also have potential as an alternative to Rovral. *(P)*

THE BIOLOGY OF GALL DEVELOPMENT IN GYPSOPHILA INFECTED WITH *ERWINIA HERBICOLA* AND *AGROBACTERIUM TUMEFACIENS*

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Dipping of *Gypsophila paniculata* cv. 'Bristol Fairy' cuttings in bacterial suspensions of *Erwinia herbicola* (EH) or *Agrobacterium tumefaciens* (AT) before rooting under mist, resulted in gall development during rooting.

With identical inoculum levels (5.10^8/ml) and cooling conditions, development of visible galls by EH was faster (50% galled cuttings in 10 days) than by AT (50% in 25 days). However, the rate of growth of individual galls incited by AT was greater and both reached equal size in 42 days. EH-galled plants have few or no roots, while with AT-galled plants roots are formed, but to a lesser extent than on healthy plants. EH galls were friable and brownish, while AT galls were hard and white.

The percent of EH-galled plants (42 days after inoculation) rose with increasing bacterial concentration from 2.5% with 5.10^2/ml to 100% with 5.10^5/ml, and gall size increased from 10 to 425 mg with bacterial suspensions of from 5.10^2 to 5.10^6/ml, respectively. With AT, 100% galled plants were reached with 5.10^6/ml bacteria, but gall size increased gradually from 194 to 1344 mg with inoculum levels of 5.10^4 to 5.10^9/ml, respectively.

Population counts of bacteria during gall formation showed a constant increase of EH in galls from 5.10^2/mg on day zero to 5.10^6/mg on day 56. In AT-incited galls the pathogen levels were constant on a per-gall basis and therefore declined when expressed on a per-mg tissue basis, to 5.10^3/mg on day 56. *(P)*

SOFT ROT OF GYPSOPHILA CUTTINGS UNDER MIST PROPAGATION AND TRIALS FOR ITS CONTROL

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The soft rot of stem cuttings of *Gypsophila paniculata* cv. 'Bristol Fairy' under mist conditions is caused by *Pythium aphanidermatum* and *Rhizoctonia solani.* In sterilized rooting media infested artificially by each pathogen alone and by a combination of both pathogens, disease spread occurred at similar rates. Complete rot of stem cuttings occurred within 12 days in infested media. When inoculated by zoospore suspensions of *P. aphanidermatum,* a similar disease incidence developed within 8 days in cuttings maintained under the same conditions. In rooting media infested with both pathogens, only *R. solani* was isolated from decayed cuttings; nonetheless, *P. aphanidermatum* could be isolated readily from the infested medium. Airborne reinfestation of cuttings in sterilized media was due primarily to *P. aphanidermatum,* and to a lesser extent to *R. solani.*

The efficacy of various combinations of fungicides for control of *R. solani* – quintozene (Terrachlor 75 WP), tolclofos-methyl (Rhizolex 50 WP), pencycuron (Monceren 50 WP), furmecyclox [N-cyclohexyl-N-methoxy-2,5-dimethyl-3-furancarboxamide; Campogran (BAS 389) 50% EC] and prothiocarb (Previcur 70 EC) – was evaluated in weekly spray applications. Results showed that mixtures containing fenaminosulf (Dexone) or quintozene failed to give adequate control, while mixtures of pencycuron or tolclofos-methyl with prothiocarb protected cuttings against decay by both fungi for 50 days. In non-infested media fenaminosulf prevented rooting of cuttings; quintozene and the combination of furmecyclox with prothicocarb resulted in a 50% reduction in rooting. The greatest level of rooting occurred in cuttings treated with tolclofos-methyl or pencycuron alone or in combination with prothiocarb. *(P)*

ANTHRACNOSE DISEASE OF ANEMONE

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Anthracnose disease of anemone caused by *Colletotrichum gloeosporioides* first appeared in Israel in 1978. The pathogen was imported with corms and spread to local and wild anemones. It survived in corms left in the ground through the summer. Examination of corms imported from Europe during 1979 and 1980 revealed disease incidence up to 70%. As a result, the import of anemone corms was stopped; the disease has not been found during the past 2 years in anemone grown from seed or local corms.

Disease symptoms consist of leaf curling, stem twisting, leaf drying and death of corms. The pathogen was isolated from all plant parts having symptoms. Inoculation of corms or drenching of soil with a spore suspension resulted in typical symptoms at sprouting. Leaf curling appeared a few days after inoculated plants were kept at 15-30° C. Isolates of *C. gloeosporioides* from other crops (apple, avocado, guava, almond) failed to infect anemone corms or leaves.

Hot water treatment (HWT) for 15 min at 43.5°, 48° and 50° C killed the fungus in 50, 95 and 100% of the stem pieces, respectively. Local anemone corms (first year from seed) were not damaged by 15 min of HWT at 50-55° C when treated on various dates from July to September and after storage at 30° or 17° C.

Second-year germination from seed corms was low (50% and 32% after storage at 17° and 30°C, respectively) and most HWT resulted in further damage.

Three years of trials for control of the foliar phase of the disease showed that although many fungicides were found to be effective in bioassays (benomyl, dithianon, iprodione, thiram (THTD), oxyquinoline sulfate), all failed to prevent the disease under high inoculum levels. *(P)*

BASAL PLATE DISEASE OF NARCISSUS AND ITS CONTROL

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Premature yellowing of foliage of *Narcissus tazetta papyraceus* (paper white) accompanied by root rot and dark sunken basal plates, caused destruction of many commercial crops grown for bulb production in the past 2 years.

Root and plant development were inversely correlated with the degree of damage to the basal plate of the planted bulbs. Plant height was reduced by 50-70% and the number of flowers by 40-80%, in comparison with plants grown from healthy bulbs. No fungal or bacterial pathogens were isolated from roots or basal plates.

The effect of several fungicide dips applied after harvest, before planting or in combination with hot water treatment (HWT) of 43.5°C for 3 h, was studied. At harvest, HWT reduced disease incidence from 81% in untreated bulbs to 12% in HWT with no fungicide added and to 5% with captan and formaldehyde. Postharvest or preplant dips in fungicide alone reduced disease incidence to 34% only with the best treatment (TOG, a product containing 15% thiabendazole and 15% 8-hydroquinoline).

The results indicated a possible involvement of nematodes in the disease syndrome, possibly in combination with fungi. The nematode *Aphelanchoides subtenuis* was isolated from untreated bulbs (Dept. of Nematology, ARO), but its direct involvement has not been proven yet. *(P)*