MEETINGS

ABSTRACTS OF PAPERS PRESENTED AT THE FOURTH ISRAEL CONGRESS OF PLANT PATHOLOGY

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A: *GENERAL TOPICS*

CROP ROTATION FOR CONTROL OF CERTAIN NEMATODES

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During the last few years, unusually large populations of nematode species hitherto uncommon in Israel, were recorded in several fields: cyst-forming nematodes *Heterodera rostochiensis* on potatoes, *H. schachtii* on various brassicaceous crops, *H. trifolii* on carnations and *H. latipons* on cereals. Heavy damage by the root-knot nematode *Meloidogyne arenaria* was found on peanuts, and by *Longidorus cohni* on oats. Investigation of the history of these fields revealed that the hosts had been cultivated on the same fields for several years. Under conditions of inadequate crop rotation, even nematodes which are at the edges of their natural distribution range can attain high population levels and cause economic losses. Crop rotation interrupts host continuity and serves as an efficient and inexpensive means against nematodes with a relatively specific host range.

Recently, large populations of two nematodes were found: *Rotylenchulus reniformis*, a pathogen of cotton and other crops; and *Pratylenchus thornei*, a polyphagous nematode which also parasitizes wheat. As these hosts are cultivated every year on the same fields on a rather large scale, the spread and increased population build-up of these nematodes can be expected.

INCREASING SOIL TEMPERATURES BY MULCHING FOR THE CONTROL OF SOIL-BORNE DISEASES

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Irrigated soils in the hot Bet She'an and Jordan Valley regions were mulched with 0.03-mm-thick, transparent polyethylene plastic sheets during July and August, thereby increasing soil temperatures. Maximum temperatures in the mulched soils were 45-48°C and 40-48°C at depths of 5 and 15 cm, respectively. Microsclerotia of *Verticillium dahliae* and chlamydospores of *Fusarium oxysporum* f. sp. *lycopersici* were buried in mulched and nonmulched soils at various depths and recovered after various time intervals. The percent of inoculum control achieved was estimated using selective culture media. After two weeks of exposure under plastic, *V. dahliae* in the 0-25-cm layer was controlled 100%. Control of *F. oxysporum* f. sp. *lycopersici* at a depth of 5 cm was 90-100%; at 15 cm, 70-100%; and at 25 cm, 50-70%. Two field experiments with eggplant and one with tomato showed that plastic mulch spread prior to sowing, controlled weeds, enhanced plant development, decreased wilt disease (*V. dahliae*) incidence by 60-90%, and increased crop yield by 300%.

This new method of controlling soil-borne disease is much less expensive than fumigation, involves neither soil pollution nor phytotoxicity, and is easily applied. It is suggested that both thermal and biological control of the pathogens takes place during soil mulching.

QUANTITATIVE ISOLATION OF *VERTICILLIUM DAHLIAE* FROM SOIL

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Generally, microsclerotia of *Verticillium dahliae* are separated from soil particles and concentrated before plating-out on a semiselective medium in order to minimize soil fungistasis and to enable quantitative counts of *V. dahliae* colonies. However, with most techniques large quantities of soil particles still accompany the microsclerotial fraction. A new technique has been developed, based on differences in specific weight between microsclerotia and soil particles. An air-dried soil sample of 5 g is shaken thoroughly in 20 ml caesium chloride solution (specific gravity 1.6). The microsclerotial fraction then floats on the surface while most soil particles precipitate. After washing, the microsclerotia are dispersed in a semiselective medium and the *V. dahliae* colonies can be counted.

A SPECIES OF PHLYCTOCHYTRIUM ATTACKING NEMATODES AND OOSPORES OF DOWNY MILDEW FUNGI

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An apparently new species of *Phlyctochytrium* was found attacking oospores of the downy mildew fungus, *Sclerospora sorghi*, which had been shaken in water together with soil. This fungus, when isolated in pure cultures, attacked live and heat-killed oospores of *S. sorghi* and *S. graminicola*, pollen of various plants, and various stages of the nematodes *Xiphinema index*, *X. brevicolle*, *Tylenchulus semipenetrans* and *Mylonchulus sigmaturus*. Heat-killed conidia of *Helminthosporium turcicum* and *Epicoccum* sp. were also attacked, as well as live eggs of *X. index*, *T. semipenetrans* and *Meloidogyne javanica*.

The fungus grows well on various solid media as well as in shake cultures, with an optimum temperature range of 23-27°C. It survived at 6°C in peptone - malt extract - glucose agar slants for 28 months. The species has a smooth-walled sporangium producing one to many papillae, and well-developed rhizoids. Formation of apophyses is irregular.

The fungus is considered to have a high potential as a biological control agent against some pathogenic fungi and nematodes.

SOIL AERATION AFFECTING RESISTANCE OF TOMATO PLANTS TO *FUSARIUM OXYSPORUM LYCOPERSICI*

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Fairly constant moisture levels were maintained, and correspondingly constant soil-aeration values were attained, by applying predetermined suctions to the soil, via tensiometer-like ceramic cups. In the tension range of easily available water, small changes in soil water tension

can result in large changes in soil aeration.

When 'Moneymaker' tomato seedlings were about 4 weeks old, *Fusarium* inoculum was injected into the soil, through pre-inserted tubes, thus avoiding wounding of roots. Three weeks later the effect of soil conditions on plant development was obvious. From a comparison of infected plants with their controls in each suction treatment it was inferred that in the range of easily available water, soil aeration is the decisive factor: in poorly aerated soil, inoculated plants succumbed to disease, whereas the combination of sufficient available water with good aeration was beneficial to plant tolerance to the disease.

PRELIMINARY STUDIES OF THE EFFECT OF WATER STRESS ON *FUSARIUM* INFECTION OF YOUNG VEGETABLE PLANTS

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Water stress effects on four vegetable varieties inoculated with *Fusarium* isolates were studied in a greenhouse. The seedlings, grown in containers of medium loam soil, were inoculated 8-12 days after emergence, and then subjected to the following irrigation treatments: Half of the plants in each series were given a predetermined amount of water once in 2-3 days and the other half were given twice that amount once in 5-6 days; at the larger irrigation interval, the first symptoms of loss of turgor became evident.

The action of weakly pathogenic isolates was accentuated by water stress, *e.g.* isolates of *F. oxysporum* from cucumber affected young tomatoes and onions (but not cucumbers) more severely under stress than under ideal conditions. Likewise, *F. equiseti*, which is generally considered a weak pathogen, and *F. javanicum*, which in the field has been found to affect only cucurbits, affected onions markedly under stress but hardly at all under conditions of full water supply.

EFFECTS OF HOST AGE ON INFECTION OF VEGETABLES BY *FUSARIUM*

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Seedlings of several vegetable crops grown in greenhouses in containers of medium loam soil were inoculated with isolates of five species of *Fusarium.* Inoculations were performed 8-12, 24-28, and 42-45 days after the containers were seeded.

In most cases inoculations at the earliest stage, as expected, affected markedly higher percentages of plants than later inoculations. This was true for most isolates on plants that were not their original hosts, *e.g. F. solani* isolates from cucumber, watermelon and sweet corn on onions, or from peanuts on cucurbits; *F. oxysporum* isolates from watermelon on onion and tomato; and *F. equiseti* isolates from cucumber on onion and watermelon. An exception was *F. oxysporum* from watermelon, which affected onions markedly also after inoculation at the later stages.

In inoculations with isolates on the hosts from which they originated, the effect of host age at inoculation was sometimes less marked. Thus, *F. javanicum* from cucurbits affected watermelons almost as much at the middle stage as at the earliest stage of inoculation.

The large numbers of *Fusaria* from various sources present in irrigated soil are capable of affecting a considerable range of host plants, which usually will be infected mostly in their early growth stages.

LEAF ABSCISSION IN PEPPER INDUCED BY *LEVEILLULA TAURICA*

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Leveillula taurica, the causal agent of powdery mildew of pepper, induced leaf abscission in pepper plants. Strains of *L. taurica* isolated from tomatoes and eggplants also induced leaf abscission in peppers, but not in *L. taurica*-infected tomatoes and eggplants. Abscission of pepper leaves was not associated with symptom development.

Shedding was affected by relative humidity and temperature during the incubation period.

Inoculated plants incubated for 7 days at 20°C and then kept at this temperature for the rest of the experimental period, developed the most severe symptoms and simultaneously shed the greatest number of leaves. Plants inoculated as above and then transferred to 30°C developed no symptoms, but shed the same number of leaves as at 20°C. No symptoms appeared on plants transferred from 30°C back to 20°C.

Plants inoculated at low relative humidity (daytime) developed less severe disease symptoms but a higher percentage of the infected leaves was shed than on plants incubated at high R.H.

It is suggested that *L. taurica* induces leaf abscission in pepper plants at the initial stages after its establishment in the host. Induced abscission was expressed even at a temperature lethal for the pathogen.

B: *FUNGICIDES*

UPTAKE AND ACCUMULATION OF BENOMYL IN GLADIOLUS CORMS

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Uptake and accumulation of benomyl (Benlate, [methyl 1-(butylcarbamoyl)-2 benzimidazole carbamate]) were followed in winter 'Spic and Span' gladiolus corms, size 12/14. Corms were dipped in 0.25% benomyl suspension for 15 min., and slices of the treated corms were bioassayed for the presence of the fungicide, using *Penicillium* sp. as the test organism. Most of the benomyl which penetrated the corms was associated with the lower sections of the central part of the corm, which contain the vascular system. Acidification of the benomyl suspension to pH 2.0 increased the uptake by 40-50%. No fungicide could be detected in corms 3 months after planting.

DIFFERENCES IN UPTAKE BY, AND FUNGICIDAL EFFECT OF CARBENDAZIM AND THIABENDAZOLE ON PEANUT PLANTS AFTER SOIL INJECTION

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The fungicides carbendazim and thiabendazole were applied to the rhizosphere of peanut plants by injecting aliquots of 10 ml suspension into the soil to a depth of 10 cm at points 7 cm apart and along the row, close to the plants. Both fungicides were applied at doses of 0.1, 0.5 and 2.5 g per 1-m row.

Analysis of peanut leaves showed that the two fungicides were rapidly taken up by the plant during the first week after treatment, and that the quantities accumulated in leaves were dependent upon the doses applied. Two weeks after treatment the concentration of both fungicides extracted from leaves dropped sharply. During the rest of the season until harvest, the concentration of carbendazim in the high dose treatment (2.5 g/1-m row) was 0.1 μg/g fresh weight. Conversely, there was a gradual increase in the concentration of thiabendazole in the leaves 3-4 weeks after treatment, from 0.1 to 2.0 μg/g for the highest dose. The concentration remained at this level for the next 2 months, until harvest.

At the end of the growing season treated plants were infected with *Cercospora* leaf spot (*Cercospora personata*) less than the untreated control, the thiabendazole-treated plants being better protected than the carbendazim-treated plants. Furthermore, plants treated with the highest dose of thiabendazole were the only ones that did not wilt.

Studies of the mechanism of adsorption of these fungicides on soil constituents revealed that carbendazim is less adsorbed and also less persistent than thiabendazole. It is conjectured that carbendazim is more rapidly depleted from the rhizosphere due to fast initial uptake by the plants and degradation of the reservoir. Conversely, thiabendazole was available to the plants in smaller amounts but for a longer period of time.

BENZIMIDAZOLE-RESISTANT STRAINS OF CITRUS FRUIT MOULDS

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Benzimidazoles are fungicides very effective against moulds, *e.g. Penicillium digitatum* (the causal agent of green mould) and *P. italicum* (blue mould), inhibiting their growth at concentrations of 2 ppm or less. However, some time after the benzimidazoles were introduced into citrus packing-houses as standard treatments, mouldy fruits (particularly blue moulds) began to appear, in spite of the treatment.

Experiments with cultures isolated from such mouldy fruits have shown that the isolates are resistant to high concentrations of benzimidazoles (in extreme instances up to 12,000 ppm); most of these resistant strains belong to *P. italicum*. The resistant strains are pathogenic to various citrus fruits, cause decay of the fruit, and sporulate freely, regardless of the benzimidazole treatment at various concentrations given to the fruit before inoculation. Resistant strains isolated from fruits treated with a given benzimidazole were resistant, both *in vitro* and *in vivo*, to other fungicides of the benzimidazole group, indicating a phenomenon of cross-resistance. However, they were susceptible to Imazalil, and at least partly susceptible to fungicides other than the benzimidazoles, such as sodium 0-phenyl-phenate and 2-aminobutane.

These findings are of great importance in planning packing-house treatments to prevent postharvest decay of citrus fruits.

ANTISPORULANT ACTION OF FUNGICIDES AGAINST *PODOSPHAERA LEUCOTRICHA* ON APPLE SEEDLINGS

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Among the factors responsible for the continuing difficulty in controlling apple powdery mildew caused by *Podosphaera leucotricha* is the short period of time required for a complete generation of the fungus coupled with the ability of its conidia to infect leaves under a wide

range of climatic conditions and the high rate of the fungus sporulation. Field observations have suggested that suppression of sporulation of the fungus is an important aspect of the action of some spray materials.

A number of commercial fungicides and substituted 2,6-dinitrophenolic compounds were tested for their ability to suppress further sporulation of established infections of the apple mildew fungus on seedlings in the greenhouse. At the concentrations of the tested compounds, which were those generally recommended for high-volume application, sporulation was drastically reduced for at least 18 days by the benzimidazole fungicides benomyl and Topsin (thiophanate-methyl), and by the two organophosphorus compounds Afugan (pyrazophos) and Plondrel (0,0-diethyl phthalimidophosphonothioate). Growth of fresh, but non-sporing mycelium occurred only after two weeks. Other fungicides, *e.g.* Karathane and Morocide, known to control apple mildew in the field, had a less marked effect; thiabendazole enhanced sporulation.

In quantitative experiments sporulation was assessed by counting the yield of spores of five seedlings, each bearing four or five previously treated leaves, with a total leaf area of approx. 180 cm^2. After 18 days of the treatment with the benzimidazole fungicides and the two organophosphorus compounds, only a few spores were found. In comparison with the control seedlings that yielded 25.4 million spores/180 cm^2, the Karathane-treated seedlings yielded 2.4 million spores and the Morocide-treated seedings yielded 3 million spores/180 cm^2.

C: *DISEASES OF FIELD AND VEGETABLE CROPS*

TRANSPORT AND TRANSMISSION OF *FUSARIUM* PATHOGENS BY TOMATO AND ONION SEEDS

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Seeds were extracted from wilted tomato plants infected by *Fusarium oxysporum* f. sp. *lycopersici* (race 1 or 2) and plated out on peptone-PCNB selective medium. Isolates were obtained and their pathogenicity was determined. Varying degrees of infestation (up to 100%) by race 1 or race 2 of *Fusarium* were detected. The race of the isolated pathogen was identical to that isolated from the xylem of the same plant. Incidence of the disease was higher and its progress was faster in tomato plants obtained from infested seeds and sown in sterile soil rather than in natural soil. Treatment with sodium hypochlorite solution freed the seeds from infestation. The incidence of infestation decreased upon storage of the seeds, in some cases to zero after 12 months.

In onion plants infected with *Fusarium*, seeds were found to carry the pathogen in varying degrees up to 100%.

A COMPLEX OF YELLOWS DISEASES IN POTATO FIELDS IN THE GOLAN

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In summer 1972, potato fields for seed production in the Golan were discarded for seed purposes as a result of yellowish purple discoloration, inward rolling of apical leaves, and subsequent wilting of leaves. The phenomenon was considered to be caused by *Fusarium* spp.,

but no vascular discoloration was observed and no artificially inoculated plant (made with 200 isolates of *Fusarium* spp. from diseased potatoes) showed those symptoms.

The disease could not be transmitted by mechanical inoculation with *Myzus persicae, Aphis gossypi* or *Bemisia tabaci.*

Tops showing symptoms were grafted on *Datura stramonium* L., *Lycopersicon esculentum* L. var. Marmande and var. Burley White, and resistant Hicks and Samson varieties of *Nicotiana tabacum* L. Results obtained with grafted test plants, and from growing tubers of affected plants, have shown that the syndrome is caused by a complex of different yellows diseases, which were identified as stolbur, purple-toplike disease and leaflet stunt. In the first two, mycoplasma-like bodies were observed in phloem cells. Regarding leaflet stunt, Rickettsia-like bodies were found in phloem cells of infected plants only.

The vectors of these diseases have not yet been identified.

EXPERIMENTS FOR PROTECTING TOMATOES FROM TOBACCO MOSAIC VIRUS (TMV) BY PRIOR INFECTION WITH THE AVIRULENT STRAIN, M-II-16

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Plants infected with TMV were collected from a tomato crop grown under plastic tunnels. About 70% of the samples of TMV were classified as tomato strains. In the remaining samples mixed infections of tobacco and tomato strains were found.

Cross-protection experiments were carried out in the greenhouse, whereby plants were first inoculated with the avirulent strain M-II-16. Cross-protection with M-II-16 was effective against some of the tomato strains, but the avirulent strain did not provide any protection against mixed infections of tobacco and tomato strains.

EFFECT OF FUNGICIDAL FIELD SPRAYS ON POSTHARVEST *BOTRYTIS* ROT OF STRAWBERRIES

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Botrytis cinerea is the most important fungus causing postharvest fruit rot of strawberries. To determine the effectiveness of preharvest applications in preventing *Botrytis* infection, strawberries var. Tioga were sprayed in the field with two preparations of thiabendazole (TBZ), benomyl and captan. Sprays were applied once a week for 10-20 weeks, after which the fruit was picked at random, packed in plastic baskets, and stored at 15°C. Rot incidence was determined daily during 5 days of storage.

All the treatments tested during February and March were effective in reducing *Botrytis* decay in storage. The effectiveness of benomyl was apparent after 2 days of storage only, whereas captan was still effective after 4 days of storage. During April and May, when *Rhizopus stolonifer* was the main cause of fruit decay, field sprays were ineffective in reducing rot incidence. These results are in good agreement with the *in vitro* sensitivity to the fungicides of the two species of fruit.

The effect of preharvest sprays on the reduction of *Botrytis* decay in storage indicates that the fungicides prevent the infection of floral parts, which may serve as the main pathway of fruit infection.

TREATMENTS TO PREVENT SPOILAGE FUNGI IN STRAWBERRIES

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The main spoilage fungi of harvested strawberries are *Botrytis cinerea, Mucor mucedo, Rhizopus stolonifer* and *R. sexualis*. The following studies were carried out to find ways and means of preventing or reducing fungal development.

The ability of the above fungi to germinate, grow, and infect strawberries, at temperatures ranging from 0° to 25°C, was determined, and the variation among strains of each species was examined. As a result of the use of preharvest benzimidazole fungicides, there exist strains of *B. cinerea* tolerant of high concentrations of these fungicides, and resistant strains were therefore included here.

The fungicidal effect of a range of fungicides for activity against all of the important spoilage organisms, was studied *in vitro*. The fungicides which had a strong effect *in vitro* were tested as field sprays. The field spray reduced the incidence of decay developing in stored fruit only slightly; it was effective in reducing the incidence of rot which developed on the fruit in the field only.

Postharvest vapor treatment of strawberries was investigated by continuous gassing with sulfur dioxide released from potassium metabisulfite 0.02%, or by a single treatment with acetaldehyde 0.5%. Prevention of rot development was attempted by dipping in 0.5% dehydroacetic acid or 0.1% diethyl pyrocarbamate solution, and phytotoxic effects of such treatments on the fruit were investigated. In general, sulfur dioxide, dehydroacetic acid and diethyl pyrocarbamate decreased the incidence of rot without damaging the fruit; acetaldehyde was less effective and more phytotoxic.

CHEMICAL CONTROL OF *SEPTORIA* LEAF BLOTCH DISEASE OF WHEAT IN ISRAEL

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The *Septoria* leaf blotch disease of wheat caused by the fungus *Septoria tritici* Rob. ex Desm. often assumes epidemic proportions and causes serious reductions in yield. The degree of damage depends on the level of primary inoculum in the field, favorable environmental conditions, and vulnerability of the cultivar. Varietal resistance, chemical control and suitable cultural procedures reduce losses.

The present scarcity of resistant varieties and the destructiveness of the disease have prompted us to resort to fungicidal protection as a stop-gap measure, until extensive breeding programs in Israel and elsewhere provide disease-resistant wheat cultivars.

Our studies on chemical control of the disease have dealt primarily with the following problems: (*a*) disease control attained by maneb [manganous ethylenebis (dithiocarbamate)] dust of 80% a.i., and benomyl [methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate] dust of 50% a.i.; (*b*) design of effective and economically feasible application schedules; and (*c*) effectiveness of various application methods.

A yield increase of 30% as compared with untreated plots was attained by 3-4 sprays with maneb during the season at the rate of 250 g/1000m^2. Low-volume application at the rate of 3 l/1000m^2 was less effective than at 5 l/1000m^2. The spraying program was started after the

disease had become established on the upper leaves, and was terminated not later than 26 days before harvest, to reduce the hazards of fungicide residues. The *Septoria* control scheme allows 50-60 days of protection based on sprays applied at 10-14-day intervals.

In limited tests performed with benomyl, four applications (at 80 g/1000m^2) were equally effective in disease control and yield protection as nine applications of maneb. The number of benomyl sprays may possibly be reduced still further without detracting from its value, provided that applications are properly timed.

EPIPHYTOTICS OF SORGHUM DOWNY MILDEW ON SWEET CORN AND VIDAN IN ISRAEL

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Epiphytotics of *Sclerospora sorghi*, the causal agent of sorghum downy mildew, occur in June-July in the Rehovot area (coastal plain) on Vidan (*Sorghum vulgaris* x *Sorghum sudanense*) and sweet corn (cv. Jubilee). The percentage of infected plants in commercial fields of sweet corn varied from 5 to 50%, and in one field 95% of the plants were infected.

Three types of symptoms were observed on sweet corn: half-leaf and full systemic infections; striated systemic infection on the cob-protecting leaves; and local lesions on leaves. Systemically infected Jubilee plants produced small ears (one-third of the normal cob-weight) or none at all, even when chlorotic symptoms were very mild. In one field half of the plants displayed local lesions.

On Vidan, relatively few systemically infected plants were found at first, and most stricken plants had local lesions. After the first cutting, however, 10-15% of the new shoots were systemically infected, and the percentage rose after each additional cutting. Transmission via seeds was not found. Other possibilities of dissemination of the pathogen were considered. Although most lines of the wild *Sorghum halepense* had previously been shown to be highly resistant, numerous local lesions were found on this species in two localities.

EFFECT OF SEQUESTRENE ON THE REACTION TO *VERTICILLIUM DAHLIAE* OF PEANUTS GROWING IN CALCAREOUS LOESS SOIL

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Verticillium dahliae Kleb. retards the development of peanut plants and causes irregular chlorosis and wilt. Sequestrene FE-183, an iron chelate compound [sodium ferric ethylene diamine di(-θ-hydroxyphenol acetate)], was tested to reduce the damage.

Some cultivars and experimental breeder lines which had previously been found to be partially resistant to or highly tolerant of the disease in alluvial clay, succumbed to *V. dahliae* in calcareous loess, except when Sequestrene (1 kg/1000 m^2) was spread on the soil next to the plants, at the age of approximately 7 weeks.

This treatment improved the health and yield of the *Verticillium*-susceptible cv. 'Shulamit' and restored the yields of some tolerant cultivars or lines to approximately normal level. In one experimental line, however, the yield was equally moderate in both the chelate-treated and the control plants. It is presumed that this *Verticillium*-tolerant line is able to

withdraw sufficient iron from calcareous soil to mask the effect of *V. dahliae* on the iron metabolism of the plant.

D: *DISEASES OF FRUIT TREE CROPS*

TRANSMISSION OF GRAPEVINE LEAFROLL VIRUS TO HERBACEOUS PLANTS

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The grapevine leafroll disease, well known for many years, has been found in all grape-growing countries, including Israel. It was first identified in 1936, and was considered to be caused by a viral agent. The only proof for this was the fact that the disease was graft-transmissible to several grape varieties. All attempts to transmit grape leafroll by mechanical inoculation to herbaceous test plants failed. No vector of grape leafroll has yet been found.

The basic assumption in work was that the failure of mechanical transmission may be due to the fact that the virus might be bound to intracellular structures, such as membranes, and the usual procedure of sap extraction does not dissociate the virus from these structures. We therefore tried to extract RNA from the infected tissue, which is easier than releasing the whole virus from the intracellular structure.

RNA was extracted from healthy and infected leaves by the phenolic method. Different plants of several families were inoculated with the extract, but the only plants that gave systemic reactions were *Nicotiana* spp., on which symptoms appeared after 2-3 months. Another, though less efficient way of transmitting the disease to herbaceous plants was by macerating inoculated leaves in the presence of a buffer and a detergent (Celmusol).

The success in transmitting grape leafroll to herbaceous plants may help in the development of a method for rapid indexing of the disease.

PATHOGENIC SPECIALIZATION IN RUST OF STONE FRUITS

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Stone fruit rust is caused by *Tranzschelia pruni-spinosae* var. *discolor*, which occurs in Israel on almond, apricot, Japanese plum, European plum, peach, cherry, and the like. From the phytopathological and epidemiological points of view, it is very important to understand the pathogenic relationships between the various stone fruit species and the rust fungus that develops on each of them. These relationships were studied by reciprocal inoculations on 11 varieties of five species of the genus *Prunus*: almond, apricot, Japanese plum (*P. salicina*), plum (*P. domestica*), and peach, with rust isolates originating from these five species.

Five pathogenic races were found, corresponding to the sources of the rust. Details of their virulence were as follows: (*a*) To the pathogenic race of almond, almonds were susceptible and the four other species were highly resistant; (*b*) to the pathogenic race of apricot, apricots and Japanese plums were susceptible, plums and peaches showed mixed reactions, and almonds were highly resistant; (*c*) to the pathogenic race of Japanese plum, Japanese plums were susceptible,

apricots showed mixed reactions, and the three other species were highly resistant; (*d*) to the pathogenic race of plum, plums were susceptible, apricots showed mixed reactions, and the three other species were highly resistant; and (*e*) to the pathogenic race of peach, peaches and apricots were susceptible, and the three other species were highly resistant.

Following inoculations with the pathogenic race of plum on Japanese plum varieties, characteristic symptoms developed on leaves: necrotic spots, brown irregular spots, and dropping out of the necrotic tissue – resulting in "shot-hole" symptoms. Similar resistance reactions developed on almond leaves when they were inoculated with races to which almonds were resistant. It was not known until now that these symptoms in stone fruit trees result from a resistance reaction to the rust.

MONILIA DISEASE (*SCLEROTINIA LAXA*) AND ITS CONTROL IN STONE FRUIT ORCHARDS

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This disease was first revealed in Israel in 1952 in a section of a Japanese plum (Vickson) orchard in the Jerusalem area. The disease subsequently spread to apricot orchards planted with local varieties. In the past few years the disease has caused severe damage to the flowers and young vegetative growth of the commercial variety 'Canino'.

In 1974 several products were tested for the control of Monilia (all concentrations are expressed in terms of percent of formulated product): Methyl 1-(butylcarbamoyl)-2-benzimidazolecarbamate (benomyl) – 0.05%; copper oxychloride (Cuprox) – 0.5%; piperazin-1,4-diyl-bis-(1-(2,2,2-trichlorethyl) formanide (Triforine) – 0.1%; and tetrachloro-isophthalonitrile (Chlorothalonil) – 0.3%. One, two or three applications were given after bud break. (The whole area had been sprayed with pentachlorophenate before bud break.) One or two applications of Triforine was the most effective treatment for controlling the disease; second best was three applications of benomyl; the remaining products did not provide satisfactory protection.

CONTROLLING RUST DISEASE (*TRANZSCHELIA DISCOLOR*) IN STONE FRUIT ORCHARDS

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In the past few years the incidence of rust disease in stone fruit orchards has increased, even though they have been treated with the standard recommended fungicides. In 1973 trials were begun to test the effectiveness of various new fungicides for the control of this disease in European plum (*Prunus domestica*), almonds (*Prunus amygdalus*) and apricot (*Prunus armeniaca*).

European plum: The following products were tested (all concentrations are expressed as percent of formulated product): 2-iodobenzoic acid anilide (Benodanil) – 0.1%; 5-6-dihydro-2-

methyl-1,4-oxathin-3-carboxanilide-4,4-dioxide (Oxycarboxin) – 0.1% zinc activated polyethylene thioram disulphide (Metiram) – 0.2%; zinc ethylenebisdithio-carbamate (Zineb) – 0.2%; piperazin-1,4-diyl-bis-(1-(2,2,2-trichlorethyl) formanide (Triforine) – 0.1%.

In one trial conducted over a period of 2 years, with four applications per season, Benodanil and Zineb were the most effective products in controlling the disease. Oxycarboxin was effective but phytotoxic. In another trial with the same products at half the above concentrations, with three spray applications per season, Benodanil again proved to be the most effective product, followed by Zineb. Oxycarboxin at a low concentration of 0.05% was phytotoxic.

Almonds: The products tested were: Benodanil – 0.1%, Oxycarboxin – 0.1%, Triforine – 0.1%, and manganese ethylene bisdithiocarbamate (Maneb) – 0.15%. Following a total of four applications, Benodanil was the most effective product, with only 0.5% infection on the leaves, as compared with Triforine (10% infection), Maneb (15%), Oxycarboxin (20%), and the control (43% infection).

Apricots: Four applications of Benodanil – 0.1%; Oxycarboxin – 0.1%; Zineb – 0.2%; Maneb – 0.2%; and zinc ion plus manganese ethylene bisdithiocarbamate (Mancozeb) – 0.2% were tested. The degree of infection in the control in this trial was relatively low (10%); Benodanil – the most outstanding treatment – reduced it to only 0.2%. Treatments with the other products reduced fruit infection to 2.2-3%.

RELATIONSHIP BETWEEN THE TIME OF BENOMYL TREATMENT AND ITS EFFECTIVENESS IN BANANA TIP ROT CONTROL

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The main causal agents of banana tip rots are *Fusarium* spp. and *Deightoniella torulosa* in the coastal region, and *Colletotrichum musae* and *Fusarium* spp. in the Jordan Valley. Previous work had shown that spraying young bunches (7 days after shooting) with thiabendazole compounds gave good control in both of these regions.

The aim of the present study was to determine the relationship between the age of the bunch at spraying time and the effectiveness of the treatment. Experiments were carried out in both regions on bunches of different ages, at 7-day intervals. Each bunch was sprayed once with 0.2% benomyl (50% a.i.). The treatment was effective only when applied between 7 and 14 days after bunch emergence. This information will be of help in planning a spraying schedule for banana plantations.

A NEWLY DISCOVERED GUMMOSIS DISEASE ON LEMON TREES IN ISRAEL CAUSED BY THE FUNGUS *HENDERSONULA TORULOIDEA*

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In the last few years the incidence of gummosis in lemon groves in the northern part of Israel has increased greatly. It was suspected that a new etiological agent was involved. In many isolations from diseased branches, the fungus *Hendersonula toruloidea* Nattrass was found. The Koch test proved that this fungus was the causal agent of the disease.

The symptoms of the disease are abundant secretion of gum from the affected areas of the branches and trunk, mainly up to 1½ m high; necrosis of the bark with the effect of girdling; and necrosis of the xylem and spreading of the fungus to deeper parts of the wood in the form of wedges.

Damage is expressed as a reduction in the crop of the diseased branch at the early stages of the disease, and later by death of the branch.

In a countrywide screening it was found that the fungus causes the disease in all regions where lemon is grown: Upper Galilee, Western Galilee, Bet She'an Valley, Gilboa region, Sharon plain, Rehovot area, western Negev, and the Besor region.

The infective units of the fungus, under local conditions, are pycnidiospores. These are produced in black pycnidia, which form on the bark of diseased branches. The main period of spread of the fungus, both in the diseased branches and from them to healthy ones, takes place in the summer.

The main difficulty encountered in the treatment of a diseased branch is in bringing the fungicide into contact with the fungus that has penetrated deeply. In control experiments in the groves, carried out on superficial lesions, copper sulfate, "Carbo-Ets" (carbolineum, a coal-tar fraction), and phenyl mercury chloride gave good results, especially when the diseased area was removed prior to treatment of the branch.

THE BIOLOGY OF THE FUNGUS *HENDERSONULA TORULOIDEA*, THE CAUSE OF GUMMOSIS DISEASE ON LEMON TREES

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In experiments carried out to determine the host range of *Hendersonula toruloidea*, it was found that walnut (*Juglans regia*) overcomes attack by isolates of the fungus from lemon under local conditions, and that most of the citrus species cultivated in Israel are susceptible to the fungus. The order of decreasing susceptibility as determined *in vitro* was: Eureka lemon, Marsh Seedless grapefruit, Washington Navel orange, Sour orange, Jaffa orange, Valencia orange, and Clementine.

H. toruloidea is a facultative parasitic fungus; in Israel the dispersal units are pycnidiospores. Thallospores are produced only under laboratory conditions. A wound is not essential for infection by spores, but its presence enhances the infection process.

The fungus grows well on standard media in the following descending order: vegetable-juice agar, potato dextrose agar, yeast-extract agar, Czapek agar, and malt-extract agar.

In order to obtain pycnidia and pycnidiospores in culture, the fungus colony should be irradiated with near-U.V. at 420 nm. Ripe pycnidia exude whitish cirrhi which contain hyaline one-celled fusiform spores, usually 15 x 5μ. After a few days the entire cirrhus and one-celled spore become dark. By internal septation the spores become two- or three-celled.

The optimum temperature for a number of life processes that were examined was 28-30°C. The fungus was resistant to chloramphenicol, achromycin and tetracycline when these antibiotics were added to the media at the rate of 250 mg/liter. The fungus was extremely sensitive to benomyl and mercury compounds, moderately sensitive to copper sulfate and "Carbo-Ets" (carbolineum, a coal-tar fraction), and slightly sensitive to Daconil.

CHANGES OCCURRING IN CITRUS FRUIT INFECTED BY DIFFERENT PATHOGENIC FUNGI

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The response of lemon fruit to infection by *Alternaria citri, Diplodia natalensis, Fusarium moniliforme, Geotrichum candidum, Penicillium digitatum* and *P. italicum* was studied.

It was found that different pathogenic fungi induce evolution of different amounts of ethylene in the same species of fruit. The more ethylene evolved by the fruit as a result of infection with a given fungus, the higher the respiration rate of the infected fruit. In general, the magnitude of ethylene production and the respiration rate of the fruit infected by different fungi were inversely correlated with the length of their incubation period. The respiration rate and the amount of ethylene evolved by infected fruit were higher in green than in yellow fruit.

MUTUAL RELATIONSHIP BETWEEN BLUE AND GREEN MOULDS IN CITRUS FRUITS TREATED WITH THIABENDAZOLE

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The green mould fungus (*Penicillium digitatum*) was for many years responsible for the vast majority of rots attacking citrus fruits after harvest, while the incidence of blue mould (*P. italicum*) was of secondary importance. In recent years a conspicuous increase in blue moulds was noticed.

The mutual relationship between the green and blue moulds was studied on Shamouti and Valencia oranges artificially inoculated with spores of the causal agent of the green mould. Thiabendazole was found to control effectively the green mould but, simultaneously with the decrease in this decay, a substantial increase in the incidence of blue mould was observed. *Vice versa*, in treatments that did not control the green mould, the incidence of blue mould was low. Sometimes the sum of the percentages of both moulds did not vary much between the different treatments. This phenomenon can be explained by another finding, namely, the increase in the population of strains of the moulds, mainly the blue one, that are resistant to the benzimidazoles.

In view of the danger involved in the appearance of resistant strains, the use of fungicides other than the benzimidazoles is imperative, if postharvest rots of citrus fruits are to be controlled effectively.