Fusarium stem and fruit rot of sweet pepper in Ontario greenhouses

W.R. Jarvis[1], *S.K. Khosla*[2] *and S.D. Barrie*[1]

The causal agent of a stem and fruit rot disease of greenhouse sweet peppers was found to be *Nectria haematococca* (anamorph *Fusarium solani).* It infected wounds caused by salt damage at the stem base and scars left by careless leaf removal and fruit picking. No fungicides were considered suitable for field trials after in vitro screening; none is registered in Canada for sweet peppers. Very good control was achieved by scrupulous greenhouse hygiene and improved ventilation and nutrition, and by clean-cutting leaves, axillary shoots and fruit with a sharp knife rather than breaking and tearing, which left very susceptible wounds.

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Nectria haematococca (l'anamorphe *Fusarium solani)* est l'agent causal de la pourriture du fruit et de la tige du poivron cultive en serre. Les blessures causees par le sel a la base de la tige et les cicatrices laissées par une cueillette et un effeuillage négligents ont ete infectees par l'agent causal. Aucun fongicide n'a semble convenir pour les essais au champ apres les tests in vitro; il n'existe pas au Canada de fongicide homologue pour les poivrons. Une tres bonne prevention contre l'infection a pu être assuree grâce aux mesùres suivantes : proprete rigoureuse dans la serre; ventilation et nutrition ameliorees; coupe rase des feuilles, des nouvelles pousses et des fruits a l'aide d'un couteau bien aiguise, plutôt que d'avoir recours a l'arrachage et ainsi risquer fortement qu'une infection ne survienne.

In the summer of 1990, a severe disease appeared in a l-ha sweet pepper crop *(Capsicum annuum* L.) cv. *Cubico* grown hydroponically in rockwool in a greenhouse. The estimated yield loss was about 50%. In subsequent years a similar disease, but less severe was noted in nearby greenhouse pepper crops. In all cases, dark brown, sunken lesions occurred at the base of the stem, at leaf-scars and at wounds left by axillary shoot removal. Infection also occurred where periderm over the scars was breached by newly emerging axillary shoots. Later in the season infection also occurred where wound periderm was breached by emerging new shoots.

Growth rate was slowed and affected plants tended to wilt on hot days. The upper leaves became characteristically slightly mottled between the veins, a symptom reminiscent of magnesium deficiency. Interveinal tissue later became necrotic. Fruits on affected plants had fine, longitudinal, pale or brown striations, and the shoulders were markedly Flattened. The calyx lobes became brown and curled upwards. Fruits rotted usually from beneath the calyx, and occasionally from the flower end. Affected fruits contained few seeds which were discoloured brown around the margin. The fruit cavity often contained whitish-pink mycelium.

Both stem and fruit lesions often had superficial whitish mycelium and sporodochia of *Fusarium solani* (Mart.) Sacc., and reddish-brown perithecia of *Nectria haematococca* Berk. & Broome.

Isolates from surface-sterilized lesions and from superficial mycelium all yielded cultures of *F. solani* and almost all isolates developed perithecia of *N. haematococca.* Reinoculation of stem wounds and of picked fruit with conidia reproduced the symptoms. Of 40 surface-sterilized discoloured seeds taken from rotting fruit, four yielded cultures of *F. solani.* No isolates were recovered from apparently healthy seed taken from fruit with the striate symptoms.

This disease resembles one reported from England and the Netherlands (1) and from Hungary (3).

1 Agriculture and Agri-Food Canada, Harrow Research Centre, Harrow, Ontario NOR 1G0.

2 Ontario Ministry of Agriculture, Food and Rural Affairs, Harrow, Ontario NOR 1G0.

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Control: Fungicides

No fungicide is registered for greenhouse peppers in Canada. The results of a preliminary screening of some fungicides incorporated into potato-dextrose agar (Difco) are summarized in Table 1. Two isolates of *N. haematococca,* 268 and 269, were used but there was no significant difference between them in response to the treatments and the data for the two isolates were pooled for a multiple mean comparison. The data were transformed by a ln - 0.1 transformation.

Table 1. Radial growth (mean of four replicate measurements) of two isolates, 268 and 269, of *Nectria haematococca* on potato dextrose agar incorporating commercial fungicides.

Fungicide and rate g product L^{-1}	Radial growth of colony cm		SE
Benlate 50 WP 0.55	1.285	a*	0.075
Benlate 50 WP 0.55 + Manzate 200 2.25	1.300	ab	0.050
Benlate 75 WP 1.25	1.505	b	0.055
Ferbam 76 WP 1.5	2.415	c	0.115
Manzate 80 WP 2.25	2.525	c	0.025
Dithane M45 2.0	2.610	c	0.030
Maneb 80 WP 2.0	2.625	c	0.015
Botran 75 WP 1.25	2.650	c	0.110
Rovral 50 WP 1.0	2.700	c	0.600
Maneb 80 WP 0.75	2.960	cd	0.180
Check, no fungicide	3.980	de	0.150
Micro-Niasul 90 0.75	4.810	e	1.470

* Values followed by the same letter are not significantly different, P=0.05. All fungicides except Micro-Niasul 90 and Maneb 80 WP inhibited radial growth, the Benlate formulations significantly more so than the others.

Control: Cultural Practices

A rigorous clean-up program was established from *a priori* principles of greenhouse hygiene (2). It comprised complete removal of all crop debris, removal and steam-sterilization of rockwool bags, replacement of torn plastic sheeting on the soil surface, and complete surface sterilization of the superstructure with high pressure water spray followed by a spray of 1% sodium hypochlorite. When the new crop was planted in rockwool blocks on rockwool slabs, the fertigation emitter was placed so as to eliminate the tissue-damaging accumulation of salts left at the stem base by evaporation, where infection apparently first occurred. Pruning of excess and axillary shoots was done with a sharp knife, not by breaking and tearing which also had been observed to cause large, poorly-healing wounds very susceptible to infection. Similarly, fruit was cut, not pulled off. As the crop matured, new axillary shoots breaking through the wound periderm were cut off cleanly, not broken off, permitting new wounds to heal quickly.

In addition to these revised hygiene and pruning procedures, the environment control computer was reprogrammed to ensure that dew was never deposited, and ventilation through the crop was improved. These improvements in the environment and operating procedures resulted in insignificant levels of infection in the next two crops. The crop fertigation was also adjusted to provide a slightly lower nitrogen supply and a higher EC (electrical conductivity, reflecting the matric potential of the nutrient solution). The water supply was also adjusted to enhance root activity.

Discussion

Fusarium stem and fruit rot caused by *Nectria haematococca* (anamorph *Fusarium solani*) presents a serious threat to the rapidly expanding sweet pepper production in Ontario greenhouses. However, a strict program of crop hygiene and environment control has brought an acceptable level of disease control without recourse to fungicides.

That seed from infected fruit was found to be infested is of concern but we do not know if commercial seed is a source of inoculum. *N. haematococca,* however, is a common soilborne fungus with airborne ascospores, so that inoculum sources could be in the greenhouse or close by outside. Covering all the soil in the greenhouse with intact plastic sheeting, however, eliminates the soil source within the greenhouse, and keeping the headerhouse clean and as soil-free as possible also reduces the inoculum.

Of the fungicides assayed in vitro, only benomyl inhibited growth appreciably of two isolates of the fungus. No greenhouse trials were done and no conclusions can be drawn about fungicidal control.

Literature cited

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Figure 1. Fusarium stem and fruit rot of greenhouse pepper: lesion at the base of the stem at the site of salt damage.

Figure 2. Nodal lesion at a removed leaf scar.

Figure 3. Leaf symptoms resemble those of magnesium deficiency.

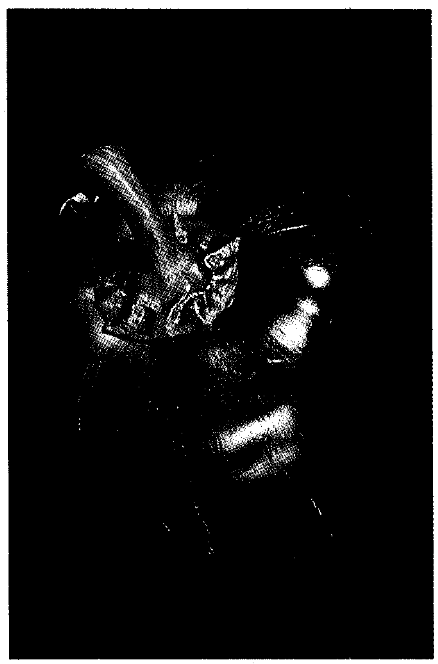

Figure 4. Striate symptoms on fruit from an affected plant.

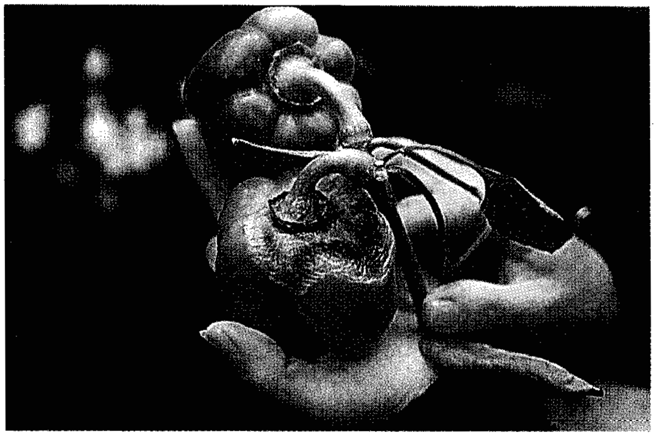

Figure 5. Fruit usually rots from the calyx end.

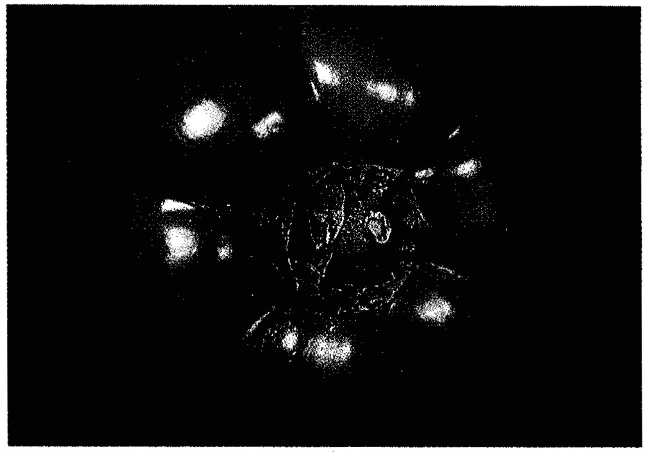

Figure 6. Incipient fruit rot beneath the calyx lobes.

Figure 7. Nodal lesion at the site of an infected fruit peduncle.