Improved Chemical Control of Botrytis Blight in Roses

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Botrytis cinerea causes latent infections of rose flowers, which can develop into aggressive rot (botrytis blight) at pre- and postharvest stages. Botrytis blight is the cause of major rose flower losses. The effect of deposit and cover density of fungicides (pyrimethanil or prochloraz-Zn – folpet) on the development of botrytis blight was tested. For pyrimethanil drop size and cover density (ranging between 80 and 1000 μm drops/cm^2) had no effect on disease rate, if the pesticide deposit was sufficient for disease control. For prochloraz-Zn – folpet, however, control efficacy (for equal deposit) increased with cover density. Secondary distribution of pyrimethanil was by the vapor phase. Effective control was obtained when rose petals were exposed only to pyrimethanil vapors, while any direct contact with the fungicide was prevented; no control was recorded for prochloraz-Zn – folpet under these conditions. Botrytis blight was delayed in cut flowers when bunches of 20 flowers were wrapped in packing paper strips or cellophane bags which had been sprayed previously with pyrimethanil and packed (20 bunches) in cardboard boxes. No pesticide stains could be seen on the flowers.

KEY WORDS: *Botrytis cinerea*; botrytis blight; postharvest treatment; rose flowers; pyrimethanil; prochloraz-Zn – folpet; pesticide deposit; cover density; vapor action; secondary distribution.

INTRODUCTION

Roses are grown in Israel in greenhouses, the majority of which are polyethylene-covered. The Israeli greenhouse production of the flowers is very intensive, and involves modern technologies of construction, environmental control and agronomic treatments. Yet, the quality of flowers is constantly threatened by pathogens and pests, among which *Botrytis cinerea* Pers. ex Fr. is most important.

Botrytis cinerea is a pathogen for a wide variety of economically important plants grown inside and outside greenhouses, such as vegetables, ornamentals, bulbs and fruits and is a saprophyte on senescing and dead plant material (4,10). It is one of the main airborne pathogens in greenhouse ornamentals. *B. cinerea* is a problem during both the preharvest and postharvest periods, but its major damage is caused to rose flowers during the postharvest stage (2,5). In Israel, at least 20% of the rose flowers are sorted out due to *B. cinerea* infections, before export, during the winter season. The infection rate is influenced by the numbers of conidia present on the flower surface. In spite of intensive control efforts, flowers regularly are found infected by *B. cinerea* at the foreign markets and auctions – up to 5% of the rose flowers.

Botrytis cinerea is an airborne fungus, with conidia as the most important propagules in greenhouses. Conidia of *B. cinerea* are always present, day and night, throughout the

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season, in the greenhouse air volume. The horizontal and vertical distribution of conidia in the greenhouse is fairly uniform, irrespective of the crop. The main source of conidia found on cut flowers is the greenhouse population, during the production stage. Sedimentation by gravity is the major mechanism of deposition (8). Air circulation might improve deposition and penetration into the partially opened flower.

Typical necrotic lesions (spotting) caused by young *B. cinerea* colonies, occur on flower buds and petals during the postharvest period (2). Infections are caused at preharvest stages and remain symptomless until postharvest stages, but there are cases where the small lesions occur even in greenhouses (2). Symptoms of *B. cinerea* infection are promoted by >93% r.h. The transport stage, at which flowers are packed into cardboard boxes and rapid changes in temperature occur owing to transfer from cold storage into less-cooled trucks and then into cold store again after transport, creates conditions conducive to *B. cinerea* development (2). Even when the temperature is kept below 10°C during the entire transport stage, relative humidity can be >95%, and the damage caused by *B. cinerea* can be severe. Within 24 h of harvest many lesions occur at 18 to 25°C. *B. cinerea* in rose flowers can infect whole petals. On susceptible roses 1–3 lesions/flower are enough to colonize and destroy a flower (8). Quality loss caused by *B. cinerea* during the pre- or postharvest period is hard to avoid with fungicides (3,8). Besides application problems, related to poor penetration of the pesticides into the bunch, this is due also to the nature of the disease (2,5) or to resistance of pathogen populations to the pesticide (5).

Growers are taking intensive actions other than fungicide applications in order to reduce spoilage damages caused by *B. cinerea*. Greenhouses are intensively heated and ventilated. The use of thermal screens and overhead air circulators contributes to minimizing the persistence of water film on the petals. Despite this, postharvest chemical treatment of low toxicity that can be applied before packaging or during export, can greatly improve the quality and shelf-life of the flowers.

MATERIALS AND METHODS

Host pathogen and disease

Rose (*Rosa hybrida* L.) flowers of the cultivars 'Mercedes', 'Fresco' and 'Lambada' were harvested in commercial greenhouses, in which no fungicides were applied against the pathogen. Experiments were carried out with detached petals (cv. Mercedes) and whole flowers (cvs. Fresco and Lambada). Suspensions of *B. cinerea* conidia (10^4/ml) washed from 14-day-old PDA cultures, were supplemented with 0.01% glucose (Merck, Germany) and 0.07% K_2HP0_4 (Sigma, USA). The suspension was applied to petals or flowers and air-dried immediately afterwards. Infected flower material was then exposed to fungicide treatment as described below.

Treated petals were incubated in boxes at 0.8–1.0 kPa and 20±2°C. Severity of disease on detached petals was evaluated according to a scale of six degrees, where 0 = no visible symptoms and 5 = petals completely covered by botrytis blight, with developed botrytis signs. Whole flowers were incubated in bunches (20 flowers each), placed in standard boxes used for export (13.5 × 39 ×x 99 cm, with two 4-cm-diam ventilation holes on the narrowest walls). The closed boxes were kept under conditions of transport and storage (2–4°C for 3 days). The boxes were then opened, and the flowers transferred to 20°C at 0.8–1.0 kPa for symptom development. Blight rate on each flower was evaluated (in percentage) for each bunch of flowers.

TABLE 1. Combinations of droplet cover density over the target and size of droplets applied to rose petals or on lids of petri dishes

Cover density (drops/cm^2)	Drop diameter (μm)	Total volume deposited (μl/cm^2)
1000	80	0.25
500	100	0.25
60	200	0.25

Fungicides and their application

Pyrimethanil – 300 g/l *N*-(4,6-dimethylpyrimidin-2-yl)aniline) as Mythos EC, AgrEvo GmbH, Berlin, Germany (9).

A mixture of prochloraz-Zn - 150 g/l *N*-propyl-*N*-[2-(2,4,6-trichlorophenoxy) ethyl]imidazole-1-carboxamide and folpet 600 g/l *N*-(trichloromethanesulphenyl)-phthalmide as Mirage F WP, Makhteshim, Be'er Sheva, Israel (9).

Laboratory bioassays

Detached rose leaves: Thirty infested petioles were placed on round 30-cm-diam cardboard dishes and sprayed in a laboratory spray chamber (7) with predetermined droplet size, to the desired cover density (60–1000 drops/cm^2), as counted on water-sensitive paper (Ciba Geigy, Switzerland). When equal deposits with different cover densities were needed, drop diameter was adjusted without changing the volume sprayed per area unit (Table 1).

Rose flowers (in bunches): The commonly used wrapping paper or cellophane bags were used for studying the effect of pyrimethanil vapors on the delay of botrytis blight during transport. Paper strips (51.5 × 20.5 cm) or cone cellophane bags were sprayed on the side facing the flowers (44.5 × 20.5 and 32.0 × 30.0 cm, respectively) in the laboratory spray chamber with 100 μm volume median diameter (VMD) droplets, to a cover density of 1000 droplets/cm^2 (6). Twenty-flower bunches were wrapped in a sprayed cover after drying.

Since pyrimethanil showed a pronounced effect of disease control by vapor activity, it was decided to test the possibility of vapor action on whole rose flowers which were maintained under transport conditions. No fungicide was applied directly to the flowers; it was applied to the inner surface of a standard box used for rose export, on a sponge which was later placed among the flower bunches in the box or on the bunch covers.

RESULTS AND DISCUSSION

Rose petals experiments

The importance of the fungicide deposit and cover density on control efficacy was tested on the basis of equal deposits. It was observed for pyrimethanil that the drop size had practically no effect on the control of disease, whereas the concentration of the fungicide did affect the control efficacy (Fig. 1). For prochloraz-Zn – folpet, on the contrary, control rate increased with the cover density of the fungicide drops on the rose petals (Fig. 1). The differences between the effect of cover density of the two fungicides pointed at a better secondary distribution of pyrimethanil, as compared with prochloraz-Zn – folpet (1).

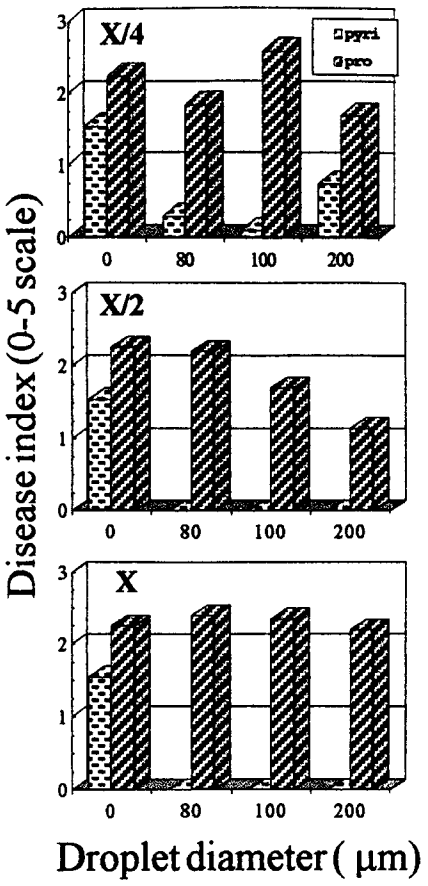

Fig. 1. Control of botrytis blight on rose petals, as affected by the amount of fungicide deposited on the target, and the cover density. Initial deposits for pyrimethanil (pyri) were 80 ng/cm^2 (X), 40 ng/cm^2 (X/2), and 20 ng/cm^2 (X/4); and for prochloraz-Zn – folpet (pro) 200 ng/cm^2 (X), 100 ng/cm^2 (X/2), and 50 ng/cm^2 (X/4).

Both pyrimethanil and prochloraz-Zn – folpet components are barely soluble in water (121 mg/*l* at 25°C for pyrimethanil, and 34.4 mg/*l* and 1 mg/*l* for prochloraz-Zn and folpet, respectively). It was quite clear that the secondary distribution by solubility in the water films on the leaves might be poor. There are, however, distinct differences between the vapor pressure of these fungicides. The vapor pressure of pyrimethanil (2.2 mPa at 25°C) is almost double that of folpet (1.3 mPa) and 15 times higher than that of prochloraz (0.15 mPa) (9). It is suggested that the good secondary distribution of pyrimethanil is by the vapor phase.

To check this assumption, the fungicides were applied at the above mentioned concentrations and cover densities to the internal side of petri dish covers. These lids were used to cover humidity chambers (petri dishes containing untreated but infected rose petals). Effective control was found under the pyrimethanil-treated lids, whereas none was observed under the prochloraz-Zn – folpet-treated lids (Fig. 2).

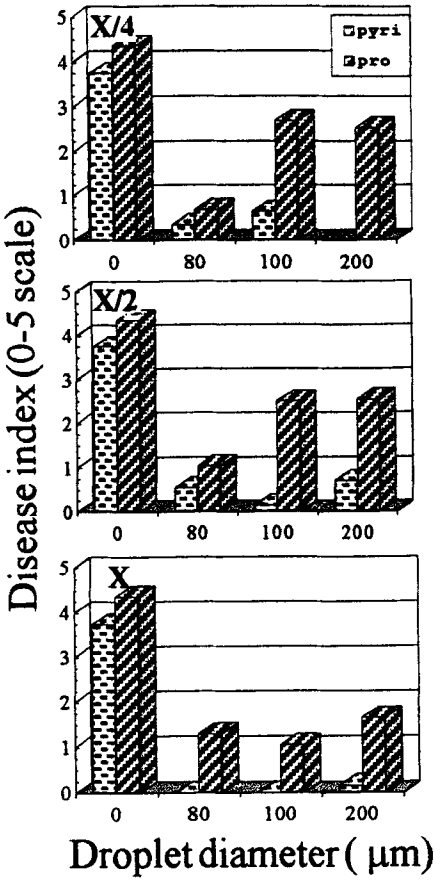

Fig. 2. Control of botrytis blight on rose petals, as affected by the vapor action and the cover density of various dosages of fungicide deposited on the lids of the humidity chambers, without touching the petals. Initial deposits for pyrimethanil (pyri) were 80 ng/cm^2 (X), 40 ng/cm^2 (X/2), and 20 ng/cm^2 (X/4); and for prochloraz-Zn – folpet (pro) 200 ng/cm^2 (X), 100 ng/cm^2 (X/2), and 50 ng/cm^2 (X/4).

Whole flower experiments

Significant control of botrytis blight was achieved by all means of application in both rose cultivars used. It is concluded that the vapor action of pyrimethanil can produce effective control of botrytis blight of rose cut flowers caused by *B. cinerea* (Fig. 3). This effect is enough to slow down blight development during storage, even when applied from without 20 flowers, despite the very dense vegetation which might interfere with the movement of the fungicide to the flowers located inside the bunch (6). The treatment leaves no signs on the flower, and the deposit (and hence residue) of vapors is very small. This effect of pyrimethanil will be tested on other crops in order to alleviate the problems caused by *B. cinerea* to the shelflife of cut flowers.

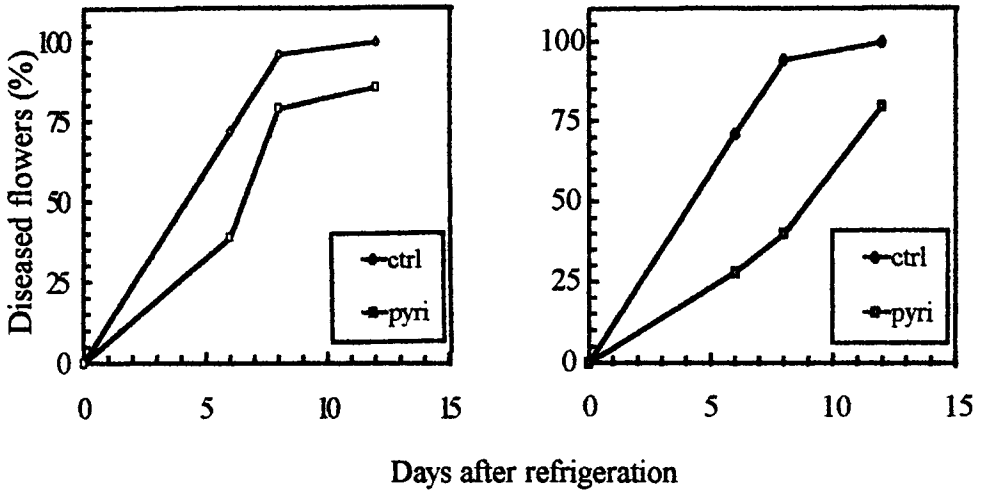

Fig. 3. Effect on botrytis blight of pyrimethanil (pyri) applied to covers of rose bunches: applied to paper strips (right) or to cone cellophane bags (left), sprayed on the side facing the flowers.

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