Efficacy of Fungicides for Postharvest Treatment of Muskmelon Fruits

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Abstract. Fruit of muskmelon (Cucumis melo L.) were treated with 0–10⁴ mg/liter of the fungicides: benomyl (methyl-1-[(butylcarbamoyl)-2-benzimidazole carbamate); etaconazole (1-[(2-(2,4-dichlorophenyl)-4-ethyl-1,3-dioxolan-2-yl]-methyl)-1 H-1,2,4-triazole); fenapanil (1-butyl-1-phenyl-1 H-imidazole-1-propanenitrile); imazalil (1-[2-allyloxy-2-(2,4-dichlorophenyl)ethyl]imidazole); and prochloraz (1-[N-propyl-N-[2-(2,4,6-trichlorophenoxo)ethyl]]carbamoylimidazole). Damage from Fusarium soft rots, and Alternaria surface blemish was assessed. Fenapanil, imazalil, and prochloraz had the most useful range of fungicidal activities. Prochloraz was the most efficacious fungicide tested, expressed as disease control per unit concentration of active ingredient.

Several fungicides have been found which, when applied as postharvest dips at room temperature, help to control disease in muskmelons. Three of these fungicides are imazalil (2), benomyl, and guazatine (7). When applied as dips at 57°C, captan (6) and sodium dimethyldithiocarbamate (1, 2) are also effective. The postharvest disease complex which affects muskmelons (7, 8) is not, however, readily controlled by any one fungicide. This fact has prompted the testing of many fungicides, often using conventional culture-plate testing techniques (e.g., 7). The limitations of culture-plate tests are well known (3), and tests should be made on disease-susceptible fruit at an early stage of the screening program. In this paper, we report the relative efficacies of 5 fungicides applied to muskmelons at room temperature. A rapid and economical test method was used which generated dosage/response curves for each treatment.

'Goldpak' muskmelons were harvested from a commercial crop at "full-slip" maturity (i.e., abscission crack between fruit and peduncle) and "western choice" ripeness (4) (fruit yellowish-tan in color). The melons were inoculated by dipping for 1 min in a suspension containing 10⁵ spores/ml of Fusarium spp. (mixed isolates grown on melons and lesions excised from the fruit and blended to obtain spores). After incubation at ambient conditions for 16 hr, the melons were randomized and dipped for 1 min in solutions or suspensions of benomyl, etaconazole, fenapanil, imazalil, and prochloraz.

Each fungicide was tested at concentrations of 0, 100, 300, 600, 1000, 3000, and 10,000 mg a.i./liter. A non-ionic wetter (0.01% v/v) was added to each dip, and all dips were applied at ambient temperature. Each treatment was applied to a unit of 15 melons, so that 90 melons were treated with each fungicide.

Treated melons were drained, air-dried, packed in cartons, and transported 700 km to the laboratory. The severity of 3 types of disease was assessed after storage for 9 days at 25°C and ambient humidity. These diseases were Fusarium fruit rot, soft rots caused by both Geotrichum and Rhizopus, and surface blemish caused mainly by Alternaria. Melons were scored for severity of each disease (1 = no disease, 2 = trace, 3 = slight, 4 = moderate, and 5 = severe disease). Individual melons with a score of 2 were considered marketable without penalty, whereas a score of 3 would lead to downgrading in the market.

Dosage/response equations for each fungicide and disease combination were calculated by quadratic regression analysis, and the coefficients of determination were tabulated (Table 1). The equations were then used to predict the concentration of each fungicide required to reduce disease to an economically acceptable level, which was defined as a disease score of 2.0 (Fig. 1). Fusarium rot was reduced by all fungicides; less than 100 mg/liter of benomyl or prochloraz was needed to give a disease score of 2.0. Soft rots were

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Table 1. Correlations between fungicide concentration and disease score for several diseases of muskmelon*

<table>
<thead>
<tr>
<th>Fungicide</th>
<th>Coefficient of determination (r²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Benomyl</td>
<td>Soft rot</td>
</tr>
<tr>
<td>0.97**</td>
<td>0.87**</td>
</tr>
<tr>
<td>Etaconazole</td>
<td>0.93**</td>
</tr>
<tr>
<td>Fenapanil</td>
<td>0.84**</td>
</tr>
<tr>
<td>Imazalil</td>
<td>0.86**</td>
</tr>
<tr>
<td>Prochloraz</td>
<td>0.97**</td>
</tr>
</tbody>
</table>

*Significant at 1% level.

Fig. 1. Predicted fungicide concentrations required to reduce muskmelon diseases to an acceptable level (i.e., disease score = 2.0). A = Fusarium rots; B = Soft rots; C = Surface blemish. A break at the top of a bar denotes a predicted concentration > 10,000 mg/liter.
reduced by all fungicides, but fungicidal effi-
cicacy was low except for prochloraz. In pre-
vious experiments, benomyl, imazalil, and
fenapanil had no effect on the growth of Rhi-
zopus oryzae on culture plates, and little ef-
fect on Geotrichum candidum (7). It is doubtful
if the fungicides tested in the present study,
other than prochloraz, exerted more than an
indirect effect on soft-rot organisms. The in-
cidence of soft rots was low where primary
 Fusarium infections were controlled, sug-
gesting that the soft rots were secondary in-
flections. Surface blemish was reduced by
fenapanil, prochloraz, and imazalil; less than
100 mg/liter of these fungicides gave a dis-
ease score of 2.0.

The experimental technique used in this
work has several novel properties. Each fun-
gicide was tested over a 10³-fold concentra-
tion range, and the resultant responses were
described conveniently by quadratic equa-
tions. This treatment of the data is appro-
 priate, since the scoring system used is an
ordered classification (5). The technique en-
ables fungicides to be tested on fruit, while
requiring a minimal amount of experimental
material, and with minimal recourse to ar-
tificial inoculation (inoculation was by sur-
face contact, not deep wounding). The wide
concentration range studied was deliberately
chosen so that fungicides with high effective
doses (ED₅₀) would not be arbitrarily dis-
carded. We recognize that at dip concentra-
tions of 10⁻¹⁻¹⁰ mg/liter, surface residues of
some fungicides may have reached satu-
ratation, and calculations of the dip concen-
tration to give a particular disease score, such
as those made for soft rots, may be artificial.
Suffice it to say that the resultant estimates
will have relative meaning—i.e., the esti-
mated 6000 mg/liter of benomyl to give an
apparent soft-rot score of 2 means that ben-
omyol is not very effective.

Our results are provocative since they de-
precate the role of soft-rot organisms in pri-
mary pathogenesis and imply that control of
 Fusarium rots will curtail soft rots. Further
work is needed to clarify this point. Fena-
panil, prochloraz, and imazalil had the most
useful range of fungicidal activities in this
work; and prochloraz was the most effica-
cious fungicide, in terms of disease control
per unit concentration of active ingredient.

Chlorflurenol interrupts ovule
Development of Muskmelon

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Abstract. Application of 50 or 75 mg/liter chlorflurenol (methyl-2-chloro-9-hydroxy-
fenamino) to muskmelon (Cucumis melo L.) 10 to 12 days prior to anthesis eliminated
ovule development during later bud growth. The interruption of ovule development
increased when chlorflurenol was applied 6–14 days prior to anthesis. Chlorflurenol
did not interfere with pollination, pollen germination, or pollen tube growth.

Chlorflurenol induces parthenocarpic fruit
set on cucumbers and muskmelons (2, 3, 4,
5, 7, 8). Chlorflurenol can also improve fruit
set of pollinated flowers and usually reduces
the number of seeds per fruit (3, 4). This
observation led Cantliffe to hypothesize that
chlorflurenol interferes either with ovule or
pollen tube development (3). This study was
initiated to determine the validity of these
hypotheses.

Chlorflurenol (Curbiset, EM Industries Inc.)
at 50 mg/liter was sprayed to run-off onto 7
muskmelon lines (both cultivars and breeding
groups) grown in the field. Pollistate flowers
from treated and untreated plants were hand-
pollinated 10 days after treatment and fixed
in 8 ethanol: 1 formalin: 1 acetic acid (FAA)
at intervals from 10 to 50 hr after pollination.
Fixed flowers were rinsed, hand-sectioned,
and hydrolyzed in 1 N NaOH at 60°C for 10
min and then rinsed and stained with 0.1%
aniline blue in 0.1 N K₃PO₄. Pollen tubes
were observed under ultraviolet light ac-
tording to the methods of Martin (6). The quan-
tity of pollen on each stigma, pollen germina-
tion, and ovule number per flower were rated
on a scale of 0 (no pollen, ger-
mination or ovules) to 3 (sufficient pollina-
tion and germination or adequate ovule
number). Extent of pollen tube growth was
determined by visually assessing the location
of the tube tip within the style or ovary. There
were no statistically significant differences
among the 7 muskmelon lines.

The relationship between ovary develop-
ment at the time of chlorflurenol treatment
and the number of ovules present at anthesis
was investigated with 'Saticoy' muskmelon
plants grown in a greenhouse during the late
fall. Plants were treated as above with 0, 50,
or 75 mg/liter chlorflurenol. Ovary lengths
of pistillate flowers were measured at the
time of treatment or as soon as buds were
detected. Flowers were collected and fixed
at anthesis. Differences for date of anthesis,
ovary length, and ovule rating between the
50 and 75 mg/liter treatments were not sta-
tistically significant. Consequently, data for
these 2 treatments have been pooled for pre-
sentation.

Application of chlorflurenol did not reduce
pollination or pollen germination (Table 1).

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Pollination rating†</th>
<th>Pollen tube germination rating†</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control</td>
<td>2.9</td>
<td>2.9</td>
</tr>
<tr>
<td>Chlorflurenol</td>
<td>2.8</td>
<td>2.7</td>
</tr>
<tr>
<td>Significance</td>
<td>NS</td>
<td>NS</td>
</tr>
</tbody>
</table>

†Rating scale where 0 = no pollen or germination and 5 = abundant pollen (stigmatic surfaces
nearly covered with pollen) or pollen germination (pollen tubes appeared to occupy most of the
available space within the style or ovary).

1, 50 and 75 mg/liter combined.
NS = non-significant, 1% level.

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