Captan Deposition in Peach Orchard Hedgerows

J. D. Gaynor and R. E. C. Layne
Research Station, Agriculture Canada, Harrow, Ontario, Canada N0R 1GO

Abstract. Four hedgerow types: oblique fan, canted oblique fan, modified central leader, and open center, in a peach (Prunus persica (L.) Batsch cv. Olinda) orchard were evaluated in 1975 and 1977 for their effect on deposition of captan (N-trichloromethyl-4-cyclohexene-1,2-dicarboximide). Within hedgerows captan residues on leaves were generally higher on bottoms than tops of trees but among hedgerows, leaf residues were higher on oblique fan. The higher leaf residues resulted in 10.8\% more of the captan applied per tree retained by oblique fan compared to 31.7\% intercepted by the other hedgerows. Ground deposits for oblique fan and open center averaged 11.7\% but were 6.3\% higher for canted oblique fan and modified central leader. Ground deposits did not relate to area below trees or hedgerow type but leaf residues and that accounted for related to tree canopy volume. Compared to the standard open center, oblique fan was 41\% more efficient at intercepting captan, modified central leader 20\% more efficient and canted oblique fan showed no improvement in efficiency. Hedge-rows with smaller tree canopy volumes increased captan interception, reduced spray drift and thereby provided economic and environmental gains through more efficient captan use.

The need to optimize yields and management efficiency is becoming more important to the commercial orchardist because of rapidly rising costs (6, 9). High density plantings made possible through the development of dwarfing rootstocks have been successfully adopted in apple culture (8) but much research is needed before the practice can be applied to peach culture, especially in the absence of suitable dwarfing rootstocks for peach. Recent studies with peach indicate that yields are directly related to planting density (4, 7) which in turn affects light penetration, fruit size and color, pesticide coverage, and disease incidence (2, 4, 7, 10).

Pesticide recommendations are currently based on land area. For high density plantings of apple, rates based on land area appeared to be uneconomical and imprecise, but recommendations based on tree canopy volume seemed to be more logical (5). Planting density influences the quantity of chemical available per tree and possibly interception; therefore it was of interest to study the effect of different hedgerows on captan deposition and loss during application using conventional equipment without optimization of sprayer parameters. Captan was selected as the test pesticide because of its wide use in peach for control of brown rot and other fungal diseases (1). Data were collected from 1975 to 1977 but because of an unusually heavy leaf fall induced by hot, dry weather in 1976 prior to sampling, only the 1975 and two 1977 sampling periods are reported herein.

Materials and Methods

Hedgerow types. Four hedgerow types, 1) oblique fan, 558 trees/ha; 2) canted oblique fan, 746 trees/ha; 3) modified central leader, 536 trees/ha; and 4) open center, 383 trees/ha, were established in a peach orchard of 'Olinda' on Rutgers Red- leaf rootstock planted in 1969. Each hedgerow type was represented by a single row of trees with between the row and in row spacings: 1) 3.6 x 4.9; 2) 5.5 x 2.4; 3) 6.1 x 3.0; and 4) 6.1 x 4.3 m (measurements rounded up from British lengths) respectively. The trees were hand pruned about blossom time and from 1974 were maintained by mechanical hedging in mid July to a uniform height of 3 m and widths of 1) 1.5; 2) 2.0; 3) 3.0, and 4) 3.0 m respectively. Tree growth filled the available space within rows. The length, width, height and canopy volume of each selected tree were measured.

Sampling. Three to 5 representative trees from each hedgerow

1Received for publication November 24, 1978.
2Appreciation is expressed to F. Stroud and L. Beetham who maintained the orchard and applied the pesticides, to D. MacTavish who assisted in tree sampling and pesticide analysis, and to V. A. Dirks for statistical advice.

Literature Cited
1. California Department of Food and Agriculture. 1976. Extracts from the administrative code -- Title 3 of California pertaining to rules and regulations of fruit and vegetable quality control standardization. Article 17.
type were selected for study from 1975 to 1977. In each year, 1 week before captan application and after maximum leaf development, a count was taken of the number of leaves per tree. The average area for the upper and lower leaf surface was estimated from 2 randomly collected samples of 52-70 leaves, using a Li Cor area meter model Li-3000. This was done to quantify the amount of captan on the foliage.

Captan (3.36 kg ai/ha) was applied in 4.5 kl water/ha to both sides of each hedgerow with a Bean air blast sprayer model D-336CP calibrated and optimized for spraying conventional orchards. Spray pump was operated at 2068 kPa and tractor speed was 4.8 km/hr. Wind speed during application ranged from 3 to 16 km/hr across the hedgerows from the southwest or west. After application, 25 to 30 leaves were collected for analysis from the top and bottom of the east, west and middle portions of each tree.

To determine deposition on the orchard floor eight petri plates were located in representative areas below each tree. Residue analysis. One or 2 leaf discs with a combined upper and lower area of 3.08 cm²/disc were punched from the center of each leaf. The 25 to 30 discs were combined and extracted twice with 15-20 ml acetone: hexane (1:1). Captan was washed from the petri plates with acetone: hexane (1:1), and the leaf and petri plate extracts were dried, the residue dissolved in 5 ml hexane, and analyzed by gas chromatogram (GC) using a 63Ni electron capture detector.

Captan was chromatographed through a 0.5 m × 6.6 mm od glass column containing 10% DC-200 on chrom WHP (80/100 mesh). Carrier gas was maintained at 118 ml N₂/min and inlet, column, and detector temperatures were 190, 195 and 230°C. The concentration in the extracts was verified by S-flame photometric detector using 5% OV-17 on gas chrom Q (60/80 mesh) packed in a 1.2 m × 6.6 mm od glass column. Inlet, column, and detector temperatures were maintained as above. Carrier gas (He), H₂ and air flow rates were 35, 151, 94 (air #1), and 165 (air #2) ml/min respectively.

Results and Discussion

The uniformity of captan distribution was assessed by leaf analysis from 6 locations within trees for each hedgerow. Captan residues were generally higher on lower than upper leaves of each hedgerow and were usually higher on the west than the middle or east positions due to a prevailing southwest wind. Among hedgerow types residues were similar for canted oblique fan, modified central leader and open center hedgerows which averaged 1.96 µg captan/cm² of the leaf area and canted oblique fan had residues of 2.30 µg/cm².

The residues of captan on leaves and the leaf area per tree provided a measure of the quantity of captan deposited on the foliage (Table 1). A constant amount (3.36 kg ai/ha) of captan was applied to the study area but the quantity available per tree ranged from 4501 to 8787 mg/tree because of the different planting densities. Assuming 100% deposition of emitted spray on open center trees the modified central leader, oblique fan, and canted oblique fan would receive 71.4, 68.6, and 51.2% of this amount.

As expected, canted oblique fan, which had the highest planting density, intercepted less captan (1539 mg/tree) than the others. Among the other hedgerows no differences were noted in the quantity of captan deposited on the foliage (Table 1). Foliar deposits, expressed as a percentage of total captan applied per tree, showed that oblique fan intercepted 10.8% more of the captan than the average (31.7%) of the other hedgerows (Table 1).

The proportion of the captan applied per tree which was intercepted increased as tree canopy volume decreased (Fig. 1). Tree canopy volumes for oblique fan and canted oblique fan were similar (24.9 and 22.0 m³/tree respectively) whereas

---

**Table 1. Average captan residues on leaves in relation to amount applied on a per tree basis.**

<table>
<thead>
<tr>
<th>Type of hedgerow</th>
<th>Total applied² (mg/tree)</th>
<th>Leaf residues³ (mg/tree²)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oblique fan</td>
<td>6027</td>
<td>2562</td>
<td>42.5 b</td>
</tr>
<tr>
<td>Canted oblique fan</td>
<td>4501</td>
<td>1539</td>
<td>34.1 a</td>
</tr>
<tr>
<td>Modified central leader</td>
<td>6276</td>
<td>2132</td>
<td>34.0 a</td>
</tr>
<tr>
<td>Open center</td>
<td>8787</td>
<td>2375</td>
<td>27.0 a</td>
</tr>
</tbody>
</table>

²Total applied (mg/tree) = rate (kg/ha) ÷ planting density (trees/ha) × 10⁶. ³Mean separation in columns by Duncan’s multiple range test, 5% level. Values are the average of 3 sampling periods, 1 in 1975 and 2 in 1977. ⁴Leaf residues (mg/tree) = residues on discs (µg/cm²) × leaf area (m²/tree) × 10.

---

**Table 2. Average amount of captan below trees and percent of total applied per tree.**

<table>
<thead>
<tr>
<th>Type of hedgerow</th>
<th>Ground deposit³ (mg)</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oblique fan</td>
<td>693 a</td>
<td>11.5 a</td>
</tr>
<tr>
<td>Canted oblique fan</td>
<td>766 ab</td>
<td>17.0 b</td>
</tr>
<tr>
<td>Modified central leader</td>
<td>1273 c</td>
<td>20.3 b</td>
</tr>
<tr>
<td>Open center</td>
<td>1073 bc</td>
<td>12.2 a</td>
</tr>
</tbody>
</table>

³Mean separation in columns by Duncan’s multiple range test, 5% level. Values are the average of 3 sampling periods, 1 in 1975, 2 in 1977. YGround deposit (mg) = residue per unit area (µg/cm²) × area below trees (m²) × 10.
larger tree canopy volumes were obtained for modified central leader (28.9 m$^3$/tree) and open center (35.5 m$^3$/tree).

The amount or percent of applied captan below trees was unrelated to area below trees or tree canopy volume. Measured ground deposits below oblique fan and canted oblique fan were lower than those for the other hedgerow types (Table 2). The deposit, expressed as a proportion of captan applied per tree, averaged 11.9% for oblique fan and open center compared to 18.2% below modified central leader and canted oblique fan (Table 2). No leaf runoff was observed so that captan was deposited directly on the orchard floor. The quantity of captan below trees (11.5-20.3%) was similar to that reported below apple trees (3).

The amount of captan not accounted for on leaves and below trees increased as tree canopy volume increased (Fig. 2). Open center had the highest average tree canopy volume and 60.8% of the applied captan was unaccounted for. The other hedgerows had an average of 48.2% of the applied captan unaccounted for which was similar to that lost by spray drift from apple trees (3). The amount of captan unaccounted for included that on the tree scaffolding which was assumed to be small compared to that on leaves and passing through the trees.

The efficiency of the various hedgerows to intercept captan was assessed from deposit data for each hedgerow compared to deposit data for the standard open center. The difference between the measured deposit ratio and the ratio of what was applied per tree gave a measure of the relative efficiency for each hedgerow (Table 3). Compared to open center, modified central leader and oblique fan were more efficient at intercepting captan than the canted oblique fan. Oblique fan was 41% more efficient than open center and modified central leader was 20% more efficient. The efficiency of these systems as calculated also reflects the inefficiency of open center indicated by the 61% loss of applied captan (Tables 1 and 2).

The 4 hedgerow types had little influence on uniformity of spray coverage within trees but loss by spray drift was significantly reduced. Immediate benefits of hedgerow culture accrue from more efficient utilization of time, labor, and pesticide since in this study twice as many trees in canted oblique fan were sprayed with the same amount of pesticide and effort as open center. The results indicate that pesticide rates based on the target (tree canopy volume) may be more useful and accurate than rates based on land area since oblique fan had higher leaf residues than the other hedgerow types. This suggests that pesticide rates for some hedgerow types may be reduced without loss of efficacy.

### Literature Cited