DISSIPATION OF DISLODGEABLE FOLIAR RESIDUE
FOR CHLORPYRIFOS AND DICHLORVOS TREATED LAWN:
IMPLICATION FOR SAFE REENTRY

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Dissipation of Dislodgeable Foliar Residue for Chlorpyrifos and Dichlorvos Treated Lawn: Implication for Safe Reentry

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The reentry interval is the time elapsed after a pesticide has
been applied before a worker can safely reenter the field for
-cultural or harvesting activities while wearing normal clothing.
The safe reentry interval for a pesticide is determined by moni-
toring the dissipation of its dislodgeable foliar residue (Iwata et
al. 1979) until it reaches the established estimated-safe-level
(Knaak et al. 1980). Reentry standards have been established for
selected pesticides on various tree fruits by EPA and more string-
ently by the California Department of Food and Agriculture.

Recently, because of concern for the safety of children playing on
chlorpyrifos and dichlorvos treated lawns, a field trial was
instigated. An initial study on Kentucky bluegrass, using the
maximum recommended rate of 3.79 liters Dichloron (TM) for 508.18
m² of lawn and irrigating with 12.7 mm of water post-spray, was
found to be safe to reenter after two hours at which time the
spray had dried (Goh et al. 1985). Dichloron (TM) is a lawn
insecticide containing 3% chlorpyrifos [0,0-diethyl O-(3,5,6-tri-
chloro-2-pyridyl) phosphorothioate] and 2.6% dichlorvos/DDVP
(2,2-dichlorovinyl dimethyl phosphate) as the active ingredients.
These organophosphorus insecticides are cholinesterase inhibitors
with moderate toxicity: chlorpyrifos acute oral (rat) LD₅₀ =
82-155 mg/kg, dermal LD₅₀ = 202 mg/kg; dichlorvos oral LD₅₀ =
50-80 mg/kg, and dermal LD₅₀ = 75-107 mg/kg (Gaines 1960, 1969).
In California the estimated safe levels of dislodgeable foliar
residue for chlorpyrifos and dichlorvos are 0.50 µg/cm² and 0.06
µg/cm², respectively (Maddy et al. 1984).

This study reports the dissipation of chlorpyrifos and dichlorvos
on a clover and fescue lawn used under both recommended conditions
and a possible worse-case situation (using half the recommended
amount of water with no irrigation after spraying). To prevent
the loss of dichlorvos (vapor pressure 0.01 mm Hg at 30°C) in the
samples during transit and holdover prior to extraction and analy-
isis, this study was conducted on a lawn in the premise of the
chemistry laboratory to facilitate immediate residue analyses.
METHODS AND MATERIALS

Lawn plots were located at the California Department of Food and Agriculture's Chemistry Laboratory, Meadowview Road, Sacramento, CA during November 1984. The plots consisted of 80-90% clover, Trifolium sp. and 10-20% fescue, Festuca sp. Correlation of leaf weight to surface area was obtained by taking 12 leaf samples, ranging from 2 to 18 grams (weighed to the nearest centigram). The single surface leaf area was measured with a LI-3100 leaf area meter (LI-COR, Nebraska) to within + 0.001 cm² for each sample of known fresh weight. A linear regression of surface area (both sides) to fresh weight was generated from the data.

The experimental plot was a 2 x 2 factorial design: full (613.24 liters for 508.18 m² of lawn) and half the recommended rates of water with (12.7 mm) and without post-spray irrigation. All treatments (0.61 m x 2.4 m) were replicated four times and sprayed at the maximum recommended rate of 3.79 liters Dichloron TM for 508.18 m² of lawn. Application was made at 0700 hours (ambient temperature 11.1°C; relative humidity 90%; calm conditions) with a two-gallon Hudson hand-held sprayer under low pressure equipped with a nozzle producing coarse droplets. Immediately after spraying, half the treated plots were irrigated with 12.7 mm of water as per label directions. Leaf samples were taken before, immediately after spraying, and at 2, 6, 8, 24, 48, and 72 hours post-spray. One random sample per plot, as demarcated by a wire template of 10 x 10 cm, was taken at each sampling interval and immediately taken into the laboratory for weighing and analyses.

Dislodgable residues were extracted by rotating the leaf samples three times for 30 minutes each at 30 cycles/minute in: 1) 50 ml of water with 0.2 ml of 2% Sur-Ten (American Cyanamid) solution; 2) 50 ml of water with Sur-Ten; and 3) 50 ml water only. The 150 ml aqueous solution was extracted three times with 50, 25 and 25 ml of ethyl acetate. The solvent was dried over sodium sulfate and analyzed by HP 5880-A gas chromatography with a 25 x 0.2 mm 15, SE-54 fused silica coated capillary column. Sample solutions and appropriate standards were injected using the following instrument parameters: pressure 15 psi; oven temperature 170-240°C; injector temperature 225°C; helium carrier gas flow rate 25 ml/min; septum purge rate 2 ml/min and split vent rate 50 ml/min; retention time dichlorvos = 2.45 min and chlorpyrifos = 6.98 min. The detection limit of chlorpyrifos and dichlorvos was 1 μg/sample.

RESULTS AND DISCUSSION

The linear regression of total leaf surface area of clover and fescue (both sides) to fresh weight was Y = 55.27 x (r = 0.99) This correlation again demonstrated, as in our previous study on Kentucky bluegrass (Goh et al. 1984), a quick and accurate way for estimating leaf surface area from any sample of known weight without tedious measurement of leaf area each time. Contrary to first
Impression, Kentucky bluegrass with regression of \( Y = 79.28 x \) 
(\( r = 0.99 \)) has more surface area than clover and fescue for a 
given fresh weight. However, in terms of retention of spray resi-
dues, it was probably compensated by the flat trifoliate nature of 
clover which offer more available surface than the upright and 
narrow leaves of bluegrass.

Two methods of leaf surface area measurements were used in the 
calculation of foliage dislodgeable residue (ug/cm²): 1) total 
leaf surface area as obtained by regressing sample of known weight 
on the established regression line; and 2) leaf area represented 
by lawn area sampled, 100 cm² in this case. The latter method 
probably reflects more accurately the actual area that could be 
contacted in the course of human activities on lawn.

The dissipation of dislodgeable dichlorvos residue was remarkably 
similar to our previous trial on Kentucky bluegrass. Foliar 
dichlorvos residue, as measured by Method 1 for the treatment with 
the recommended rate and followed with 12.7 mm of post-spray 
watering, never exceeded the estimated safe level of 0.06 ug/cm² 
(Maddy et al. 1984); all other treatments were below the safe level 
within six hours post-spray (Fig. 1). Using the Method 2 calcula-
tion, the foliar residues reached safe levels within four hours in 
irrigated plots; in the worse-case situations (non-irrigated plot) 
it took 14 hours for dichlorvos to dissipate to the estimated safe 
level (Fig. 2). Dichlorvos was not detected at 48 hours and 
beaten (detection limit 1 ug/sample).

Residue levels of chlorpyrifos were well below the estimated safe 
level of 0.5 ug/cm² (Maddy et al. 1984) except in the non-irrigated 
plots (Fig. 3). Using the lawn area calculation, it took six 
hours for chlorpyrifos to dissipate to safe levels (Fig. 5). In 
the course of the experiment, Dichloron (TM) was phytotoxic to 
clover at 10 to 30 percent in the post-spray irrigated and non-
irrigated plots, respectively.

In general, the dilution rate of Dichloron (TM), i.e. using full 
or half the recommended rate of water, did not significantly alter 
the rates of dissipation for dichlorvos and chlorpyrifos. How-
ever, post-spray irrigation significantly increased the dissipa-
tion of dichlorvos and particularly chlorpyrifos folic dislodge-
able residues. Chlorpyrifos never exceeded the estimated safe 
level and dichlorvos dissipated to safe levels within four hours 
post-spray when used in the formulation Dichloron (TM) under 
Northern California's cold and wet winter. When post-treatment 
irrigation was not applied, 14 hours and 6 hours were required for 
dichlorvos and chlorpyrifos, respectively, to dissipate to the 
estimated safe levels.

The derivation of elapsed time required before safe entry to the 
treated lawn is based on the estimated safe levels for chlorpyri-
fos and dichlorvos established separately. The estimated safe 
level for simultaneous exposure to more than one toxicant as in
Figure 1. Dissipation of DDVP Foliar Dialodgeable Residue (+ S.E.) as Measured from Total Leaf Surface Area of Clover and Fescue Lawn. Sacramento, California, November 1984
Figure 2. Dissipation of DDVP Foliar Dislodgeable Residue (± S.E.) from 100 sq. cm. of Lawn Area of Clover and Fescue. Sacramento, California, November 1984
Figure 3. Dissipation of Chlorpyrifos (+ S.E.) as Measured from Total Leaf Surface Area of Clover and Fescue Lawn. Sacramento, California, November 1984
Figure 4. Dissipation of Chlorpyrifos (± S.E.) as Measured from 100 sq. cm. of Lawn Area of Clover and Fescue. Sacramento, California, November 1984
Dichloron (TM) needs to be investigated. There is also a need to adjust the safe level for repeated exposure to children from toxicants while playing or crawling on treated lawn.

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