

**EVALUATION OF POTENTIAL EXPOSURE OF  
GOLFERS AND GOLF COURSE MAINTENANCE PERSONNEL  
TO DACONIL 2787R**

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## **INTRODUCTION**

Increasing attention is being placed upon the exposure of field workers and the general public to residues of pesticides on agricultural crops and ornamentals. ISK Biotech has conducted several studies to measure potential exposure of people to residues following the use of our products. Some of these studies are required by the U.S. Environmental Protection Agency for approval of pesticide registrations which permit commercial sale and use of pesticide products. We conducted others voluntarily so as to develop a definitive, scientifically based method for assessing whether there may be risks associated with such exposure to our products. The present study is an example.

## **MATERIALS & METHODS:**

The study was conducted in 1986 at two golf courses in northern Ohio. We evaluated potential exposure of golf course personnel to the fungicide chlorothalonil during the mixing, loading, and application of Daconil 2787 Flowable Fungicide to greens, tees, and fairways. Following application, the potential exposure of workers or golfers to chlorothalonil was evaluated as they entered the treated courses to mow greens, tees, and fairways or to play golf. The re-entry evaluations were made on the same day of spraying after the spray deposits had dried.

The study was conducted on both a high maintenance and a low maintenance course. At the high maintenance course (Quail Hollow), the rate of application of Daconil 2787 Flowable to greens and tees was 7.5 oz /1000 sq. ft., while greens and tees at the low maintenance course (Deer Lake) were treated at 3.85 oz / 1000 sq. ft. Fairways at both golf courses were treated with Daconil 2787 Flowable Fungicide at six pints per acre. Exposure evaluations were made following three spray dates at each golf course.

Potential dermal exposure was evaluated by attaching gauze patches to the inside and outside of clothing and by wearing light cotton socks and gloves underneath the socks and work gloves normally worn by workers. This allowed measurement of the effectiveness of normal clothing, gloves, and socks in preventing chlorothalonil from reaching the skin. Potential inhalation exposure was evaluated by air sampling devices attached in the breathing zone of each worker or player during the entire activity period. Following completion of the work activity or the round of golf, the patches, gloves, socks, and air sampler devices were carefully removed and frozen for subsequent analysis for chlorothalonil. In the laboratory, the gauze patches, gloves, socks, air filters, and air adsorbent tubes were extracted and the levels of chlorothalonil present were determined. Potential exposure values were calculated by multiplying residues on patches (area basis) by the average surface area of the face, neck, shoulder, arms, forearms, hands, chest, back, hips, thighs, calves, and feet. Residues on the outside of clothing and that penetrating clothing were measured and used to estimate potential exposure.

## **RESULTS**

For mixers and loaders, most of the dermal exposure (on the skin) potential was on the hands (Table 1). The experienced applicators at Quail Hollow had less dermal exposure than the less experienced applicators at Deer Lake (Table 2). Only 3.3 to 7.7 percent of the residue penetrated clothing to reach the skin.

Similar results were seen with workers applying the spray to fairways and greens with only 2.4 to 6.9 percent of residue penetrating clothing (Table 3). Applications with boom sprayers resulted in low potential exposure. Fairway applications at Quail Hollow were made with a Myers air assist sprayer and resulted in greater

deposits on the outside of clothing than seen with boom sprayers. These deposits resulted from spray blowing onto the applicator as he travelled down-wind with the Myers sprayer. Little residue penetrated clothing, however.

Personnel who entered the treated golf courses to mow greens, tees, and fairways after the sprays had dried were potentially exposed to low levels of chlorothalonil (Table 4). Nearly all of this potential exposure was on the hands (92 to 95 percent of residues reaching the skin). Thus, these workers can virtually eliminate exposure to chlorothalonil by wearing gloves and washing their hands after mowing is completed.

Golfers who played on the course the same day of spraying had little to no exposure on most body parts. The only detectable residues were found on the hands, hips, and legs (Table 5).

Virtually all of the exposure potential was represented by dermal exposure. There was virtually no potential for inhalation exposure. Inhalation exposure to mixers was only 0.002 percent of the total. For applicators, inhalation exposure was only 0.004 to 0.03 percent of total potential exposure for fairways and 0.03 percent for spraying greens.

Thus, greater than 99.97 percent of potential exposure during application of Daconil 2787 Flowable Fungicide is on the skin with virtually no risk of inhalation exposure.

A similar profile was seen with workers who mowed greens and fairways on the same day of spraying. The levels of potential exposure were even lower than for workers applying the spray. The percentage of total exposure potential due to inhalation was only 0.02 to 0.1 percent for greens and fairways, respectively.

## CONCLUSIONS

This study demonstrated that for all golf course workers and golfers:

- a) A very high percentage of exposure is on the hands;
- b) Most potential exposure can be eliminated by wearing gloves;
- c) Work clothing is an effective barrier to chlorothalonil and by wearing long sleeves and trousers, workers can effectively reduce potential exposure;
- d) There is virtually no potential for inhalation exposure, so no respirators are needed.

Other studies conducted by ISK Biotech have shown that any potential for long-term exposure can be virtually eliminated by workers washing their hands after the work activity, showering at the end of the day, and laundering work clothing before re-wearing. Thus, ISK Biotech recommends that golf course workers wear gloves, long-sleeved shirts, and trousers while working with Daconil 2787, and to wash/shower and launder clothing after completing the work activity.

**Table 1. Exposure to chlorothalonil during mixing of a golf course spray suspension (high maintenance course).**

| Body Part  | Milligrams per Hour |                |
|------------|---------------------|----------------|
|            | Outer Exposure      | Under Clothing |
| Face       | .095                | .031           |
| Neck       | .013                | .013           |
| Shoulder   | .139                | .026           |
| Upper Arms | .079                | .036           |
| Forearms   | .205                | .017           |
| Hands      | 92.815              | 3.068          |
| Chest      | .058                | .014           |
| Back       | .120                | .024           |
| Hips       | 2.532               | .034           |
| Thighs     | 5.006               | .068           |
| Calves     | .119                | .078           |
| Feet       | ---                 | .007           |
| Total:     | 101.261             | 3.417          |

Total Penetration = 3.4%

**Table 2. Exposure to chlorothalonil during mixing/loading of golf course spray suspensions.**

|                          | ----- Total Milligrams per Hour ----- |                | Percentage Penetration |
|--------------------------|---------------------------------------|----------------|------------------------|
|                          | Outer Clothing                        | Under Clothing |                        |
| Low Maintenance Course:  |                                       |                |                        |
|                          | 210.4                                 | 11.7           | 5.6                    |
| High Maintenance Course: |                                       |                |                        |
|                          | 101.3                                 | 3.4            | 3.4                    |

**Table 3. Exposure to chlorothalonil during application of golf course spray suspensions.**

|                                   | ----- Total Milligrams per Hour ----- |                | Percentage Penetration |
|-----------------------------------|---------------------------------------|----------------|------------------------|
|                                   | Outer Clothing                        | Under Clothing |                        |
| Low Maintenance Course Fairways:  |                                       |                |                        |
|                                   | 10.8                                  | .77            | 7.1                    |
| High Maintenance Course Fairways: |                                       |                |                        |
|                                   | 170.8                                 | 4.16           | 2.4                    |
| Greens (Both Courses):            |                                       |                |                        |
|                                   | 25.4                                  | 1.26           | 5.0                    |

**Table 4. Exposure to chlorothalonil during application of golf course spray suspensions.**

| Activity        | ----- Total Milligrams per Hour ----- |                |
|-----------------|---------------------------------------|----------------|
|                 | Outer Clothing                        | Under Clothing |
| Mowing Fairways | 1.17                                  | .72            |
| Excluding Hands | .51                                   | .06            |
| Mowing Greens   | 2.98                                  | 2.00           |
| Excluding Hands | 1.09                                  | .11            |

**Table 5. Exposure of golfers to chlorothalonil on the day application.**

| Body Part          | Milligrams per Hour |
|--------------------|---------------------|
| Head/Neck/Shoulder | *.0052              |
| Arms               | *.0054              |
| Hand (with glove)  | .0012               |
| Hand (no glove)    | .1160               |
| Chest/Back         | *.0056              |
| Hips/Legs          | .0579               |
| Feet               | *.0015              |

\* Levels were below detection limit. One-half limit of detection was used for estimation of exposure.