

# HUMAN PESTICIDE EXPOSURE ASSESSMENT (For Section 18 Use on Cotton)

California Environmental Protection Agency  
Department of Pesticide Regulation  
Worker Health and Safety Branch

## IMIDACLOPRID

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### INTRODUCTION

Recently the Imperial County Whitefly Management Committee (El Centro, California) has submitted a petition for an emergency exemption (Section 18) use of imidacloprid on cotton in Imperial, Riverside, and San Bernardino Counties. The Committee's request for this Section 18 use was in response to the problem with silverleaf whitefly (*Bemisia tabaci*) that is now overwintering in large numbers on cotton in the three counties. Pesticides that contain imidacloprid as the active ingredient (AI) are being developed in the United States by Miles Inc. and by Bayer AG worldwide. While none of the imidacloprid products has been registered in the United States, Premise Termiticide is the only formulation concurrently being reviewed by the California Department of Pesticide Regulation (DPR) for an Experimental Use Permit (EUP).

This document is written to be an integral part of the Department's risk characterization document for imidacloprid. It will also be used as the starting point for developing mitigation measures if exposure to this pesticide is found to cause excessive risk.

### PHYSICAL AND CHEMICAL PROPERTIES

Imidacloprid (Admire<sup>®</sup>, Confidor<sup>®</sup>, Gaucho<sup>®</sup>, Merit<sup>®</sup>, Premier<sup>®</sup>, Premise<sup>®</sup>; 1-[(6-chloro-3-pyridinyl)-methyl]-*N*-nitro-2-imidazolidinimine], CAS-No. 138261-41-3, C<sub>9</sub>H<sub>10</sub>ClN<sub>5</sub>O<sub>2</sub>, MW = 255.7) is a systemically acting and contact pesticide which has been synthesized for the control of a wide range of insect and Coleopteran pests (e.g., aphids, Colorado potato beetle, corn rootworm, leafhopper, scales, thrips, whiteflies, white grubs, etc.) on many major field crops (e.g., apple, citrus, cotton, grape, pear, pecan, potato, rice, etc.). Its application has now included use for termite control, lawn care, and seed treatment. Imidacloprid has a company code name of BAY NTN 33893 and is a member of the (proposed) heterocyclic nitroguanidine group. Its technical grade is commercially available as a light yellow liquid or powder with a vapor pressure of  $6 \times 10^{-9}$  mm Hg at 20°C. It has a relative density of 1.54 g/cm<sup>3</sup> at 25°C and a melting point of 120-134°C. While imidacloprid has relatively low solubility in water (0.58 g/L at 20°C), it is miscible in acetone, dichloromethane, DMF, and DMSO (FCH, 1993; Miles Inc., 1992a; Mullins, 1993).

### U.S. EPA/CALIFORNIA STATUS

Miles Inc. has filed Section 3 (new active ingredient registration) applications with U.S. EPA for use of imidacloprid on apples, cotton, ornamentals, potatoes, and turf. The company also has an EUP application pending with U.S. EPA and concurrently with California for testing the efficacy of imidacloprid as a termiticide. Confidor-2 Flowable concentrate is the first and only imidacloprid product now being reviewed for Section 18 use in California.

## FORMULATION/INTENDED USE PATTERN

Each gallon of the Confidor concentrate contains 2.0 lbs of imidacloprid. The label for Section 18 use specifies that a maximum of 3.0 fluid ounces of the concentrate be applied per acre, and that no more than 5 ground or aerial sprays be applied per acre per season. This dose specification translates to a maximum rate of 15 fluid ounces of product (or 0.25 lb of AI) per acre per season. The label also specifies that during each application, the concentrate used must be diluted with a minimum of 20 gallons of water per acre for ground sprays, or 10 gallons of water per acre for aerial sprays. There should be a lapse of 7 days or longer between applications.

## USAGE IN CALIFORNIA

None of the imidacloprid products has been registered in the state of California; accordingly, there should be no data available on its usage on cotton (or on any crop) in California at the present time.

## LABEL PRECAUTIONS

Confidor-2 Flowable is labeled as a Toxicity Category II (CAUTION) systemic insecticide. The statement of practical treatment advises that vomiting be induced if the victim accidentally swallows the product; this can be accomplished by touching back of the throat with a finger after drinking one or two glasses of water, or by administering 1 tablespoonful of ipecac syrup followed by one or two glasses of water. For eye or dermal contact, the label recommends flushing with plenty of water.

## WORKER ILLNESSES

For reasons stated in the USAGE section, there are no data available on occupational illnesses that have been reported in California as related to imidacloprid exposure. Also, there have been no epidemiological studies reported for imidacloprid.

## DERMAL TOXICITY/SENSITIZATION

Several acute toxicity studies (Miles Inc., 1992b) on imidacloprid (with chemical purity > 94%) were submitted for health hazard evaluation. These studies were all found to have followed an acceptable protocol (MedTox, 1993). The following acute dermal toxicities were observed.

A single dose of 5,000 mg of imidacloprid per kilogram body weight, made to the consistency of a paste with 0.9% NaCl solution, was seen to be tolerated by all 10 young adult male and female Wistar rats without symptoms or mortalities. Based on this observation, the ratio of acute dermal LD<sub>50</sub> to acute oral LD<sub>50</sub> (450 mg/kg) in rats was determined to be greater than 10. Similar results were found when the acute dermal toxicity of imidacloprid was tested in 10 young adult male and female New Zealand White rabbits using the dermal limit dose of 2,000 mg/kg.

In addition to the above acute dermal toxicity tests, imidacloprid was investigated for skin sensitizing characteristics in guinea pigs using the Buehler Topical Closed-Patch Technique (Miles Inc., 1992b). In that study 30 adult male Hartley albino guinea pigs were assigned to one of four groups: imidacloprid test group (15 animals); imidacloprid noninduced control group (5 animals); DNCB-positive control test group (5 animals); and DNCB-noninduced control group (5 animals). (Animals in the two noninduced groups received only a challenge dose on day 27.) All induction and challenge sites were scored for erythema at approximately 24 and 48 hr after removal of the test substance. The DNCB test animals were found to have an incidence score of 1.0 and a severity score of 1.2

following the challenge dose. No erythema was observed at the treatment site in any of the imidacloprid test or noninduced control animals after administration of the challenge dose. This negative response to a challenge dose indicated that imidacloprid did not cause skin sensitization in guinea pigs.

## ANIMAL METABOLISM

An animal metabolism study (Klein and Karl, 1990) was submitted for health hazard evaluation, in which imidacloprid and its metabolites were isolated and identified after administration of a single intravenous or oral dose to rats. The following dose groups, each consisting of 5 adult male and 5 adult female Wistar rats, were included in the study: a single intravenous low dose of 1 mg/kg body weight; a single oral low dose of 1 mg/kg; 14 daily oral low non-radioactive doses, followed by a single radioactive dose on the 15th day; and a single oral high dose of 20 mg/kg. In addition, there were three closely-related studies (Klein, 1987; Klein, 1990; Klein and Brauner, 1991) submitted in which the biokinetic (and to some extent also the metabolic) behavior of imidacloprid was specifically investigated. Although these studies individually were found unacceptable, collectively they were considered to have provided adequate information to fulfill the data requirements for an acceptable animal metabolism study (MedTox, 1993). In these studies, some of the procedures for collection of samples and for use of test material carriers were not well documented.

[Pyridinyl-<sup>14</sup>C-methylene]imidacloprid (with a radiochemical purity > 99%) was used for radiorecovery in three (Klein, 1987; Klein, 1990; Klein and Karl, 1990) of the four metabolism/biokinetics studies. The parent compound and metabolites were identified using high performance liquid chromatography after the urine and feces samples were extracted and purified via adsorption chromatography or ultrasonication. There was very little sex dependence for metabolism of imidacloprid in the low dose group. All identified metabolites were found in both sexes and in each dose group. The differences found were thus primarily quantitative in nature. The major metabolites were identified as 6-chloronicotinic acid and its glycine conjugate, which were only found in the urine. The monohydroxylated metabolites were identified in similar amounts (ca. 14% of the recovered radioactivity) as the unchanged parent compound. All other biotransformation products were quantitatively of minor significance.

Two major pathways of biotransformation were distinguished for the metabolism of imidacloprid in rats. The parent compound imidacloprid was first seen to undergo oxidative cleavage, yielding 6-chloronicotinic acid that forms a hippuric acid type of conjugate when reacted with glycine. Both of these metabolites were excreted quickly and exclusively via urine. These two metabolites represented the majority (30% of the recovered radioactivity) of the identified metabolites in urine. Less significant quantitatively was the dechlorination of the pyridine moiety, yielding 6-hydroxynicotinic acid and its mercapturic acid derivative. The other major route of metabolic transformation was seen to be initiated by the hydroxylation of the imidazolidine ring in either the 4- or the 5-position, which then formed the olefinic metabolite NTN 35884 after elimination of the H<sub>2</sub>O moiety. These biotransformation products, together with a significant amount (ca. 14% of the recovered radioactivity) of the parent compound, were excreted via urine and feces. The guanidine-type reduction product (NTN 33823) was seen to be eliminated only with the feces. The average identification rate of the metabolites in both urine and feces from all dose groups was approximately 78% of the recovered radioactivity.

Approximately 95% of the oral dose applied in the first biokinetic study (Klein, 1987) was found to be absorbed rapidly into the body. The absorbed radioactivity was also seen to be readily eliminated from the body, as more than 90% of the renal radioactivity was excreted during the first 24 hr after dosing. The total excretion after 48 hr accounted for 96% of the applied dose, approximately 75% with the urine and 21% with the feces. Approximately 1% of the applied dose was found in the carcass, with the kidney, the liver, the lung, the skin, and the plasma having the highest

concentrations. These biokinetic data suggest that there would be no bioaccumulation of imidacloprid in the animal body.

The biokinetic and metabolic behavior of the reduced degradation (on the N-nitro moiety) product WAK 3839 was additionally investigated in the second biokinetic study (Klein, 1990), partly because the metabolite is a compound of the nitrosamine group which collectively has been classified as carcinogenic. In that investigation, the biokinetics of both WAK 3839 and the parent compound were studied at the low oral dose level of 1 mg/kg in the rat. No significant difference was observed between the two compounds with respect to absorption, distribution, and excretion of total radioactivity. WAK 3839 was eliminated slightly faster from the rat's body and the tissue concentrations of the total radioactivity were lower compared to the parent compound. The reduced compound was seen to be reproducible *in vivo* by rats under chronic feeding conditions. The rats under these feeding conditions had all been chronically pretreated for approximately one year with a diet containing 1,800 ppm of imidacloprid and then received one oral radioactive tracer dose of <sup>14</sup>C-imidacloprid.

[Imidazolidine-4,5-<sup>14</sup>C]imidacloprid (with radiochemical purity > 99%) was used for radiorecovery in the third biokinetic study (Klein and Brauner, 1991). In that study, the liver was considered to be the target tissue as it was treated as the main metabolizing organ. The maximum plasma concentrations were found between 1 hr (in the male and female rats administered a single dose of 1 mg/kg) and 4 hr (in the male rats administered a single dose of 150 mg/kg). Terminal half-lives ranged between 9 hr (high dose) and 25 hr (low dose). More than 90% of the administered dose was excreted via the renal route within the test period of 48 hr. The radioactivity of imidacloprid was determined to be rapidly distributed from the plasma to the peripheral tissues, as could be concluded from the maximum plasma concentrations.

Approximately 36% of the recovered radioactivity was found in the bile in an experiment, in which 5 bile-fistulated male rats were administered an intraduodenal dose of 1 mg/kg (Klein, 1987). The relative amount of the unchanged parent compound was seen to be higher in rats given an intravenous dose than in those given an oral dose (Klein and Karl, 1990). Otherwise, the routes of elimination were found largely comparable between intravenous and oral administration.

#### DERMAL/INHALATION ABSORPTION

There are no dermal or inhalation absorption studies for any imidacloprid formulation on file at DPR, or available in the literature. However, it is possible to conclude from the acute toxicity studies (Miles Inc., 1992b) submitted to DPR that the dermal absorption for imidacloprid is likely to be 10% or less over a 24-hour exposure period.

As stated earlier, the ratio of dermal LD<sub>50</sub> to oral LD<sub>50</sub> for imidacloprid in rats was determined to be greater than 10. This LD<sub>50</sub> ratio suggests that if the oral absorption for imidacloprid in the rat were conservatively assumed to be 100%, then the dermal absorption for imidacloprid in rats would be approximately 10% (i.e., 1/10) over a 24-hour period. The default absorption value of 100% is normally used by DPR where no animal or human studies on dermal absorption are available and, hence, was used in this worker exposure assessment. The 10% dermal absorption extrapolated from the LD<sub>50</sub> ratio was presented here only to emphasize the conservative approach undertaken by the Department.

#### DISLODGEABLE FOLIAR RESIDUES

The dissipation data for imidacloprid dislodgeables on cotton are not available since this insecticide is not yet a registered product in any cotton-growing state. As presented below, the level of

imidacloprid dislodgeables on cotton immediately after an application was estimated using foliar dislodgeable data from other compounds.

## WORKER EXPOSURE

Several groups of agricultural workers were of principal concern here in the assessment of worker exposure to imidacloprid applied to cotton. Agricultural workers may be exposed to imidacloprid residues when they mix/load the insecticide or apply it to cotton. These would include mixer/loaders, ground boom applicators, aerial applicators (pilots), and flaggers. In addition, cotton scouts are subject to occupational exposure from contact with imidacloprid dislodgeables that might have been accumulated on treated cotton foliage. (Exposure to cotton harvesters does not seem to be a concern here, given that a preharvest interval of 14 days is required.)

Measurements of imidacloprid exposure for these workers had not been made available to WH&S. Accordingly, the exposures to imidacloprid calculated by WH&S for mixer/loaders and applicators were based on surrogate data made available in a published study (Knaak *et al.*, 1989) and in a study recently reviewed by WH&S (Dong, 1993). The surrogate compound in the first study was EPTC-7EC, which was ground sprayed to red beans at the application rate of 3.3 lbs AI per acre. The second surrogate compound was deltamethrin (Decis<sup>®</sup>-5EC), which was air sprayed to grain crops at the application rate of 0.009 lb AI per acre. The surrogate data suggested by the registrant (Eberhart, 1992) were considered less appropriate, since their surrogate compound (triadimefon) was in a different (dry flowable) formulation which would require different mixing/loading techniques. Therefore only their data on inhalation exposure were used in this exposure assessment, as such were not available in the deltamethrin study. No exposure data were available for flaggers in any of the aforementioned surrogate studies. Exposures to imidacloprid for this group were hence roughly and conservatively estimated from using USEPA's PHED database (PHED, 1992). This approach was taken solely for completeness sake, in that under normal conditions exposure of flaggers to pesticides is less than that of applicators or mixer/loaders under open pour loading.

For cotton scouts, the surrogate exposures were based on the dislodgeable foliar residue (DFR) data provided by the registrant (Eberhart, 1993), and on a set of transfer factors (Dong, 1990) derived from a series of field studies by Ware *et al.* (1973; 1974; 1975). The imidacloprid dislodgeables on cotton were based on DFR data from other compounds measured immediately after an application. This approach is considered acceptable in that the DFR immediately following an application supposedly are not influenced by the chemical-specific properties of the compound being applied, but are expected to be directly proportional to the application rate.

The expected daily exposures and absorbed daily dosages for mixer-loaders and applicators are presented in Table 1; and those for cotton scouts, in Tables 2 and 3. For comparison purposes, also included in Table 1 are the expected daily exposure and absorbed daily dosage for cotton scouts under the extreme-case scenario. The 100% dermal absorption was assumed in all calculations of absorbed dosage, as mentioned earlier. Some of the assumptions used in the calculations were consistent with common practice (Thonsingthusak *et al.*, 1993) and thus were mentioned as table footnotes only. Others that require clarification or appear to be unique to cotton-based imidacloprid exposure were discussed below, along with a brief description of the calculations involved.

The surrogate estimates of dermal exposure for applicators and mixer-loaders wearing work clothing are footnoted in Table 1. These estimates were based on a weighted average taken over 15 or 16 replicates. Although the geometric mean was recommended (Leidel *et al.*, 1977) for use for this type of calculation, the arithmetic mean was used instead. There are two reasons for not using the geometric mean here. One reason is that the data from the chest dosimeter sample in one of the aerial mixer/loader replicates were already excluded as a statistical outlier in the analysis. The other more

Table 1. Expected Daily Dermal and Inhalation Exposures and Total Absorbed Daily Dosage for Cotton Scouts and for Workers Handling Imidacloprid in California Cotton Fields <sup>a</sup>

Job Class	No. of Days Exposed per Year <sup>b</sup>	Daily Exposure (mg) <sup>c,d,e</sup>		Absorbed Dosage (µg/kg BW/day) <sup>f</sup>	Seasonal (Annual) Average Dosage (µg/kg BW/day) <sup>g</sup>
		Dermal	Inhalation		
Aerial Application					
Mixer/Loaders	50	1.06	0.06	14.34	7.97 (1.96)
Pilots	50	1.05	0.05	14.14	7.86 (1.94)
Flaggers	50	0.68	0.03	9.14	5.08 (1.25)
Ground Application					
Mixer/Loaders	50	0.17	0.01	2.30	1.28 (0.32)
Applicators	50	0.18	0.03	2.57	1.43 (0.35)
Cotton Scouts	50	3.02		39.80	22.13 (5.45)

<sup>a</sup> for cotton scouts and workers wearing long-sleeved shirt and long pants without gloves.

<sup>b</sup> as provided in the deltamethrin study (Dong, 1993) and is consistent with those estimated earlier by Meinders and Krieger (1988).

<sup>c</sup> based on the following application/usage rates: 0.05 lb AI/acre; 100 acres per day for ground application and mixing/loading; 500 acres per day for aerial application; and 1,000 acres per day for mixing/loading prepared enough to be sprayed by two airplanes, as so assumed in the deltamethrin study (Dong, 1993).

<sup>d</sup> based on the following mean surrogate dermal exposures (per kg BW/lb AI handled): 0.28 µg for mixing/loading under open pour loading for aerial application (Dong, 1993); 0.55 µg for pilots (Dong, 1993); 0.36 µg for flaggers (PHED, 1992); 0.45 µg for mixing/loading under open pour loading for ground application (Knaak *et al.*, 1989); 0.48 µg for ground application (Knaak *et al.*, 1989); and for cotton scouts, see Table 3.

<sup>e</sup> based on the following mean surrogate inhalation exposures (per kg BW/lb AI handled): 0.015 µg for mixing/loading under open pour loading for aerial application (Eberhart, 1992); 0.025 µg for pilots (Eberhart, 1992); 0.017 µg for flaggers (PHED, 1992); 0.017 µg for mixing/loading under open pour loading for ground application (Knaak *et al.*, 1989); 0.085 µg for ground application (Knaak *et al.*, 1989); and assumed to be negligible for cotton scouts (since imidacloprid is basically a non-volatile compound).

<sup>f</sup> based on a male body weight (BW) of 76 kg and on an inhalation absorption of 50%, as common practice (Thongsinthusak *et al.*, 1993); as stated in the text, the dermal absorption was assumed to be 100%.

<sup>g</sup> based on a seasonal period of 90 days; in parentheses are the annualized absorbed daily dosages.

Table 2. Expected Potential Daily Dermal Exposure (in Milligrams) by Body Part for California Workers Scouting Maturing Cotton Treated with Imidacloprid Following Single or (Multiple) Applications <sup>a</sup>

Predicted DFR ( $\mu\text{g}/\text{cm}^2$ ) <sup>b</sup>	Bare Hands Dermal Exposure <sup>c</sup>	Upper Body Dermal Exposure <sup>d</sup>	Lower Body Dermal Exposure <sup>e</sup>
0.10 (0.25)	0.57 (1.43)	0.61 (1.53)	5.78 (14.46)

<sup>a</sup> daily dermal exposure for the unprotected whole body is simply the sum of the individual potential dermal exposures calculated for the above three body parts; in parentheses are DFR (dislodgeable foliar residues) and dermal exposures estimated for scouting immediately after the fifth application (based on 2.5 times of that predicted for scouting immediately after a single application).

<sup>b</sup> based on surrogate data presented in Table 4 and assuming no reentry interval.

<sup>c</sup> based on 6 hr per day [see discussion in text] and on a dermal transfer factor of 950  $\text{cm}^2/\text{hr}$  (Dong, 1990).

<sup>d</sup> based on 6 hr per day [see discussion in text] and on a dermal transfer factor of 1,020  $\text{cm}^2/\text{hr}$  (Dong, 1990).

<sup>e</sup> based on 6 hr per day [see discussion in text] and on a dermal transfer factor of 9,640  $\text{cm}^2/\text{hr}$  (Dong, 1990).

Table 3. Expected Daily Dermal Exposure and Absorbed Daily Dosage for California Workers Scouting Maturing Cotton Treated with Imidacloprid <sup>a</sup>

With Gloves		Without Gloves	
Dermal Exposure <sup>b</sup>	Absorbed Dosage <sup>c</sup>	Dermal Exposure <sup>b</sup>	Absorbed Dosage <sup>c</sup>
0.70 (1.74)	9.21 (23.03)	1.21 (3.02)	15.92 (39.80)

<sup>a</sup> for workers wearing long-sleeved shirt and long pants, with or without gloves; in parentheses are exposures (mg) and dosages ( $\mu\text{g}/\text{kg}$  body weight) estimated for scouting immediately after the fifth application (based on 2.5 times of that predicted for scouting immediately after a single application).

<sup>b</sup> based on 6 hr per day [see discussion in text]; on a 10% clothing permeation (as common practice); and on the transfer factors of 950, 1,020, and 9,640  $\text{cm}^2/\text{hr}$ , respectively, for bare hands, the clothed upper body, and the clothed lower body (Dong, 1990).

<sup>c</sup> based on a male body weight of 76 kg and on 100% dermal absorption.

apparent reason is that while the Section 18 use label for imidacloprid has no specification on clothing requirements, the workers in the surrogate studies were fully-clothed (e.g., with chemical- or fire-resistant gloves, a cap or helmet, etc.). Although an attempt was made to adjust for clothing differences in the calculation, a full adjustment of this type was not possible due to lack of complete data. Accordingly, the arithmetic mean was used here as it would provide a more conservative estimate of exposure.

The application and usage rates for imidacloprid on cotton were the maximum label rates, which are footnoted in Table 1. As shown in Table 1, the aerial mixer/loaders under open pour loading appeared to have attained the highest daily dermal exposure (i.e., 1.06 mg/day). Exposure for mixing/loading/applying by ground equipment was assumed to be approximately the sum of the individual task exposures, since the applicators were expected to work only up to 5 hr per day (because of the maximum daily acreage assumed). Mixing/loading, flying, and flagging were assumed to be done by different workers.

As noted earlier, the surrogate exposures for cotton scouts were based on a series of transfer factors derived from the Ware *et al.* studies. The procedure used for the computation of these surrogate exposures was described elsewhere (Dong *et al.*, 1991). The expected potential daily exposures for cotton scouts, as shown in Table 2, were estimated from the geometric mean transfer factors computed for *bare* hands (950 cm<sup>2</sup>/hr), the *clothed* upper body (1,020 cm<sup>2</sup>/hr), and the *clothed* lower body (9,640 cm<sup>2</sup>/hr). The *potential* dermal transfer factor for the whole body of cotton scouts is simply the sum of these individual geometric mean transfer factors. The potential daily dermal exposures *by body part*, as provided in Table 2, were prepared primarily for risk mitigation purposes.

The expected daily dermal exposures for cotton scouts wearing work clothing, with or without gloves, are presented in Table 3. As in the case of mixer/loaders and applicators, it was assumed that the cotton scouts would wear a long-sleeved shirt and a pair of long pants. The percentage of clothing permeation for the three body parts was assumed to be 10, which has been the default value adopted by WH&S (unless there is evidence to the contrary).

The predicted cotton-based imidacloprid DFR, from which its corresponding hourly dermal exposures were estimated, was based on those from 14 other compounds, as provided by the registrant (Eberhart, 1993). These DFR surrogates, which are presented in Table 4, were derived primarily from the published literature (Buck, *et al.*, 1980; Dong *et al.*, 1991; Estes and Buck, 1990; Estes *et al.*, 1979) and adjusted for differences in application rates. The time that a cotton scout is expected to be in actual contact with treated cotton foliage was assumed to be 6 hr per day. This scout exposure time appears to be reasonable, in that cotton scouts are almost always required to travel daily between fields which may be miles apart.

The maximum DFR a cotton scout could be exposed to after 5 applications of the Confidor concentrate was assumed to be 0.25 µg/cm<sup>2</sup>, as shown in Table 2; that is, equivalent to 2.5 times the DFR level expected after a single application. Although it was suggested (Eberhart, 1993) that a factor of 5 could be used to calculate this maximum DFR level due to lack of residue decay data, it is only reasonable to expect that some residue decay would occur during a 7-day period (i.e., the required minimum interval between two applications). Otherwise, it would be highly inconceivable for growers to repeat any application when the imidacloprid dislodgeables on the cotton foliage could be preserved completely from a single application. Another justification for use of the factor of 2.5 (i.e., half of what was suggested) was the argument that if the imidacloprid dislodgeables on the

cotton foliage were indeed very persistent or not easily removed, then the transfer factors used in the exposure extrapolation should have been much smaller. It is important to note that the transfer factors that were derived from the Ware *et al.* studies were based on compounds whose foliar residues were seen to be relatively highly dislodgeable. A typically unexpressed assumption is that the scout would be exposed to every field (up to 12 per day) that was treated with this product for up to 5 times.

Table 3 suggests that the dermal exposure for a cotton scout could be as high as 3.0 mg per day, if the scout were to be exposed immediately after the fifth application to cotton (in the same field and not wearing gloves). As shown in Table 1, for a cotton scout with work clothing but not wearing gloves, the daily dosage could be as high as 39.8 µg per kilogram of body weight. This daily dosage was calculated assuming a dermal absorption of 100%.

Table 4. Estimation of Imidacloprid Dislodgeable Foliar Residues (DFR) Immediately After Application at a Rate of 0.05 lb AI/Acre <sup>a</sup>

Pesticide	Application Rate (lb AI/acre)	Measured DFR ( $\mu\text{g}/\text{cm}^2$ ) <sup>b</sup>	Extrapolated DFR( $\mu\text{g}/\text{cm}^2$ ) <sup>c</sup>	Reference <sup>d</sup>
bifenthrin	0.10	0.18	0.09	1
chlorpyrifos	1.00	1.82	0.09	2
EPN	1.00	2.55	0.13	2
fenvalarate	0.20	0.43	0.11	2
methyl parathion	1.00	2.25	0.11	2
methyl parathion	1.00	2.10	0.11	2
oxamyl	0.37	0.75	0.10	2
permethrin	0.15	0.44	0.15	2
permethrin	0.15	0.32	0.11	2
profenofos	1.00	1.75	0.09	2
sulprofos	1.00	2.18	0.11	2
sulprofos	1.00	2.90	0.15	2
cyhalothrin	0.03	0.05	0.08	3
fenvalarate	0.04	0.13	0.16	3
flucythrinate	0.06	0.19	0.16	3
curacron	1.00	1.00	0.05	4
deltamethrin	0.02	0.02	0.05	4
endosulfan	1.00	0.88	0.04	4
fenvalarate	0.10	0.10	0.05	4
permethrin	0.10	0.10	0.05	4
sulprofos	1.00	1.40	0.07	4
<i>mean</i> ( $\pm \sigma$ )			<b>0.10 (<math>\pm 0.04</math>)</b>	

<sup>a</sup>based on those provided by the registrant (Eberhart, 1993).

<sup>b</sup>all measured DFR were for the time period immediately following application and were based on the surface area for both sides of the leaf.

<sup>c</sup>as expected for imidacloprid dislodgeables immediately after application; the extrapolated DFR were calculated by multiplying the measured DFR by the ratio of the application rate for imidacloprid (0.05 lb/acre) to the application rate for the surrogate compound in question.

<sup>d</sup>based on the following studies: (1) Dong *et al.*, 1991; (2) Buck *et al.*, 1980; (3) Estes and Buck, 1990; and (4) Estes *et al.*, 1979.

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HUMAN PESTICIDE EXPOSURE ASSESSMENT  
(For Section 18 Use on Cotton)

IMIDACLOPRID

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