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WASHINGTON, D. C. 20460

OFFICE OF
PREVENTION, PESTICIDES
AND TOXIC SUBSTANCES

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MEMORANDUM

SUBJECT: Tier 1 Drinking Water Assessment for Flumiclorac-pentyl on Corn and Soybeans (TRED) and Cotton (New Use)

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This memorandum provides estimated drinking water concentrations (EDWC) for the uses of flumiclorac-pentyl on corn, soybeans, and cotton. This is a screening-level assessment that uses the Tier 1 models FIRST and SCI-GROW to estimate upper-bound limits on the concentrations of flumiclorac-pentyl that may be found in raw drinking water from surface water and ground water sources.

We have assumed that the residues of interest are parent flumiclorac-pentyl (CAS Reg No.

87546-18-7), and the major degradate in the aerobic soil metabolism studies (IMCA or flumiclorac-acid, CAS Reg. No. 87547-04-4). The addition of further degradates to the assessment is unlikely to change the input parameter derived from the aerobic soil metabolism studies (half-life in soil), thus the quantitative results are unlikely to change greatly. The half-lives calculated for flumiclorac-pentyl plus flumiclorac-acid are documented in DER addenda transmitted with this memorandum. The structures of these two compounds are given below in Figures 1 and 2.

Environmental Fate Assessment

Acceptable data suggest that parent flumiclorac-pentyl is not persistent or mobile. Flumiclorac-pentyl hydrolyzes and metabolizes within hours or days into a number of bulky anionic degradates which are mobile and may be bioactive. However, the degradates representing major portions of the molecule also do not appear to be especially persistent, with soil half-lives of two weeks.

Under abiotic hydrolysis at pH 5 and 7, the tetrahydrophthalimido group appears to break off to form tetrahydrophthalic acid (THPA). At pH 5, the phenyl substituted ring moiety appears to be more stable, with pentyl 5-amino-2-chloro–4-fluorophenoxyacetate (AFE) the final product. At pH 7, this moiety degrades further to 5-amino-2-chloro-4-fluorophenoxyacetic acid (AFCA). At pH 9, degradation does not appear to be as complete, with 2-chloro-4-fluoro-5-(3,4,5,6-tetrahydrophthalimido) phenoxyacetic acid (IMCA), and N-(5-carboxymethoxy-4-chloro-2-fluorophenyl)-3,4,5,6-tetrahydrophthalamic acid (IMCA-HA) the final products. Aerobic metabolism of flumiclorac-pentyl appears to degrade it first to IMCA, and then to AFCA and THPA. Within 85 days, both AFCA and THPA may be metabolized further and become bound residues.

In the presence of light, further breakdown and/or mineralization of flumiclorac-pentyl degradates appears to be accelerate, although the half-life of parent flumiclorac-pentyl appears to be unaffected. While less than 0.5% of the applied radioactivity is released as $^{14}CO_2$ from flumiclorac systems maintained in the dark, the irradiated aqueous system with phenyl-labeled flumiclorac-pentyl released 22.81% of the applied radioactivity as $^{14}CO_2$. This effect is less striking on soil: 7.32% of the applied radioactivity was mineralized to $^{14}CO_2$ when phenyl-labeled flumiclorac-pentyl was applied to viable soil and irradiated for 21 days.

Field data appears to confirm that flumiclorac-pentyl and its degradates do not leach. Although flumiclorac-pentyl degrades to compounds that do not bind strongly to soil, these compounds themselves appear to be so short-lived that they degrade further before moving a significant distance through the soil. However, the fate of flumiclorac-pentyl residues at the surface is less clear. In radiolabeled lysimeter studies, nearly 50% of the applied radioactivity appears to have dissipated to the atmosphere in the course of studies ranging from 112 to 120 days, with the fastest dissipation occurring in 14 days. This far exceeds the rate of mineralization reported in the laboratory, and raises the possibility that some of the parent material or degradates may be volatilizing. Herbicide drift due to volatilization is considered a significant risk to off-target plants.

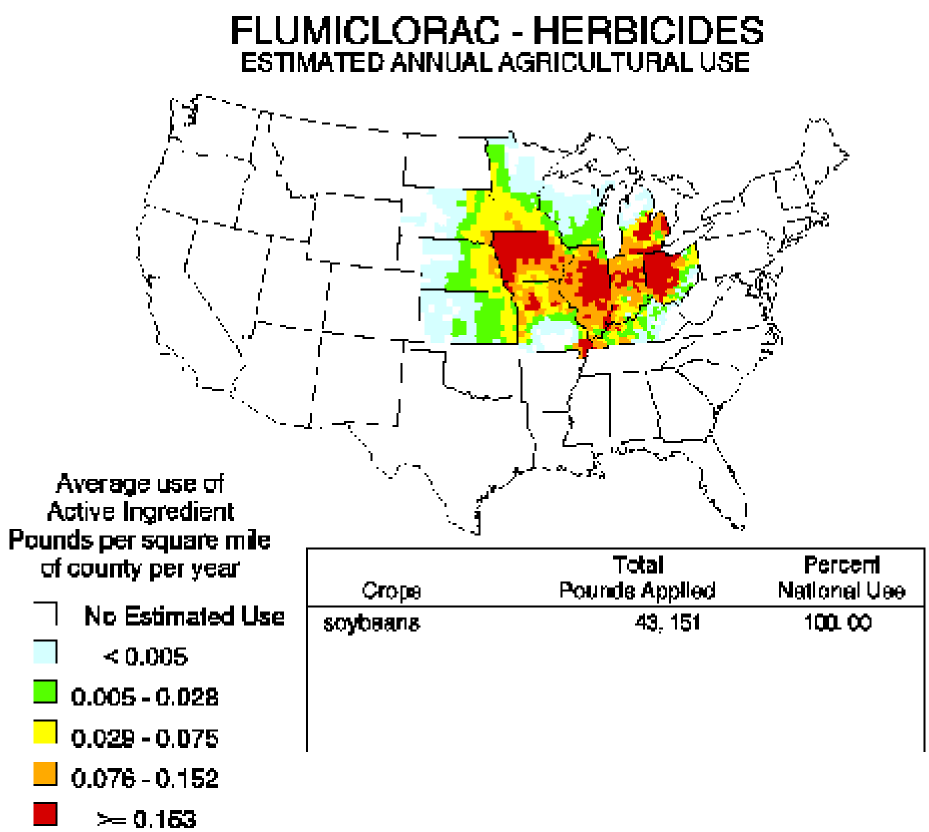
In an unconfined field situation, some of the flumiclorac-pentyl degradates could be entrained in runoff.  Although the anaerobic aquatic metabolism study suggests that the majority of the material is associated with the soil rather than the water most of the time, there are periods when the majority of the material may associate with the water.  In the field study in Kentucky, up to 28.65% of the applied radioactivity was found in the surface water at day 3.  Many early flumiclorac-pentyl degradates include large portions of the original molecule, and their off-site movement may represent a phytotoxicity hazard to non-target plants.  However, flumiclorac-pentyl degradates appear to be more susceptible to photolysis when they are in solution, and would be unlikely to persist for more than a few days in an aquatic environment.

Use Area

The map below represents the use area for flumiclorac-pentyl in 1997, as estimated by the US Geological Survey, based on NASS data.  Registration of flumiclorac-pentyl would expand the use area into the southeast, California, Arizona, and Texas.

Map 1: Use Area for Flumicloac-Pentyl

Source: (http://ca.water.usgs.gov/cgi-bin/pnsp/pesticide_use_maps_1997.pl?map=W2011



Input Parameter Selection for Modeling

Input parameters for FIRST and SCI-GROW modeling were chosen in accordance with EFED's Input Parameter Guidance of February, 2002. Soil half-lives were based on two studies, one each for phenyl- and THP-moiety labeled flumiclorac-pentyl. Half-lives were recalculated based on the sum of radioactivity of the parent and flumiclorac-acid (IMCA), using a two-parameter, single first-order exponential decay procedure (SigmaPlot).

No quantitative data were available for soil-water partitioning coefficients (Koc or Kd) of parent flumiclorac-pentyl or for flumiclorac-acid (IMCA). The only quantitative data were for the degradate AFCA. QSAR information (EPI-Suite v3.12) indicates that the Koc value used (98.7 mL/g) may underestimate Koc for the parent (estimated Koc 4801 mL/g) and may overestimate Koc for IMCA (estimated Koc 77.5 mL/g).

The lack of quantitative data for Koc or Kd for the parent and primary degradate in soil (IMCA) will make refinement of the EDWCs (i.e., Tier 2 modeling) difficult.

Percent cropped area (PCA) factors are available for each of the modeled crops, since they are all major crops, and for combinations of these crops. The PCA is the national maximum percentage of a watershed that is planted in one or more major crops.

Table 1 provides the Input Parameters used for the FIRST and SCI-GROW models

Table 1. Input Parameters

| Input Parameter | Value | Reference/Comment |
|---|---|---|
| Application Rate | 0.054 lb a.i./acre OR<br>0.081 lb a.i./acre (soy only) | BEAD Table A2 |
| Number of applications | 2 at 14 days OR 1 (soy only) | BEAD Table A2 |
| Aerobic Soil Half-life | 8.8 days (FIRST)<br>7.7 days (SCI-GROW) | MRID 42169843, 43304601 |
| pH 7 hydrolysis half-life | 19 days | MRID 42169842 |

| | | |
|---|---|---|
| Koc | 98.7 (FIRST)<br><br>98.7 (SCI-GROW) | MRID 42169846: lowest Koc for AFCA degradate<br><br>lowest Koc used when variation is > 3-fold: also for AFCA degradate |
| Incorporation depth | 0 (zero) inches | consistent with aerial spraying |
| Application Method | aerial spraying | label |
| Spray Drift | 16 % | default for aerial spray |
| Solubility | 0.189 mg/L | EFED One-Liner database (parent) |
| Wet-in? | No | label |
| Percent Cropped Area | 0.83 (corn-soy-cotton)<br>0.41 (soy)<br>0.46 (corn)<br>0.20 (cotton) | FIRST only |

## Results

The following results were obtained (Tables 2 and 3 ). The FIRST and SCI-GROW output files are attached.

Table 2. Estimated Drinking Water Concentrations (EDWC) for Flumiclorac-pentyl plus Flumiclorac-acid: Surface Water Sources

| Crop(s) | Application rate lb a.i./acre | No. of applications | Acute EDWC, ppb | Chronic EDWC, ppb |
|---|---|---|---|---|
| Corn/soybeans/Cotton | 0.054 | 2 at 14 days | 4.7 | 0.24 |
| Soybeans | 0.081 | 1 | 2.6 | 0.13 |
| Corn | 0.054 | 2 at 14 days | 2.6 | 0.14 |
| Soybeans | 0.054 | 2 at 14 days | 2.3 | 0.12 |
| Cotton | 0.054 | 2 at 14 days | 1.1 | 0.06 |

Table 3. Estimated Drinking Water Concentrations for Flumiclorac-pentyl plus Flumicolrac-acid (Ground Water Sources)

| Crop(s) | Acute EDWC, ppb | Chronic EDWC, ppb |
|---|---|---|
| All at 0.054 lb a.i./acre,<br>2 applications | 0.002 | 0.002 |

Uncertainties

1. No measured organic carbon partitioning coefficient (Koc or Kd) data were available for flumiclorac-pentyl or flumiclorac-acid (IMCA). Data were available for the degradate AFCA (5-amino-2-chloro-4-fluorophenoxyacetic acid) in MRID 42169846. The minimum Koc for a non-sand soil (98.7 mL/g) was used for this assessment. This Koc value considerably overstates the mobility of the parent chemical (EPI-Suite v3.12 estimated Koc = 4801 ml/g) but may be similar to that of flumiclorac-acid (EPI-Suite v3.12 estimated Koc 77.5, variable with pH).

2. No aerobic aquatic metabolism study was submitted. The sterile hydrolysis half-life at pH 7 (19 days) was used instead. This value is quantitatively similar to what the default input parameter for half-life in aerobic water would be (two times the soil input parameter, or 18 days).

3. Aqueous photolysis was not included in the modeling.as it did not accelerate the rate of hydrolysis of the parent.

Structures of Modeled Compounds

Figure 1. Flumiclorac-pentyl

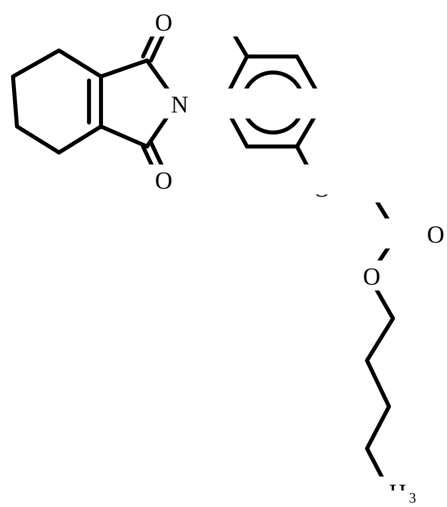
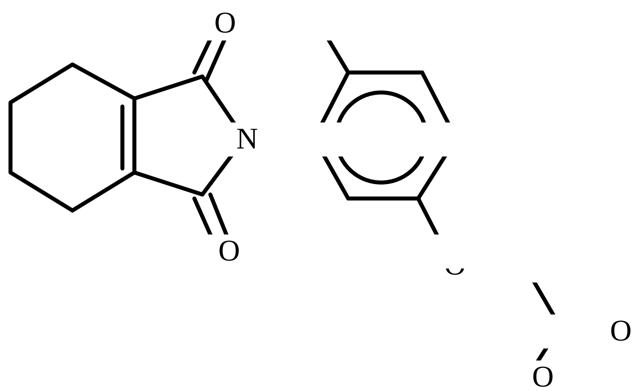


Figure 2.  Flumiclorac-acid (IMCA)



```
RUN No.   1 FOR flumiclorac-pentyl ON   corn,soy,cottton   * INPUT VALUES *
--------------------------------------------------------------------
 RATE (#/AC)   No.APPS &   SOIL  SOLUBIL  APPL TYPE  %CROPPED INCORP
  ONE(MULT)    INTERVAL    Koc   (PPB )   (%DRIFT)     AREA    (IN)
--------------------------------------------------------------------
.054(   .072)   2  14      98.7  189.0   AERIAL(16.0)  83.0    .0


FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)
--------------------------------------------------------------------
METABOLIC  DAYS UNTIL  HYDROLYSIS   PHOTOLYSIS   METABOLIC  COMBINED
 (FIELD)  RAIN/RUNOFF  (RESERVOIR)  (RES.-EFF)   (RESER.)   (RESER.)
--------------------------------------------------------------------
   8.85        2          19.00     .00-     .00     .00      19.00


UNTREATED WATER CONC (MICROGRAMS/LITER (PPB))    Ver 1.0 AUG 1, 2001
--------------------------------------------------------------------
     PEAK DAY  (ACUTE)      ANNUAL AVERAGE (CHRONIC)
       CONCENTRATION             CONCENTRATION
--------------------------------------------------------------------
           4.728                         .244



RUN No.   2 FOR flumiclorac-pentyl ON   soybeans      * INPUT VALUES *
--------------------------------------------------------------------
 RATE (#/AC)   No.APPS &   SOIL  SOLUBIL  APPL TYPE  %CROPPED INCORP
  ONE(MULT)    INTERVAL    Koc   (PPB )   (%DRIFT)     AREA    (IN)
--------------------------------------------------------------------
.081(   .081)   1   1      98.7  189.0   AERIAL(16.0)  41.0    .0


FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)
--------------------------------------------------------------------
METABOLIC  DAYS UNTIL  HYDROLYSIS   PHOTOLYSIS   METABOLIC  COMBINED
 (FIELD)  RAIN/RUNOFF  (RESERVOIR)  (RES.-EFF)   (RESER.)   (RESER.)
--------------------------------------------------------------------
   8.85        2          19.00     .00-     .00     .00      19.00


UNTREATED WATER CONC (MICROGRAMS/LITER (PPB))    Ver 1.0 AUG 1, 2001
--------------------------------------------------------------------
     PEAK DAY  (ACUTE)      ANNUAL AVERAGE (CHRONIC)
       CONCENTRATION             CONCENTRATION
--------------------------------------------------------------------
           2.589                         .134
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RUN No.   3 FOR flumicloac-pentyl ON   corn          * INPUT VALUES *
--------------------------------------------------------------------
 RATE (#/AC)   No.APPS &   SOIL  SOLUBIL  APPL TYPE  %CROPPED INCORP
  ONE(MULT)    INTERVAL    Koc   (PPB )   (%DRIFT)     AREA    (IN)
--------------------------------------------------------------------
.054(   .072)   2  14      98.7  189.0   AERIAL(16.0)  46.0    .0


FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)
--------------------------------------------------------------------
METABOLIC  DAYS UNTIL  HYDROLYSIS   PHOTOLYSIS   METABOLIC  COMBINED
 (FIELD)  RAIN/RUNOFF  (RESERVOIR)  (RES.-EFF)   (RESER.)   (RESER.)
--------------------------------------------------------------------
   8.85        2          19.00     .00-     .00     .00      19.00


UNTREATED WATER CONC (MICROGRAMS/LITER (PPB))    Ver 1.0 AUG 1, 2001
--------------------------------------------------------------------
     PEAK DAY  (ACUTE)      ANNUAL AVERAGE (CHRONIC)
       CONCENTRATION             CONCENTRATION
--------------------------------------------------------------------
           2.620                        .135



RUN No.   4 FOR flumiclorac-pentyl ON   soybeans      * INPUT VALUES *
--------------------------------------------------------------------
 RATE (#/AC)   No.APPS &   SOIL  SOLUBIL  APPL TYPE  %CROPPED INCORP
  ONE(MULT)    INTERVAL    Koc   (PPB )   (%DRIFT)     AREA    (IN)
--------------------------------------------------------------------
.054(   .072)   2  14      98.7  189.0   AERIAL(16.0)  41.0    .0


FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)
--------------------------------------------------------------------
METABOLIC  DAYS UNTIL  HYDROLYSIS   PHOTOLYSIS   METABOLIC  COMBINED
 (FIELD)  RAIN/RUNOFF  (RESERVOIR)  (RES.-EFF)   (RESER.)   (RESER.)
--------------------------------------------------------------------
   8.85        2          19.00     .00-     .00     .00      19.00


UNTREATED WATER CONC (MICROGRAMS/LITER (PPB))    Ver 1.0 AUG 1, 2001
--------------------------------------------------------------------
     PEAK DAY  (ACUTE)      ANNUAL AVERAGE (CHRONIC)
       CONCENTRATION             CONCENTRATION
--------------------------------------------------------------------
           2.335                        .121
```

```
RUN No.   5 FOR flumiclorac-pentyl ON   cotton        * INPUT VALUES *
   --------------------------------------------------------------------
    RATE (#/AC)   No.APPS &   SOIL  SOLUBIL  APPL TYPE  %CROPPED INCORP
     ONE(MULT)    INTERVAL    Koc   (PPB )   (%DRIFT)     AREA    (IN)
   --------------------------------------------------------------------
   .054(   .072)   2  14      98.7  189.0   AERIAL(16.0)  20.0    .0

   FIELD AND RESERVOIR HALFLIFE VALUES (DAYS)
   --------------------------------------------------------------------
   METABOLIC  DAYS UNTIL  HYDROLYSIS   PHOTOLYSIS   METABOLIC  COMBINED
    (FIELD)  RAIN/RUNOFF  (RESERVOIR)  (RES.-EFF)   (RESER.)   (RESER.)
   --------------------------------------------------------------------
      8.85        2          19.00     .00-     .00     .00      19.00

   UNTREATED WATER CONC (MICROGRAMS/LITER (PPB))    Ver 1.0 AUG 1, 2001
   --------------------------------------------------------------------
        PEAK DAY  (ACUTE)      ANNUAL AVERAGE (CHRONIC)
          CONCENTRATION             CONCENTRATION
   --------------------------------------------------------------------
              1.139                        .059
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                         SCIGROW
                        VERSION 2.3
             ENVIRONMENTAL FATE AND EFFECTS DIVISION
                  OFFICE OF PESTICIDE PROGRAMS
              U.S. ENVIRONMENTAL PROTECTION AGENCY
                      SCREENING MODEL
                 FOR AQUATIC PESTICIDE EXPOSURE

SciGrow version 2.3
chemical:flumiclorac-pentyl
time is  2/28/2005  16:33:20
------------------------------------------------------------------------
 Application      Number of       Total Use    Koc      Soil Aerobic
 rate (lb/acre)  applications   (lb/acre/yr)  (ml/g)   metabolism (days)
------------------------------------------------------------------------
     0.054           2.0           0.108      9.87E+01        7.7
------------------------------------------------------------------------
groundwater screening cond (ppb) =   2.02E-03
************************************************************************
```