

CONCLUSIONS

Mobility - Leaching & Adsorption/Desorption

1. This study is scientifically valid (*acceptable*) and provides useful information on the soil mobility (batch equilibrium) of mesotrione (ZA1296) in five soils (two U.S. and three foreign). This study is one of a series of three batch equilibrium studies for parent mesotrione (this MRID and MRIDs 44505203 and 44505204). There is also a separate batch equilibrium submission for the transformation product MNBA (MRID 44505201), and another for the transformation product AMBA (MRID 44505202).

In combination with other studies, EPA Subdivision N Guideline requirements for soil mobility (batch equilibrium) for parent and transformation products are *satisfied*. However, the registrant should consider the critical elements in the Comments section of this report, as these may affect the validity and consequent acceptability of future study submissions.

2. Sorption of mesotrione to the five tested soils was low. Soils were not sterilized. [Because of some possible minor instability of parent compound, ostensible results may be for parent plus transformation products (Comment 3).] In general, sorption correlated *inversely* with pH in the range from 5.1 to 8.2, and *directly* with organic carbon in the range of 0.5 to 2.6%.

The mobility of uniformly phenyl ring-labeled [¹⁴C]mesotrione was studied at nominal concentrations of 0.02, 0.14 (silt loam soil only), 0.2, 1.0, and 5.0 ppm. Soil:solution slurries (1:2.5; w:v) of silt loam soil (from Wisconsin), sandy loam (from California), British silty clay loam, French clay, and French loam were equilibrated in darkness for 24 hours at 20 ± 2°C. The silt loam soil was treated at 0.14 ppm rather than 0.2 ppm. The numerical data cited below are summarized in Tables XIV and XV on pages 40 and 41 of the submission. **Freundlich K_{ads} values** were **0.74** for the silt loam soil (2.7% o.m.), **0.13** for the sandy loam soil (0.92% o.m.), **4.5** for the silty clay loam soil (4.5% o.m.), **1.3** for the clay soil (3.1% o.m.), and **0.15** for the loam soil (1.8% o.m.); corresponding **Freundlich K_{oc} values for sorption** were **47, 25, 171, 70, and 14 mL/g**. The 1/N values were 0.91-0.95 for adsorption. Freundlich K_{des} values following a 24-hour equilibration period were 1.1 for the silt loam soil, 0.30 for the sandy loam soil, 5.2 for the silty clay loam soil, 1.5 for the clay soil, and 0.33 for the loam soil; corresponding Freundlich K_{oc} values for desorption were 67, 56, 198, 86 and 32 mL/g. The 1/N values were 0.88-0.96 for desorption. The reviewer-calculated coefficients of determination (r²) for the relationships K_{ads} vs. organic matter content, K_{ads} vs. pH and K_{ads} vs. clay content were 0.82, 0.74 and 0.09, respectively. Because of the acidic nature of mesotrione, additional correlations (or multiple correlations) would be interesting to explore.

METHODOLOGY

Based on the results of a preliminary study for the adsorption of uniformly phenyl ring-labeled [¹⁴C]mesotrione {ZA1296, [2-[4-(methylsulfonyl)-2-nitrobenzoyl]-1,3-cyclohexanedione; radiochemical purity 97%, specific activity 30.4 mCi/mmol; p. 12}, an equilibration period of 24 hours was chosen for the adsorption and desorption phases of the definitive study (p. 23). In a preliminary study, adsorption of the parent compound to Teflon tubes was not observed (p. 22). Results from a preliminary stability study of the parent compound following adsorption and desorption indicated that the test compound was stable during the study (p. 17).

For the adsorption phase of the definitive study, aliquots (9 mL) of 0.01 M CaCl₂ solution were added to Teflon centrifuge tubes containing samples (4 g) of sieved (2 mm) silt loam (from Wisconsin), sandy loam (from California), British silty clay loam, French clay, and French loam soils (Table I, p. 27) and the samples were pre-equilibrated on a shaker (pp. 15, 16). The soil:solution slurries were treated with uniformly phenyl ring-labeled [¹⁴C]mesotrione, dissolved in 0.01 M NaHCO₃ and 0.01 M CaCl₂ solution (1 mL), at nominal concentrations of 0.02, 0.2, 1.0, and 5.0 ppm; the silt loam soil was treated at 0.14 ppm rather than 0.2 ppm. Duplicate tubes were prepared for each soil type/treatment rate combination. The tubes containing the soil:solution slurries (1:2.5, w:v) were equilibrated on a shaker in darkness for 24 hours at 20 ± 2°C. Following the adsorption equilibration period, soil:solution slurries were centrifuged and the supernatant decanted. Duplicate aliquots of supernatant from each sample were analyzed for total radioactivity by LSC; the limit of detection was twice background (Appendix A, p. 52).

For the desorption phase of the definitive study, a volume of pesticide-free 0.01 M CaCl₂ solution equivalent to the volume that was decanted following the adsorption phase was added to the soil pellets from the adsorption phase of the study (p. 17). Tubes containing the soil:solution slurries were shaken in darkness for 24 hours at 20 ± 2°C. Following equilibration, the soil:solution slurries were centrifuged and the supernatants were decanted. Duplicate aliquots of supernatant from each sample were analyzed for total radioactivity by LSC.

To determine the stability of the test compound in soil:solution slurries during the adsorption and desorption phases, aliquots of supernatant from samples treated at the highest concentration (5 ppm) were analyzed by HPLC (Alltech C18 column) using a mobile phase gradient of water:acetonitrile (both with 0.1% H₃PO₄; 90:10 to 0:100, v:v) with radioactive flow detection (pp. 17-20). Eluent fractions were collected in one-minute intervals and analyzed by LSC. Extracts were co-chromatographed with a nonradiolabeled reference standard for the parent compound which was visualized with UV light (210 and 254 nm; p. 13).

To determine the stability of the test compound in soil:solution slurries during the adsorption and desorption phases, one replicate of the post-desorption soil samples treated at 5 ppm was extracted three times with 0.5 N NaOH (p. 17); the method of extraction was not reported. Supernatants were decanted and aliquots were analyzed for total radioactivity by LSC. An aliquot of the extract was acidified (pH 0-1) with 6 N HCl and partitioned with ethyl acetate. The ethyl acetate fraction was analyzed by LSC and HPLC as previously described. Extracts were further analyzed by TLC on silica gel plates developed with toluene:methanol:triethylamine (60:30:10, v:v:v; p. 19). Radioactive regions were detected with a phosphorimager. Samples were co-chromatographed with a nonradiolabeled reference standard for the parent compound which was visualized with UV light (254 nm).

Subsamples of post-extracted and nonextracted soils were analyzed for total radioactivity by LSC following combustion (p. 18).

DATA SUMMARY

The mobility of uniformly phenyl ring-labeled [^{14}C]mesotrione (radiochemical purity 97%), at nominal concentrations of 0.02, 0.2 (0.14 ppm for the silt loam soil only), 1.0, and 5.0 ppm, was studied in silt loam (from Wisconsin), sandy loam (from California), British silty clay loam, French clay, and French loam soil:solution slurries (1:2.5; w:v) that were equilibrated in darkness for 24 hours at $20 \pm 2^\circ\text{C}$. Freundlich K_{ads} values were 0.74 for the silt loam soil, 0.13 for the sandy loam soil (0.92% o.m.), 4.5 for the silty clay loam soil (4.5% o.m.), 1.3 for the clay soil, and 0.15 for the loam soil (Table XV, p. 41); corresponding K_{oc} values were 47, 25, 171, 70, and 14 mL/g. Respective $1/N$ values were 0.92, 0.95, 0.91, 0.92, and 0.95 for adsorption (Table XIV, p. 40). The reviewer-calculated coefficients of determination (r^2) for the relationships K_{ads} vs. organic matter content, K_{ads} vs. pH and K_{ads} vs. clay content were 0.82, 0.74 and 0.09, respectively. Freundlich K_{des} values following a 24-hour equilibration period were 1.1 for the silt loam soil, 0.30 for the sandy loam soil, 5.2 for the silty clay loam soil, 1.5 for the clay soil, and 0.33 for the loam soil; corresponding K_{oc} values were 67, 56, 198, 86 and 32 mL/g. Respective $1/N$ values were 0.92, 0.96, 0.88, 0.90, and 0.93 for desorption.

Data indicating the percentages of the applied radioactivity adsorbed to and desorbed from the five soils (across all application rates) were not reported. Total radioactivity data (dpm) for adsorption of the test compound to the soil, desorption of the test compound from the soil, and nonextractable radioactivity were provided along with the initial radioactivity in the samples for each soil type/treatment rate combination (Tables III-VII, pp. 29-33). Concentration data for adsorption and desorption of the test compound to and from all soils were also provided (Tables IX-XIII, pp. 35-39).

HPLC data (5.0 ppm treatment only) indicated that the parent compound was stable in the supernatants during the adsorption and desorption phases, and in the soil extracts following desorption (Table VIII, p. 34); 93.9-98.7% of the radioactivity (across all soil types) present in the supernatants and 89.7-96.0% of the radioactivity present in the soil extracts with the exception of 81.3% for the loam soil, was present as parent (see Comment #3).

Material balances (for individual replicates across all application rates) were 93.7-100.1% for the silt loam soil, 97.9-99.9% for the sandy loam soil, 88.9-97.1% for the silty clay loam soil, 89.6-99.6% for the clay soil, and 97.7-101.9% for the loam soil (Tables III-VII, pp. 29-33).

COMMENTS

1. Method detection limits were not reported for HPLC or TLC. Both method detection and quantitation limits should be reported to allow the reviewer to evaluate the adequacy of the method for the determination of the test compound.
2. The reviewer confirmed that the silt loam soil (from Wisconsin) was the same type of soil used in two submitted aerobic soil metabolism studies (MRIDs 44505130 and 44373531).
3. Based on HPLC analysis, the stability of the parent compound in the loam soil was questionable (Table VIII, p. 34); 81.3% of the radioactivity present in the soil extract was present as parent. However, based on TLC analysis, 88.3% of the radioactivity present in the soil extract was present as parent. Additionally, based on HPLC analysis, 89.7%, 90.4%, and 92.2% of the radioactivity present in the silt loam, sandy loam, and silty clay loam soil extracts was present as parent. The study author stated that Freundlich constants for both adsorption and desorption were calculated without correction for the slight decomposition of the parent compound in the supernatants or extracts over the course of the study (p. 23).
4. The soil series names were not reported for the domestic (U.S.) soils. Instead, the soils were referred to by their geographic locations (Table I, p. 27).
5. The study was conducted with two domestic (U.S.) and three foreign (one from the U.K. and two from France) soils. The EPA strongly prefers the use of domestic soils in mobility studies. However, EPA will accept foreign soils for two of the four soils required if, and only if, the soils are characterized according to the USDA system. The reviewer confirmed that the soils were characterized using the USDA classification system (Table I, p. 27).

6. The study author stated that the adsorption of mesotrione is inversely related to pH and directly related to the soil organic matter content (p. 25). The reviewer-calculated coefficient of determination (r^2) values for the relationships K_{ads} vs. organic matter content and K_{ads} vs. pH were 0.82 and 0.74, respectively.
7. The solubility of the test compound in water was reported as "0.2% at pH 7-9" (p. 12; temperature not specified); solubility in the test solution was not reported.
8. Data indicating the percentages of the applied radioactivity adsorbed to and desorbed from the five soils (across all application rates) were not provided. Generally, batch equilibrium studies include the percentages of the applied radioactivity data for adsorption, desorption, and nonextractables.
9. The study author stated that the radiolabeled test substance was enriched with ^{13}C in the exocyclic carbonyl group to aid in the mass spectral characterization of metabolites (p. 12); however, MS was not performed in this study.

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