DYNAMAC
CORPORATION

TRIFLURALIN

Final Report

Task 2: Environmental Fate and Exposure Assessment

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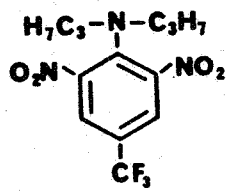
Environmental Fate and Exposure Assessment

Trifluralin

TREFLAN, ELANCOLAN, CRISALINA, DIGERMIN, FARMCO, IPERSAN, SINFLOURAN, SU SEGURO CARPIDOR, TRIM, TREFANOCIDE, TREFICON, TRIFLUREX



a,a,a-Trifluoro-2,6-dinitro-N,N-dipropyl-p-toluidine

Trifluralin is a selective preemergent herbicide registered for use on a variety of terrestrial food crops (field, vegetable, and orchard), terrestrial nonfood crop (ornamentals including golf courses), aquatic nonfood crop (ditch-banks), terrestrial noncrop, and domestic outdoor sites. Of the total amount of trifluralin applied in the United States, ~64% was used on soybeans, ~19% was used on cotton, ~7.8% was used on sunflowers, and ~3.4% was used on vegetable crops. Application rates range from 0.28 to 8.0 lb ai/A on all sites except for prepaving applications for which the rates range from 12 to 16 lb ai/A. Trifluralin may be formulated with disulfoton, tebuthiuron, diphenamid, or oryzalin. Single active ingredient formulations consist of 0.2-10.0% G, 3.1% WP, 4 and 5 lb/ gal EC, and 1.75% PrD. Trifluralin is generally surface applied by broadcast or directed spray using ground equipment or aircraft, then soil incorporated. Applicators need not be certified or under the direct supervision of applicators certified to apply trifluralin.

Available data are insufficient to fully assess the environmental fate of trifluralin and the exposure of humans and nontarget organisms to trifluralin. The data summarized here are scientifically valid but do not fulfill registration requirements unless noted. The hydrolysis data fully satisfy registration requirements.

[^{14}C]Trifluralin (analytical grade, radiochemical purity 99.5%), at 0.2 and 0.04 ppm, was stable to hydrolysis for up to 32 days in sterile buffer solutions at pH 3, 6, and 9, incubated in the dark at 25 C (Mosier and Saunders, 00131135).

Trifluralin (analytical grade, purity unspecified) incorporated into a silt loam soil at 200, 1, and 0.1 ppm degraded with ~100, 18, and 9%, respectively, of the applied trifluralin detected after 40 days of irradiation at 25 C (Parr and Smith, 00105772-G). In the dark, trifluralin degraded with ~95% of applied trifluralin recovered from all treatment levels after 40 days.

Trifluralin (analytical grade, purity unspecified) at 5 ppm degraded with ~15% of the applied trifluralin lost after 20 days in a silt loam soil (Parr and Smith, 00105772-G). The addition of an alfalfa meal soil amendment did not affect the degradation rate. Approximately 2.5% of the applied trifluralin evolved from alfalfa amended soil incubated for 20 days. The samples were incubated in the dark at 25 C and 0.33 bar moisture.

Trifluralin (analytical grade, purity unspecified) at 5 ppm degraded in nonsterile silt loam soil with <1% of applied trifluralin detected after 20 days of incubation at 0.33 bar moisture in the dark at 25 C under N_2 gas. Autoclaving and flooding the soil decreased the degradation rate of trifluralin (Parr and Smith, 00105772-G).

Trifluralin (44.5% EC), at 8-32 ppm was adsorbed to sandy clay loam, clay, and loam soils as indicated by a nonspecific bioassay method where sorghum coleoptile elongation was reduced when grown in the filtered supernatant from the soils (Horowitz et al., 00105772-C). Trifluralin was adsorbed onto a Plano silt loam soil (Harvey, 00105772-H). With 1-, 2-, and 4-g samples of Plano silt loam soil, 25, 17, and 12%, respectively, of the applied trifluralin remained in solution after equilibration at 25 C. Two-gram samples equilibrated at 5 C had 8% of the applied trifluralin left in solution. Trifluralin (EC, purity unspecified) at 1, 2, and 4 lb/A was relatively immobile in columns (2, 4, and 6 inches in height) of fine sand, silt loam, and muck soils leached with 2 inches of water, as indicated by a nonspecific bioassay method (Eshel and Warren, 00040425). Mobility was greatest in fine sand and least in muck. [^{14}C]Trifluralin (purity unspecified), at 1.1 kg/ha, was relatively immobile in sand, sandy loam, silt, loam, and clay loam soil columns (30-cm height) eluted with 60 cm of water, with >90% of the applied radioactivity remaining in the top 0- to 10-cm segment (Gray et al., 00094816). Trifluralin (test substance uncharacterized) concentrations in runoff (water/sediment suspen-

sions) were <0.04% of the applied amount for 3 consecutive years following treatment at 1.4 kg/ha and ~13-27 cm of rainfall (Willis et al., 00017935). The field plots (silty clay loam soil, 0.2% slope) were planted to cotton or soybeans.

In the field, [^{14}C]trifluralin (99% pure) at 0.84-6.72 kg/ha dissipated in the top 0-15 cm layer of a silt loam soil with 14, 4, and 1.5% of applied remaining 1, 2, and 3 years, respectively, after application (Golab et al., 00131137). Approximately 30 minor degradates were identified and quantified; none of which represented >2.8% of applied. Trifluralin (4 lb/gal EC) at 0.75 and 1.5 lb/A dissipated in a medium loam soil with ~20 and 32%, respectively, of the applied remaining 120 days after treatment (Helmer et al., 00002796 and Johnson, 00131133). Trifluralin (4 lb/gal EC) dissipated from a sandy loam soil treated at 1.0 lb ai/A, with a half-life of 2-4 months (Miller, 00116874-A).

Trifluralin was detected in 107 soil samples taken nationwide at <0.01-0.98 ppm in fields treated with trifluralin (test substance uncharacterized) at various rates for 1, 2, 3, or 4 consecutive years (Parka and Tepe, 00105694). Trifluralin (test substance uncharacterized) was detected in ~12% of the soil samples taken from 80 sites in 15 states in areas considered to be regular pesticide use areas based on available pesticide use records (Stevens et al., 00115693). Concentrations detected in soils ranged from <0.01 to 0.48 ppm. Trifluralin residues were detected in 3.5% of the 1,729 agricultural soils sampled in 1969 (Wiersma et al., 00047258). Trifluralin was detected at a maximum concentration of 0.25 ppm. Residues of volatile nitrosamines (dimethylnitrosoamine, N-nitro-sodipropylamine, or N-butyl-N-ethyl-N-nitrosoamine) were not detected in water samples taken from ponds or wells located in or near fields which had been treated with trifluralin at various rates (Day et al., 00124903).

Trifluralin (test substance uncharacterized), applied alone or in combination with chloropropham, or with chlorpropham plus PPG-124, dissipated with a half-life of 42-84 days in sandy loam or silt loam soil incubated at 72-75 F and ~18% moisture content under laboratory conditions (Maliani, 00036010). Trifluralin (4 lb/gal EC), at 1 lb ai/A alone or in combination with vernolate (3 lb ai/A), dissipated in sandy loam and fine sand soils with a half-life of

2-3 months and ~1 month, respectively (Stauffer Chemical, 00105790).

[^{14}C]Trifluralin residues did not accumulate in cabbage, corn, soybeans, sugarbeets, or tomatoes grown in rotation with soybeans in silt loam soil treated with [^{14}C]trifluralin (>99% pure) at 1.0 lb ai/A (Golab, 00131136). Total radioactivity in rotational crop tissues ranged from 0.002 to 0.143 ppm, but none of the radioactivity was characterized as trifluralin, α,α,α-trifluoromethyl-2,6-dinitro-N-propyl-p-toluidine, or α,α,α-trifluoromethyl-2,6-dinitro-p-toluidine. Trifluralin residues detected in the soil after the growing period (73 weeks) ranged from 10.9 to 19.6% of the applied radioactivity.

[^{14}C]Trifluralin residues accumulated in bluegill sunfish exposed to [^{14}C] trifluralin (purity unspecified) at an average of 7.87 μg/l for 35 days, with exposure levels in the water ranging from 4.29 to 11.27 μg/l (Bionomics EG&G, 00105772-K). Mean [^{14}C]trifluralin residues in edible fish tissue ranged from 5.50 to 12.00 mg/kg over the 35 days of exposure. Of the [^{14}C]trifluralin residues accumulated in fish tissue by day 35, ~92% in the edible portion had been eliminated from the fish after 7 days of depuration.

Dermal, ocular, and inhalation exposures to workers may occur during application. The primary potential for exposure from the EC formulation is during mixing and loading where both dermal and ocular exposure can occur via splashing. Inhalation and dermal exposure may occur during opening and pouring of the WP formulation; splashing during dilution, mixing, and loading operations may result in dermal, ocular, and ingestion exposures. Inhalation and dermal exposure may occur during the application of the PrD formulation. Application from aircraft increases the potential for exposure of humans and nontarget organisms to trifluralin due to spray drift and volatilization. Human exposure to trifluralin during handling, mixing, and application operations could be minimized by the use of approved respirators and protective clothing. However, no data are available to assess such exposures. No federal reentry intervals have been established for trifluralin. Reported pesticide incidents involving trifluralin alone between 1966 and 1981 included 49 involving human exposure, 9 involving environmental contamination, 2 involving plants, and 1 involving wildlife. Most incidents occurred at agricultural and home/domestic sites. Agricultural site incidents occurred pri-

marily during mixing/loading or application, while incidents at home/domestic sites primarily involved back-siphoning and accidential ingestion of the pesticide. Commonly reported exposure symptoms included dermal and eye irritation, and nausea.

In summary, trifluralin is stable to hydrolysis at pH 3, 6, and 9. Trifluralin at 200, 1.0, and 0.1 ppm photodegrades in a silt loam soil with ~100, 18, and 9%, respectively, of applied detected after 40 days. Photodegradation products include α,α,α-trifluoro-2,6-dinitro-n-propyl-p-toluidine and α,α,α-trifluoro-2,6-dinitro-p-toluidine. Under aerobic laboratory conditions, trifluralin degrades slowly with 15% of applied lost after 20 days in a silt loam soil, but under anaerobic conditions, trifluralin degrades more rapidly with <1% of applied detected after 20 days producing α,α,α-trifluoro-N,N-dipropyl-5-nitrotoluene-3,4-diamine and α,α,α-trifluoro-N,N-dipropyltoluene-3,4,5-triamine. Trifluralin and its residues are adsorbed to sandy clay loam, silt loam, loam, and clay soils, are not readily leached in fine- to course-textured soils, and are not mobile in runoff. In the field, trifluralin dissipates in loam soils with a half-life of ~2-4 months. The major degradation product is α,α,α-trifluoro-2,6-dinitro-p-toluidine. Monitoring studies indicate that trifluralin can be found at <1 ppm in previously treated soils nationwide. Combining trifluralin with chloropham or vernolate does not affect its rate of dissipation. [^{14}C]Trifluralin residues do not accumulate in cabbage, corn, soybeans, sugarbeets, or tomatoes rotated in soils treated the previous year. [^{14}C]Trifluralin residues did accumulate in bluegill sunfish to <12 mg/kg after 35 days of exposure to an average [^{14}C]trifluralin concentration of 7.87 μg/l, but decreased ~92% during depuration.

The following data are required (EPA Data Requirements for Registering Pesticides) to fully assess the environmental fate and transport of, and the exposure to trifluralin: photodegradation studies in water, on soil, and in air; aerobic and possibly anaerobic soil metabolism studies; aerobic and anaerobic aquatic metabolism studies; leaching and adsorption/desorption studies; laboratory and possibly field volatility studies; terrestrial, and possibly long-term field dissipation studies; aquatic field dissipation studies; and accumulation studies on rotational and irrigated crops, fish, and possibly aquatic nontarget organisms.

Hydrolysis studies: One study (Moiser and Saunders, 00131135) was reviewed and considered scientifically valid and fulfills data requirements by providing information on the hydrolysis of trifluralin at pH 3, 6, and 9.

Photodegradation studies in water: One study (Crosby and Leitis, 00094029) was reviewed and considered scientifically invalid because: Experiments 1 and 2 - no dark controls were run, the treatment rates were not within the aqueous solubility of trifluralin (<1 ppm), and the sampling protocol was inadequate to accurately assess the photodegradation of trifluralin in water; and Experiment 3 - no data were provided for the dark control and the sampling protocol was inadequate to accurately assess the photodegradation of trifluralin in water. In addition, this study would not fulfill data requirements because the test substance was not characterized; soil characteristics were not reported (Experiment 3); incubation temperatures were not reported; precautions were not taken to minimize loss by volatilization; the sunlight (Experiment 1) was not characterized; the light source (Experiments 2 and 3) was not related to natural sunlight; the test substance was added to soil, not directly to the water (Experiment 3); and the concentration of the cosolvent exceeded 1% (Experiment 2). All data are required.

Photodegradation studies in soil: Five studies were reviewed. One study (Parr and Smith, 00105772-G) is considered scientifically valid; however, this study does not fulfill data requirements because the light was uncharacterized, the soil was uncharacterized, the identified degradates were not quantified and their formation and decline was not addressed, the material balance was incomplete, half-life estimates were not provided, and the purity of the test substance was not reported. The second study (Eli Lilly Co., 00105759-B) is scientifically invalid because dark controls were not used and photodegradation and volatilization of the test substance were not controlled during the bioassay. In addition, this study would not fulfill data requirements because a nonspecific bioassay method was used; photoproducts were not identified or quantified; the sunlight, test substance, and soil were uncharacterized; the sampling intervals were insufficient to accurately assess the half-life of the test substance; and a material balance was not provided. The third study (Day, 00094807) is considered scientifically invalid because dark controls were not used. In addition, this study would not fulfill data requirements because photodegradation products were not

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identified or quantified, the intensity and wavelength of the light source was not provided, the test substance was uncharacterized, the test was not conducted on soil, and a material balance was not reported. The fourth study (Elanco Products Co., 00041576) is considered scientifically invalid because dark controls were not used. In addition, this study would not fulfill data requirements because the intensity of the light sources were not provided, the study was not conducted on soil, the test substance was uncharacterized, photoproducts were not identified, volatility losses were not controlled, a material balance was not provided, the sampling protocol was insufficient to accurately assess the decline of the test substance (Experiments 1 and 2), and the wavelength of the light sources were not provided (Experiments 2 and 3). The fifth study (Golab et al., 00131137; 00125328) is considered scientifically invalid because dark controls were not used, the sampling protocol and method of analysis were not described, and quantitative data were not provided. In addition, this study would not fulfill data requirements because the intensity and wavelengths of the light were not reported, the test was not conducted on soil, degradation products were not detected or quantified, and the test was conducted with a degradate of the test substance. All data are required.

Photodegradation studies in air: No data were submitted, but all data are required.

Aerobic soil metabolism studies: Nine studies were reviewed and one study is considered scientifically valid. The first study (Parr and Smith, 00105772-G) is considered scientifically valid; however, this study does not fulfill data requirements because the sampling period (20 days) was of insufficient length to accurately assess the degradation of the test substance, the formation and decline of degradates was not addressed, the soil was uncharacterized, the material balance was incomplete, half-life estimates were not provided, and the purity of the test substance was not reported. The second study (Corbin, 00114837) is considered scientifically invalid because the experimental design was inadequate to accurately assess the degradation of trifluralin in soil. In addition, this study would not fulfill data requirements because a nonspecific bioassay method was used, the material balance was not addressed, the soils were not completely characterized, and the test substance was not technical grade or purer. The third study (Eli Lilly Co., 00105759-A) is considered

scientifically invalid because the data were too variable to accurately assess the metabolism of trifluralin in soil, and the bioassay results were not related to trifluralin concentrations. In addition, this study would not fulfill data requirements because a nonspecific bioassay method was used, the soils were not completely characterized, the test substance was uncharacterized, and a material balance was not provided. The fourth study (Horowitz et al., 00105772) is considered scientifically invalid because sorghum growth was not related to the concentration of trifluralin, no attempt was made to control volatilization and photolysis of the test substance during the bioassay, and the sampling interval was inadequate to accurately assess the degradation of the test substance in soil (Experiments 1 and 3). In addition, this study would not fulfill data requirements because a nonspecific bioassay method was used, the test substance was not technical grade or purer, two of the soils used were incompletely characterized, the incubation temperature was not reported (Experiments 1 and 2), the soil moisture content was not reported (Experiments 1 and 2), degradates were not identified, a material balance was not provided, and the application rate was not confirmed. The fifth study (Kearney and Plimmer, 00105772-D) is considered scientifically invalid because insufficient data were generated to accurately assess the pattern of trifluralin degradation in soil. In addition, this study would not fulfill data requirements because the soil temperature was not reported as being held constant between 18 and 30 C, the pattern of formation and decline of degradates was not addressed, a material balance was not provided, and the purity of the test substance was not reported. The sixth study (Schweizer and Holstun, 00031882) is considered scientifically invalid because a standard curve relating trifluralin concentrations to phytotoxicity to oats was not provided. In addition, this study would not fulfill data requirements because the soil temperature during incubation was not reported, a nonspecific bioassay method was used, the pattern of formation and decline of degradates was not addressed, material balance and half-life estimates were not determined, and the test substance was uncharacterized. The seventh study (Golab et al., 00131137; 00125328) cannot be considered scientifically valid because the application rate was not confirmed, and the quantitative data provided were insufficient (one sample) to accurately assess the degradation of the applied trifluralin degradate in soil. In addition, this study would not fulfill data requirements because the soil incubation temperature was not reported and the study was conducted with a degradation product, not with the parent compound.

The eighth study (Welch, 00124024) is considered scientifically invalid because the injury ratings for the bioassay were not related to trifluralin concentrations. In addition, this study would not fulfill data requirements because a nonspecific bioassay method was used, the soil incubation temperature and moisture were not reported, the soil was uncharacterized, and the test substance was uncharacterized. The ninth study (Savage, 00105772-L) is considered scientifically invalid because the data were too variable to accurately assess the degradation of trifluralin in soil. In addition, this study would not fulfill data requirements because the test substance was not characterized, complete soil characteristics were not presented, the incubation temperature was not reported, and the formation and decline of degradates was not addressed. All data are required.

Anaerobic soil metabolism studies: Four studies were reviewed and one study is considered scientifically valid. The first study (Parr and Smith, 00105772-G) is considered scientifically valid; however, this study does not fulfill data requirements because the sampling period was of insufficient length to accurately assess the degradation of the test substance, the pattern of formation and decline of degradates was not addressed, the soil was uncharacterized, the material balance was incomplete, half-life estimates were not provided, and the purity of the test substance was not reported. The second study (Welch, 00124024) is considered scientifically invalid because the injury ratings for the bioassay were not related to trifluralin concentrations. In addition, this study would not fulfill data requirements because a nonspecific bioassay method was used, the soil incubation temperature was not reported, the test substance was uncharacterized, the test soil was uncharacterized, and the treated soil was not incubated aerobically for 30 days or one half-life prior to establishing anaerobic conditions. The third study (Elanco Products Co., 00002814) is considered scientifically invalid because the recovery of trifluralin and two unidentified degradates from spiked soil samples was unacceptably low (35-73%). In addition, this study would not fulfill data requirements because the treated soil was not incubated aerobically for 30 days or one half-life prior to establishing anaerobic conditions, the soil was uncharacterized, the test substance was uncharacterized, a material balance was not determined, and degradates were not identified. The fourth study (Golab et al., 00131137; 00125328) cannot be considered scientifically valid because the application rate was not

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confirmed, and quantitative data provided were insufficient to accurately assess the degradation of the test substance or its degradates in soil. In addition, this study would not fulfill data requirements because the soil incubation temperature was not reported, and the treated soil was not aged prior to inducing anaerobic conditions. All data are required unless an acceptable anaerobic aquatic metabolism study is submitted.

Aerobic aquatic metabolism studies: One study (Holzer, 00105772-M) was reviewed and is considered scientifically invalid because the sampling protocol was inadequate to accurately assess the degradation of the test substance in soil and water, and the analytical methods were not described. In addition, this study would not fulfill data requirements because the purity of the test substance was not reported, the soil and water were not characterized, soil moisture and incubation temperature were not reported, degradates were not identified, a residue decline curve was not generated, and a material balance and half-life estimates were not provided. All data are required.

Anaerobic aquatic metabolism studies: No data were submitted; however, all data are required.

Leaching and adsorption/desorption studies: Fifteen studies were reviewed and five studies are considered scientifically valid. The first valid study (Horowitz et al., 00105772) does not fulfill data requirements because the test substance was not technical grade or purer, a nonspecific bioassay method was used, the calcium ion solution used as the diluent was too concentrated (>0.01 M), and K_d values were not determined. The second valid study (Harvey, 00105772-H) does not fulfill data requirements because the test substance was uncharacterized, adsorption was studied in distilled water rather than a calcium ion solution, desorption was not determined, and K_d values were not reported. The third valid study (Eshel and Warren, 00040425) does not fulfill data requirements because the soil columns were of insufficient height (<12 inches), the volume of water used to leach the columns was insufficient (<20 inches), the muck soil was not completely characterized, the test substance was not technical grade or purer, K_d values were not determined, a nonspecific bioassay method was used, and the soils were not analyzed. The fourth valid study (Gray et al., 00094816) does not fulfill data require-

ments because the purity of the test substance was not reported, and soil/water relationship (K_d values) was not determined. The fifth valid study (Willis et al., 00017935) is a runoff study but does not fulfill data requirements because the method used was not one of the three recommended (i.e., soil column, soil TLC, or batch equilibrum) for determining pesticide mobility in soil, and the test substance was not characterized. The sixth study (Helling, 000444017; Helling and Turner, 00121867) is considered scientifically invalid because no attempt was made to control volatilization or photolysis of the test substance during air-drying and autoradiography of the soil TLC plates. In addition, this study would not fulfill data requirements because the test substance was uncharacterized, the application rate was not reported, and K_d values were not determined. The seventh study (Barrentine, 00002804) is considered scientifically invalid because no attempt was made to control volatilization or photolysis of the test substance after application and prior to eluting the soil columns or during the bioassay. In addition, this study would not fulfill data requirements because the soil was incompletely characterized, an insufficent volume of water (<20 inches) was used to elute the soil columns, a nonspecific bioassay method was used, K_d values were not provided, trifluralin was not applied at the highest application rate, and the test substance used was not technical grade or purer. The eighth study (Barrentine, 00002803) is considered scientifically invalid because no attempt was made to control volatilization or photolysis of the test substance after application and prior to eluting the soil columns or during the bioassay. In addition, this study would not fulfill data requirements because the soil was incompletely characterized, an insufficient volume of water (<20 inches) was used to elute the soil columns, a nonsecific bioassay method was used, K_d values were not provided, trifluralin was not applied at the highest recommended application rate, and the test substance used was not technical grade or purer. The ninth study (Helmer and Thompson, 00002805) is considered scientifically invalid because there was no standard curve to relate the growth inhibition of millet to the concentration of the test substance, and there was no attempt made to control volatilization or photolysis of the test substance after application and prior to eluting the soil columns or during the bioassay. In addition, this study would not fulfill data requirements because the purity of the test substance was not reported, the soil was incompletely characterized, the soil columns were not long enough (<30 cm), an insufficient volume of water (<20 inches) was used to elute the soil

columns, a nonspecific bioassay method was used, K_d values were not determined, and the leachate was not analyzed. The tenth study (Harris, 00027871) is considered scientifically invalid because there was no standard curve to relate the growth reduction of oats to the concentration of the test substance, and there was no attempt made to control volatilization or photolysis of the test substance after application and prior to subirrigating the soil columns and during the bioassay. In addition, this study would not fulfill data requirements because the test substance was uncharacterized, a nonspecific bioassay method was used, K_d values were not determined, and the soils were incompletely characterized. The eleventh study (Eli Lilly Co., 00105759-D) is considered scientifically invalid because no attempt was made to control volatilization or photolysis of the test substance after application and prior to eluting the soil columns or during the bioassay, and there was no standard curve relating the growth reduction of crabgrass to the concentration of the test substance. In addition, this study would not fulfill data requirements because the soil columns were not adequately described, the soils and the test substance were uncharacterized, an insufficient volume of water (<20 inches) was used to elute the columns, the soil columns were not segmented, the leachate was not analyzed, K_d values were not determined, and a nonspecific bioassay method was used. The twelfth study (Eli Lilly Co., 00105759-C) is considered scientifically invalid because there was no standard curve to relate the growth reduction of crabgrass to the concentration of the test substance, and there was no attempt made to control volatilization or photolysis or the test substance after application and prior to eluting the soil columns or during the bioassay. In addition, this study would not fultill data requirements because the test substance was uncharacterized, the test soils were incompletely characterized, an insufficient volume of water (<20 inches) was used to elute the soil columns, a nonspecific bioassay method was used, K_d values were not determined, and the leachate was not analyzed. The thirteenth study (Dryden, 00092529) is considered scientifically invalid because there was no standard curve to relate the growth inhibition of crabgrass to the concentration of the test substance, and there was no attempt made to control volatilization or photolysis of the test substance after application and prior to eluting the soil columns or during the bioassay. In addition, this study would not fulfill data requirements because the soil was not completely characterized, the test substance was not technical grade or purer, an insufficient volume of

water (<20 inches) was used to elute the soil columns, a nonspecific bioassay method was used, K_d values were not determined, and the leachate was not analyzed. The fourteenth study (Eli Lilly Co., 00105772-J) is a runoff study and is considered scientifically invalid because the experimental design was inappropriate for assessing the mobility of trifluralin in soil. In addition, this study would not fulfill data requirements because the analytical methods were not reported, complete soil characteristics were not presented, the test substance was not characterized, soil samples were not taken to confirm the application rate, and the method was not one of the three recommended (i.e., soil column, soil TLC, or batch equilibrium) for determining the mobility of trifluralin in soil. The fifteenth study (Anderson et al., 00077676) is considered scientifically invalid because no attempt was made to control volatilization or photolysis of the test substance after application and prior to eluting the soil columns or during the bioassay. In addition, this study would not fulfill data requirements because the soil was incompletely characterized, an insufficient volume of water (<20 inches) was used to elute the soil columns, a nonspecific bioassay method was used, K_d values were not provided, trifluralin was not applied at the highest application rate, and the test substance was not characterized. All data are required.

Laboratory volatility studies: Three studies were reviewed and all are invalid. One study (Saunders et al., 00124914) is considered scientifically invalid because the experimental design was inadequate to accurately assess trifluralin volatilization from soil. In addition, this study would not fulfill data requirements because the test substance was not a typical end-use product and air samples were not taken. A second study (Elanco Products Co., 00105759-E) is considered scientifically invalid because crop growth inhibition was not related to trifluralin concentrations and it could not be determined whether the controls included were appropriate. In addition, this study would not fulfill data requirements because the soil was uncharacterized, air temperature and relative humidity were not reported, recovery values and air concentration data were not reported, vapor pressure of the test substance was not provided, and a nonspecific bioassay method was used. The third study (Herberg, 00105759-F) is considered scientifically invalid because volatiles were not trapped and the experimental design was inappropriate to determine if volatilization of the test substance occurred. In

addition, this study would not fulfill data requirements because the test substance was uncharacterized, relative humidity was not reported, air concentrations and recovery values were not provided, the sand was uncharacterized, the concentration in the air was not monitored continuously, and a material balance was not provided. All data are required.

Field volatility studies: No data were submitted; however, the requirement for data is deferred pending the receipt of laboratory volatility data.

Terrestrial field dissipation studies: Twenty-one studies were reviewed and six studies are considered scientifically valid. The first valid study (Golab et al., 00131137; 00125328) does not fulfill data requirements because the test substance was not an end-use product, there was no pretreatment sampling, field test data were incomplete, and the plot size was not representative of actual use conditions. The second valid study (Helmer et al., 0002796; Johnson, 00131133) does not fulfill data requirements because the soil was incompletely characterized, the field test data were incomplete, and the pattern of formation and decline of degradates was not addressed. The third valid study (Miller, 00116874-A) does not fulfill data requirements because preapplication samples were not submitted, complete field test data were not provided, the test soil was not characterized, the formation and decline of degradates was not addressed, and trifluralin was not applied at the highest registered rate. The fourth valid study (Parka and Tepe, 00105694) is a monitoring study and does not fulfill data requirements because the test substance was uncharacterized, the soils were incompletely characterized, application rates were not confirmed, the sampling protocol was inadequate to establish a decline curve for trifluralin, the pattern of formation and decline of degradates was not determined, and field test data were incomplete. The fifth valid study (Stevens et al., 00115693) is a monitoring study and does not fulfill data requirements because the test substance was not characterized, the soils were not characterized, and pesticide application rates and methods were not completely reported, field test data were not provided, the pattern of formation and decline of degradates was not determined, and more than one pesticide was applied. The sixth valid study (Wiersma, 00047258) is a monitoring study and does not fulfill data requirements because insufficient information was provided regarding application rates, treatment and sampling dates, and the

formulation of the test substance. One study (Schweizer and Holstun, 00031882) is considered scientifically invalid because the sampling protocol (one sampling interval) was inadequate to accurately assess the dissipation of trifluralin from soil, standard curves relating trifluralin concentrations to phytotoxicity to cotton and oats were not provided, and a second herbicide was applied prior to bioassay analysis. In addition, this study would not fulfill data requirements because a nonspecific bioassay method was used, no pretreatment or immediate posttreatment samples were taken, the pattern of formation and decline of degradates was not addressed, material balance and half-life estimates were not determined, the sampling depth was insufficient (<15 cm), and field test data were incompletely reported. A second study (Bryant and Andrews, 00114669) is considered scientifically invalid because a standard curve relating the crop injury rating to the concentration of the test substance was not provided. In addition, this study would not fulfill data requirements because a nonspecific bioassay method was used, the application rate was not confirmed, no quantitative data were provided, the soils were not completely characterized, the test substance was uncharacterized, and the field test data were incomplete. A third study (Adler, 00018122) is considered scientifically invalid because the data were too variable to accurately assess the dissipation of the test substance from soil. In addition, this study does not fulfill data requirements because nonspecific bioassay methods were used, the bioassay methods were not described, degradation products were not identified, sampling techniques and size were not reported, the soil was uncharacterized, the test substance was uncharacterized, and more than one pesticide was applied to the soil. A fourth study (Burnside, 00105772-A) is considered scientifically invalid because the sampling protocol (one sampling interval) was inadequate to accurately assess the dissipation of trifluralin from soil. In addition, this study would not fulfill data requirements because the test substance was uncharacterized, there were no pretreatment or immediate posttreatment samples taken and analyzed to confirm the application rate, field test data were incomplete, and the bioassay methods used did not differentiate trifluralin from its phytotoxic residues. A fifth study (Ciba-Geigy Corp., 00116874-B) cannot be considered scientifically valid because the analytical methods were not provided. In addition, this study would not fulfill data requirements because sampling methods and sample size were not reported, pretreatment sampling was not conducted, meteorological data were not pro-

vided, the soil was incompletely characterized, the test substance was uncharacterized, cultivation and irrigation practices during the study were not provided, and the formation and decline of degradates was not addressed. A sixth study (Elanco Products Co., 00105772-E) is considered scientifically invalid because the sampling protocol (one sampling interval) was inadequate to accurately assess the dissipation of the test substance in soil, a standard curve relating the growth inhibition of crabgrass to trifluralin concentration was not used, and no attempt was made to control volatilization and photolysis of the test substance during soil preparation prior to and during the bioassay. In addition, this study would not fulfill data requirements because a nonspecific bioassay method was used, the formation and decline of degradates was not addressed, the soil was uncharacterized, and the field test data were incomplete. A seventh study (Elanco Products Co., 00002800) is considered scientifically invalid because the sampling protocol (one sampling interval) was inadequate to accurately assess the dissipation of trifluralin from soil, and the growth reduction values for the bioassay were not related to trifluralin concentrations. In addition, this study would not fulfill data requirements because immediate posttreatment samples were not analyzed to confirm the application rate of the test substance, the test soil was uncharacterized, meteorological and field test data were not provided, and a nonspecific bioassay method was used. An eighth study (Johnson, 00105753) is considered scientifically invalid because the sampling protocol was inadequate to accurately assess the dissipation of trifluralin from soil, and the analytical methods used to determine trifluralin residues were not described. In addition, this study would not fulfill data requirements because complete field test data were not provided, the pattern of formation and decline of degradates was not determined, and trifluralin was not applied at the highest registered rate. A ninth study (Kennedy et al., 00024857) is considered scientifically invalid because the experimental and analytical methods were not described in sufficient detail to accurately assess the dissipation of trifluralin from soil (Experiment 1), and sorghum growth inhibition was not related to trifluralin concentration (Experiment 2). In addition, this study would not fulfill data requirements because data for pretreatment and immediate posttreatment samples were not provided to confirm the application rates, the soil was not completely characterized, the test substance was uncharacterized, the field test data were incomplete, and a nonspecific bioassay method was used (Experiment 2). A tenth study

(Koerwer, 00058163) is considered scientifically invalid because crop mortalilty ratings were not related to trifluralin concentrations. In addition, this study would not fulfill data requirements because a nonspecific bioassay method was used, the test substance was not characterized, soil characteristics were not reported, complete field test data were not presented, and the pattern of formation and decline of degradates was not determined. An eleventh study (Miller, 00105772-B) is considered scientifically invalid because the sampling protocol was inadequate to accurately assess the dissipation of trifluralin from soil. In addition, this study would not fulfill data requirements because the test substance was not characterized, complete soil characterisitics were not provided, complete field test data were not provided, the pattern of formation and decline of degradates was not determined, and trifluralin was not applied at the highest registered rate. A twelfth study (Menges and Tamez, 00105772-F) is considered scientifically invalid because the sampling protocol was inadequate to accurately assess the dissipation of trifluralin from soil. In addition, this study would not fulfill data requirements because complete field test data were not provided, the pattern of formation and decline of trifluralin degradates was not addressed, the application rate was not confirmed by posttreatment analysis, trifluralin was not applied at the highest registered rate, and the test substance was not characterized. A thirteenth study (Watson, 00002798) is considered scientifically invalid because the bioassay data were too variable to accurately assess the dissipation of trifluralin phytotoxic residues from soil. In addition, this study would not fulfill data requirements because a nonspecific bioassay method was used, the test soils were not completely characterized, the pattern of formation and decline of degradates was not determined, and complete field test data were not reported. A fourteenth study (West et al., 00124902) is considered scientifically invalid because the recovery values from fortified samples were too variable to accurately assess the dissipation of trifluralin and the pattern of formation and decline of degradates in soil. In addition, this study would not fulfill data requirements because the sampling protocol was inadequate to assess the decline of trifluralin or the patterns of formation and decline of degradates in soil, the test substance was not completely characterized, the soils were not characterized, and complete field test data were not reported. A fifteenth study (Savage, 00105772-L) is a monitoring study but could not be scientifically validated because the analytical methods were not described. In addition, this study would not fulfill data require-

ments because insufficient information was provided regarding application rates, treatment dates, soil characteristics, complete field test data, and the formulations of the applied test substance. All data are required.

Aquatic field dissipation studies: No data were submitted; however, all data are required.

Forestry dissipation studies: No data were submitted; however, no data are required because currently trifluralin has no registered forestry uses.

Dissipation studies for combination products and tank mix uses: Three studies were reviewed and two studies (Maliani, 00036010, and Stauffer Chemical Co., 00105790) are considered scientifically valid. The third study (Norris, 00076721) is considered scientifically invalid because the trifluralin concentrations in the soil samples were too variable to accurately assess the dissipation of trifluralin in soil. Data requirements for combination products and tank mix uses are currently not being imposed for this Standard.

Long-term field dissipation studies: No data were submitted, but all data may be required based on the results from aerobic soil metabolism/terrestrial field dissipation studies.

Confined accumulation studies on rotational crops: Two studies were reviewed. One study (Golab, 00131136) is considered scientifically valid but does not fulfill data requirements because the soil analytical methods were not provided, the application rate was not confirmed, the soil was uncharacterized, meteorological data were not provided, and all degradates were not characterized. The second study (Golab et al., 00131137; 00125328) is considered scientifically invalid because quantitative data were not presented to support the stated conclusion. In addition, this study would not fulfill data requirements because the study was conducted with a degradate of trifluralin, and the field test data were incomplete. All data are required.

Field accumulation studies on rotational crops: No data were submitted; however, the requirement for data is deferred pending receipt of data for confined accumulation studies on rotational crops.

Accumulation studies on irrigated crops: No data were submitted; however, all data are required.

Laboratory studies on pesticide accumulation in fish: Four studies were reviewed. Only one study (Bionomics EG&G, 00105772-K) is considered scientifically valid, but does not fulfill data requirements because the [^{14}C] trifluralin residues in fish tissue were not characterized, residues in whole fish were not determined, the concentration of the test substance in the exposure water was not constant, and the purity of the test substance was not reported. A second study (Kearney et al., 00094030) is considered scientifically invalid because the procedures and protocols used were insufficient to assess the accumulation potential of trifluralin in fish; i.e., the concentration in water was not compared with the concentration in aquatic organisms over time to generate accumulation data. In addition, this study would not fulfill data requirements because the fish (*Gambusia affinis*) were not exposed to trifluralin for 28 days; there was no depuration period; the fish samples were not fractionated into edible and visceral tissue; major radioactive degradates were not identified; aquatic organisms were not exposed to a constant concentration of trifluralin; and the test water, test substance, and test soil were not characterized. The third study (Isensee and Yockim, 00114193) is considered scientifically invalid because the data presented were too variable to accurately assess the accumulation of trifluralin in fish. In addition, this study would not fulfill data requirements because the fish were not fractionated into edible and visceral tissues, the concentration of the test substance was not constant during the exposure period, test conditions were not completely described, and radioactive residues were not characterized. The fourth study (Sanborn, 00098842) is considered scientifically invalid because the procedures were inadequate to estimate the potential of trifluralin to accumulate in aquatic organisms; i.e., the concentration in water was not compared with the concentration in aquatic organisms over sufficient time to generate accumulation data. In addition, this study would not fulfill data requirements because aquatic organisms were not exposed to a constant concentration of trifluralin, samples were not fractionated into edible and visceral tissues, the test substance was not characterized, and incubation conditions were incompletely characterized. All data are required.

Field accumulation studies on aquatic nontarget organisms: No data were submitted; however, all data are required.

Reentry studies: One study (Day et al., 00105782; Gramlich et al., 00126074) was reviewed and is considered scientifically invalid because the control was contaminated with trifluralin and application rates were not confirmed. No data are required.

Exposure studies: Two studies were reviewed. One monitoring study (Day et al., 00124903) is considered scientifically valid. One groundwater study (Schneider et al., 00059413; 00027145) is considered scientifically invalid because trifluralin in the samples was sorbed to the polyethylene sample containers; therefore, the analytical results were not quantitative.

Label Restrictions

Pending the submission of crop rotational data, it is suggested that crops other than those with registered trifluralin uses be restricted from being planted in trifluralin-treated soils.

Pending the submission of irrigated crop data, do not use water containing trifluralin residues from ditchbank applications to irrigate crops used for food or feed which are not registered for use with trifluralin.

References

Adler, E.F. 1966. Effects of soil incorporation and time of planting on the performance of herbicides in furrow-irrigated carrots. CR fl 24-11D. Unpublished study received Dec. 21, 1967 under 1471-35; prepared by U.S. Agricultural Research Service, Crops Research Div., submitted by Elanco Products Co., Div. of Eli Lilly and Co., Indianapolis, IN; CDL:006222-E. (00018122)

Anderson, W.P., A.B. Richards, and J.W. Whitworth. 1967. Leaching of trifluralin, benefin, and nitralin in soil columns. Weed Sci. 16(2):165-169. (00077676)

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Barrentine, J.L. 1969. Experiment No. JLB9-1: Soil leaching data. Unpublished study received Apr. 30, 1970 under OF0968; submitted by Elanco Products Co., Div. of Eli Lilly and Co., Indianapolis, IN; CDL:091661-O. (00002803)

Barrentine, J.L. 1969. Experiment No. JLB9-2: Soil leaching data. Unpublished study received Apr. 30, 1970 under OF0968; submitted by Elanco Products Co., Div. of Eli Lilly and Co., Indianapolis, IN; CDL:091661-P. (00002804)

Bionomics EG & G, Inc. 1973. Exposure of fish to ^{14}C-trifluralin: accumulation, distribution, and elimination of ^{14}C-residues. In Elanco Products Co. 1975. Trifluralin...: PR Notice 70-15 data. Compilation; unpublished study received July 16, 1976 under 1471-35; submitted by Elanco Products Co., CDL:222334-A. (00105772-K)

Bryant, T.A., and H. Andrews. 1967. Disappearance of diuron, norea, linuron, trifluralin, diphenamid, DCPA and prometryne from the soil. Proc. South. Weed Conf. 20:395-404. (00114669)

Burnside, O.C. 1974. Trifluralin dissipation in soil following repeated annual applications. Weed Sci. 22(4):374-377. In Elanco Products Co. 1975. Trifluralin...: PR Notice 70-15 data. Compilation; unpublished study received July 16, 1975 under 1471-35; CDL:222334-A. (00105772-A)

Ciba-Geigy Corp. 1973. Environmental studies to determine the fate of CGA10832 in the environment: Report No. GAAC-72078. Compilation; unpublished study received Mar. 23, 1973 under 3F1294; CDL:091938-A. (00116874-B)

Corbin, F. 1965. The influence of pH on the detoxication of herbicides in soil. Doctoral thesis, North Carolina State Univ., Dept. of Crop Science. Unpublished study received Mar. 18, 1976 under 3E1385; submitted by U.S. Dept. of Interior, Bureau of Reclamation, Washington, DC; CDL:095210-N. (00114837)

Crosby, D.G., and E. Leitis. 1973. The photodecomposition of trifluralin in water. Bull. Environ. Contam. Toxicol. 10(4):237-241. Also In unpublished submission received Jan. 28, 1982 under 100-EX-72; submitted by Ciba-Geigy Corp., Greensboro, NC; CDL:246685-B. (00094029)

Day, E.W., Jr. 1976. Preliminary photochemical studies with the herbicide ethalfluralin. Unpublished study received Feb. 4, 1982 under 1471-122; submitted by Elanco Products Co., Div. of Eli Lilly and Co., Indianapolis, IN; CDL:070676-F. (00094807)

Day, E., J. Helmer, E. McKinney, et al. 1977. Special Arizona Treflan Study--II. Unpublished study received Apr. 25, 1977, under 1471-35; submitted by Elanco Products Co., Div. of Eli Lilly and Co., Indianapolis, IN; CDL:233218A. (00105782)

Day, E., S. West, and M. Amundson. 1977. Residues of volatile nitrosamines in water samples from fields treated with Treflan: Pre-RPAR Review submission #8. Unpublished study received Dec. 21, 1977 under 1471-35; submitted by Elanco Products Co., Div. of Eli Lilly and Co., Indianapolis, IN; CDL:233223-B. (00124903)

Dryden, R.M. 1970. Letter sent to Anson R. Cooke dated Oct. 20, 1970: A-820 leaching study. Unpublished study received Sep. 26, 1973 under 264-235; submitted by Union Carbide Agricultural Products Co., Inc., Ambler, PA; CDL:120461-G. (00092529)

Elanco Products Company. 1963. General summary: Trifluralin studies. Compilation; unpublished study received Oct. 10, 1963 under 1471-35; CDL:119190-A; 120368; 119194. (00105759-E)

Elanco Products Company. 1968. Photodecomposition. Unpublished study received Apr. 30, 1979 under OF0968; CDL:091661-AB, 091660. (00041576)

Elanco Products Company. 1968. Introduction: Degradation of El-1791. Unpublished study received Apr. 30, 1970 under OF0968; prepared by Elanco Products Co., Div. of Eli Lilly and Co.; CDL:091661-AA. (00002814)

Elanco Products Company. 1969. Experiment No. CDH8-32X: Soil persistence data. Unpublished study received Apr. 30, 1970 under OFO968; prepared by Elanco Products Co., Div. of Eli Lilly and Co.; CDL:091661-J. (00002800)

Elanco Products Company. 1975. Trifluralin...: PR Notice 70-15 Data. Compliation; unpublished study received July 16, 1975 under 1471-35; CDL:222334-A. (00105772-E)

Eli Lilly and Company. 1963. Stability of trifluralin in sunlight. Experiment Nos. GLP2-55 and GLP2-58. In Elanco Products Co. 1963. General summary: Trifluralin studies. Compilation; unpublished study received Oct. 10, 1963 under 1471-35; CDL:119190-A; 120368; 119194. (00105759-B)

Eli Lilly and Company. 1963. Experiment No. 637-203: Trifluralin and diphenamid disappearance in soil. In Elanco Products Co. 1963. General summary. Trifluralin studies. Compilation; unpublished study received Oct. 10, 1963 under 1471-35; CDL:119190-A; 120368; 119194. (00105759-A)

Eli Lilly and Company. Experiment No. G35-213: The leaching of the trifluralin, diphenamid, dipropalin and diphenatrile from the soil surface. In Elanco Products Co. 1963. General summary: Trifluralin studies. Compilation; unpublished study received Oct. 10, 1963 under 1471-35; CDL:119190-A; 120368; 119194. (00105759-D)

Eli Lilly and Company. Experiment No. G35-217 and Experiment No. GLP2-17: Trifluralin leaching rate in comparison to diuron and simazine. In Elanco Product Co. 1963. General summary: Trifluralin studies. Compilation; unpublished study received Oct. 10, 1963 under 1471-35; CDL:119190-A; 120368; 119194. (00105759-C)

Eli Lilly and Company. 1964. Runoff study: Experiment No C4-76. In Trifluralin--: PR Notice 70-15 Data. Compilation; unpublished study received July 16, 1975. Submitted by Elanco Products Co. under 1471-35; CDL:222334-A. (00105772-J)

Eshel, Y., and G.F. Warren. 1967. A simplified method for determining

phytotoxicity, leaching, and adsorption of herbicides in soils. Weeds 15(2):115-118. Also In unpublished submission received Feb. 24, 1977 under 748-161; submitted by PPG Industries, Inc., Barberton, OH; CDL:096035-B. (00040425)

Golab, T. 1983. Radiochemical studies with ^{14}C-trifluralin on various rotational crops: soybeans and others. Unpublished study received Sep. 20, 1983 under 1471-70; submitted by Elanco Products Co., Div. of Eli Lilly and Co., Indianapolis, IN; CDL:251257-B. (00131136)

Golab, T., W. Althaus, and H. Wooten. 1978. Fate of ^{14}C-trifluralin in soil. Unpublished study received Sep. 20, 1983 under 1471-70; submitted by Elanco Products Co., Div. of Eli Lilly and Co., Indianapolis, IN; CDL: 251257-C. (00131137)

Golab, T., and J. Occolowitz. 1978. Soil degradation of trifluralin: mass spectrometry of products and potential products: Pre-RPAR Review Submission #25. Unpublished study received Nov. 30, 1978 under unknown admin. no.; submitted by Elanco Products Co., Div. of Eli Lilly and Co., Indianapolis, IN; CDL:249282-D. (00125328)

Gramlich, J., J. Helmer, E. Day, et al. 1977. Special Arizona Treflan Study--February 23-28, 1977: Part 1: Field Methodology. Unpublished study received 1977 under 1471-35; submitted by Elanco Products Co., Div. of Eli Lilly and Co., Indianapolis, IN; CDL:233213-A. (00126074)

Gray, J.E., A. Loh, R.F. Sieck, et al. 1982. Laboratory leaching of ethalfluralin. Unpublished study received Feb. 4, 1982 under 1471-122; submitted by Elanco Products Co., Div. of Eli Lilly and Co., Indianapolis, IN; CDL:070676-Q. (00094816)

Harris, C.I. 1976. Movement of herbicides in soil. Weeds 15:214-216. Also In unpublished submission received Sep. 8, 1970 under unknown admin. no.; submitted by American Cyanamid Co., Princeton, NJ; CDL:120350-J. (00027871)

Harvey, R.G. 1974. Soil adsorption and volatility of dinitroaniline

herbicides. Weed Sci. 22(2):120-124. In Elanco Products Co. 1975. Trifluralin...: PR Notice 70-15 Data. Compilation; unpublished study received July 16, 1975 under 1471-35; CDL:222334-A. (00105772-H)

Helling, C.S. 1971. Pesticide mobility in soils: II. Applications of soil thin-layer chromatography. Soil Sci. Soc. Am. Proc. 35:737-748. Also In unpublished submission received May 5, 1975 under 464-323; submitted by Dow Chemical U.S.A., Midland, MI; CDL:221997-S. (000444017)

Helling, C., and B. Turner. 1968. Pesticide mobility: Determination by soil thin-layer chromatography. Science 162:562-563. Also In unpublished submission received Dec. 21, 1982 under 239-2247; submitted by Chevron Chemical Co., Richmond, CA; CDL:249103-A. (00121867)

Helmer, J.D., W.S. Johnson, and T.W. Waldrep. 1969. Experiment No. WB(F) 9-132: Soil persistence data. Unpublished study received Apr. 30, 1970 under OF0968; submitted by Elanco Products Co., Div. of Eli Lilly and Co.; Indianapolis, IN; CDL:091661-F. (00002796)

Helmer, J.D., and L.L. Thompson. 1969. Experiment No. WB9-56; Soil leaching data. Unpublished study received Apr. 30, 1970 under OF0968; submitted by Elanco Products Co., Div. of Eli Lilly and Co., Indianapolis, IN; CDL: 091661-Q. (00002805)

Herberg, R.J. Evaporation rate of trifluralin. In Elanco Products Co. 1963. General summary: Trifluralin studies. Compilation; unpublished study received Oct. 10, 1963 under 1471-35; CDL:119190-A; 120368; 119194. (00105759-F)

Holzer, F.J. 1966. Treflan E.C. Experiment. In Trifluralin...: PR Notice 70-15 Data. Compilation; unpublished study received July 16, 1975 under 1471-35; submitted by Elanco Products Co., CDL:222334-A. (00105772-M)

Horowitz, M., N. Hulin, and T. Blumenfeld. 1974. Behavior and persistence of trifluralin in soil. Weed Res. (14):213-220. In Elanco Products Co. 1975. Trifluralin ...: PR Notice 70-15 Data. Compilation; unpublished study received July 16, 1975 under 1471-35; CDL:222334-A. (00105772-C)

Isensee, A., and R. Yockim. 1980. Freshwater micro-ecosystem development and testing of substitute chemicals. By U.S. Dept. of Agriculture, Science and Education Administration, Pesticide Degradation Laboratory. Duluth, MN: U.S. Environmental Protection Agency, Office of Research and Development, Environmental Research Laboratory. EPA-600/3-80-008; Contract No. EPA-IAG05; Olin 3678; available from: NTIS, Springfield, VA: PB80-151533; published study; CDL:248282-M. (00114193)

Johnson, W. 1974. Trifluralin residues found in soil when applied in a water mixture and on dry fertilizer carrier. Unpublished study received Mar. 5, 1975 under 1471-35; submitted by Elanco Products Co., Div. of Eli Lilly and Co., Indianapolis, IN; CDL:120633-A. (00105753)

Johnson, W. 1977. Determination of trifluralin in agricultural crops and soil: Procedure No. 5801616. Supercedes procedures No. 5801210 and No. 5801110. Unpublished study received Sep. 20, 1983 under 1471-70; submitted by Elanco Products Co., Div. of Eli Lilly and Co., Indianapolis, IN; CDL: 251256-B. (00131133)

Kearney, P.C., A.R. Isensee, and A. Kontson. 1977. Distribution and degradation of dinitroaniline herbicides in an aquatic ecosystem. Pestic. Biochem. Physiol. 7:242-248. Also In unpublished submission received Jan. 28, 1982, under 100-EX-72; submitted by Ciba-Geigy Corp., Greensboro, NC; CDL:246685-E. (00094030)

Kearney, P.C., and J.R. Plimmer, et al. 1975. Persistence and metabolism of dinitroaniline herbicides in soil. In Elanco Products Co. 1975. Trifluralin: PR Notice 70-15 data. Compilation; unpublished study received July 16, 1975 under 1471-35; CDL:222334-A. (00105772-D)

Kennedy, J.M., R.E. Talbert, and B. Fischer. 1974. Dinitroaniline herbicides: their persistence on the soil surface, residual activity, and relative crop tolerance. Unpublished study received 1975 under 2G1285; prepared by Univ. of Arkansas, Agricultural Experiment Station, submitted by Union Carbide Agricultural Products Co., Ambler, PA; CDL:095154-E. (00024857)

Koerwer, J. 1970. Soil persistence of A-820. Unpublished study received Oct. 14, 1971 under 264-265; submitted by Union Carbide Agricultural Products Co., Inc., Ambler, PA; CDL:002239-I. (00058163)

Maliani, N. 1976. CIPC and CIPC + PPG-124 interaction study (Exhibit E): Laboratory No. 97021. Unpublished study received Sep. 21, 1976 under 748-161; prepared by Morse Laboratories, Inc., submitted by PPG Industries, Barberton, OH; CDL:095292-W. (00036010)

Menges, R.M., and S. Tamez. 1973. Movement and persistence of bensulide and trifluralin in irrigated soil. Weed Sci. 22(1):67-71. Also In Trifluralin: PR Notice 70-15 Data. Compilation; unpublished study submitted by Elanco Products Co., received July 16, 1975 under 1471-35; CDL: 222334-A. (00105772-F)

Miller, J.H. 1973. Residue Report AGA 2527 - 2nd Report Project No. 120002. (00116874-A)

Miller, J.H., et al. 1975. Soil persistance of trifluralin, benefin, and nitralin. Weed Sci. 23(3):211-214. Also In Trifluralin: PR Notice 70-15 Data. Compilation; unpublished study received July 16, 1975 under 1471-35; CDL:222334-A. (00105772-B)

Mosier, J., and D. Saunders. 1978. A hydrolysis study on the herbicide trifluralin. Unpublished study received Sep. 20, 1983 under 1471-70; submitted by Elanco Products Co., Div. of Eli Lilly and Co., Indianapolis, IN; CDL:251257-A. (00131135)

Norris, F.A. 1979. Letter sent to D.D. Phillips dated June 12, 1979: Soil dissipation studies, ethoprop alone and in combination with trifluralin: Project No. 15915. Unpublished study received Mar. 19, 1981 under 2224-44; submitted by Mobil Chemical Co., Industrial Chemicals Div., Richmond, VA; CDL:244801-A. (00076721)

Parka, S., and J. Tepe. 1969. The disappearance of trifluralin from field soils. Weed Sci. 17(1):119-122. Also In unpublished submission received June 20, 1969 under 9F0851; submitted by Elanco Products Co., Div. of Eli

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Lilly and Co., Indianapolis, IN; CDL:093147-A. (00105694)

Parr, J.F., and S. Smith. 1973. Degradation of trifluralin under laboratory conditions and soil anaerobiosis. Soil Sci. 115(1):55-63. In Elanco Products Co. 1975. Trifluralin ...: PR Notice 70-15 Data. Compilation; unpublished study received July 16, 1975 under 1471-35; CDL:222334-A. (00105772-G)

Sanborn, J.R. 1974. The fate of select pesticides in the aquatic environment. By Illinois, Natural History Survey. Corvallis, OR: U.S. Environmental Protection Agency, National Environmental Research Center. EPA-660/3-74-025; available from: Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402 and NTIS, Springfield, VA 22151: PB 239 749; published study; CDL:232569-Z. (00098842)

Saunders, D., J. Mosier, and M. Amundson. 1977. Volatilization of nitrosodipropylamine from soil after surface application of Treflan: Pre-RPAR Review Submission #9. Unpublished study received Dec. 21, 1977 under 1471-35; submitted by Elanco Products Co., Div. of Eli Lilly and Co., Indianapolis, IN; CDL:233223-H. (00124914)

Savage, K.E. 1973. Nitralin and trifluralin persistence in soil. In Trifluralin: PR Notice 70-15 Data. Compilation; unpublished study received July 16, 1975 under 1471-35; CDL:222334-A. (00105772-L)

Schneider, A.D., A.F. Wiese, O.R. Jones, et al. 1971. Determining the fate of herbicides in the Ogallala Aquifer. College Station, TX: Texas A & M Univ., Agricultural Experiment Station. B-1112; also In unpublished submission received Sep. 26, 1974, under 464-323; submitted by Dow Chemical U.S.A., Midland, MI; CDL:120353-D. (00059413)

Schneider, A.D., A.F. Wiese, and O.R. Jones. 1977. Movement of three herbicides in a fine sand aquifer. Agron. J. 69(?/May-June):432-436. Also In unpublished submission received July 19, 1978, under 201403; submitted by Shell Chemical Co., Washington, DC; CDL:234472-W. (00027145)

Schweizer, E.E., and J.T. Holstun, Jr. 1966. Persistence of five cotton

herbicides in four southern soils. Weeds 14 (?):22-26. Also In unpublished submission received Sep. 27, 1974 under 677-318; submitted by Diamond Shamrock Agricultural Chemicals, Cleveland, OH; CDL:009849-R. (00031882)

Stauffer Chemical Co. 1979. Vernam 7E: Residue data. Compilation; unpublished study received Mar. 16, 1979 under 476-2155; CDL:237823-A. (00105790)

Stevens, L., C. Collier, and D. Woodham. 1970. Monitoring pesticides in soils from areas of regular, limited, and no pesticide use. Pestic. Monit. J. 4(3):145-166. Available from: U.S. Government Printing Office, Washington, DC 20402; published study; CDL:248580-E. (00115693)

Watson, J.H. 1969. Experiment No. JHW9-21X: Soil persistence data. Unpublished study received Apr. 30, 1970 under OF0968; submitted by Elanco Products Co., Div. of Eli Lilly and Co., Indianapolis, IN; CDL:091661-H. (00002798)

Welch, J. 1970. The degradation of AN 56477 under aerobic and anaerobic greenhouse conditions. Unpublished study received Sep. 29, 1970 under 1F1047; submitted by Ansul Chemical Co., Weslaco, TX; CDL:094847-D. (00124024)

West S., E. Day, and M. Amundson. 1977. Residues of N-nitrosodipropylamine and trifluralin in soil from fields treated with Treflan: Pre-RPAR Review Submission #8. Unpublished study received Dec. 21, 1977 under 1471-35; submitted by Elanco Products Co., Div. of Eli Lilly and Co., Indianapolis, IN; CDL:233223-A. (00124902)

Wiersma, G.B., H. Tai, and P.F. Sand. 1972. Pesticide residue levels in soils, FY 1969--National Soils Monitoring Program. Pestic. Monit. J. 6(3):194-201. Available from: Superintendent of Documents, U.S. Government Printing Office, Washington, DC, published study; CDL:226965-G. (00047258)

Willis, G.H., R.L. Rogers, and L.M. Southwick. 1975. Losses of diuron, linuron, fenac, and trifluralin in surface drainage water. J. Environ.

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Qual. 4(3):399-402. Also In unpublished submission received Aug. 20, 1976 under 39445-1; submitted by American Carbonyl, Inc., Tenafly, NJ; CDL:228229-AY. (00017935)

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