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# EFED NEW CHEMICAL REVIEW FOR

## Flucarbazone-Sodium

**DRAFT 09/13/00**

Environmental Fate and Ecological Effects Division
Office of Pesticide Programs

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Table of Contents

# I. ENVIRONMENTAL RISK CONCLUSIONS

## Ecological

The use of flucarbazone-sodium poses a risk to non-target plants from runoff. Endangered and threatened plant species near wheat fields may be affected by the use of flucarbazone-sodium at labeled rates of application via runoff and spray drift. Since this herbicide is to be applied only by ground equipment, the amount of flucarbazone-sodium drifting to nearby non-target plants does not presently approach a level of concern. However, if the use of aerial application is to be granted for flucarbazone-sodium at a future date, non-target plants nearby and afar may be at risk.

Flucarbazone-sodium is a member of the sulfonylurea class of herbicides whose mode of action in the plants is inhibition of amino acid synthesis. There are concerns of sulfonylurea herbicides having an adverse reproductive effect on non-target plants at levels of exposure several orders of magnitudes below the labeled rates of application. Currently, EPA does not have data on flucarbazone-sodium to assess the reproductive impact to non-target plants/crops.

Because the proposed use of flucarbazone-sodium is for all classes of wheat, and wheat is so widely grown, endangered plant species may be affected in many areas of this nation.

The use of flucarbazone-sodium on wheat appears to pose minimal adverse affects on nontarget aquatic plants, birds, mammals, and honey bees.

## Water Resources

Because of the high solubility and mobility of the parent compound, and the high mobility and persistence of its sulfonamide and sulfonic acid degradates, both surface and ground water contamination are likely to occur.

A major issue associated with the ground water concern is the relative insensitivity of the analytical methods for soil and water and the inability to detect concentrations of concern. In the case of water, methods have been provided only for the parent, for which the Limit of Quantitation (LOQ) is 1.0 µg/L; the LOQ for parent and degradates in soil is 1.0 µg/kg soil.

## Drinking water

The modeling inputs for the Estimated Environmental Concentrations (EECs) to be used to estimate exposure from flucarbazone-sodium parent in drinking water are the same as those used to generate EECs for aquatic organisms (Table 4) and results are presented in Table 1. Because this is a new registration for this chemical, there are no monitoring data available. Concentration estimates for the parent alone were calculated.

Table 1a. EECs for flucarbazone-sodium parent for use in the human health risk assessment

| Crop | App Rate (lbs ai/acre) | GENEEC Peak EEC (ppb) | GENEEC 60 Day EEC (ppb) | SCIGROW concentration (ppb) |
|---|---|---|---|---|
| Spring wheat, durum wheat, and winter wheat | 0.027 (30 g ai/ha) | 1.42 | 1.25 | 0.02 |

In addition, EFED was requested to provide concentrations of total residues of flucarbazone-sodium and degradates containing the sulfonamide moiety.

Table 1b. EECs for total flucarbazone-sodium residues for use in the human health risk assessment

| Crop | App Rate (lbs ai/acre) | GENEEC Peak EEC (ppb) | GENEEC 60 Day EEC (ppb) | Estimated concentration in soil pore water (ppb) |
|---|---|---|---|---|
| Spring wheat, durum wheat, and winter wheat | 0.027 (30 g ai/ha) | 1.45 | 1.44 | 50 |

## II. INTRODUCTION

### A. Use Characterization

Flucarbazone-sodium (4,5-dihydro-3-methoxy-4-methyl-5-oxo-N-[2-[(trifluoromethoxy)phenyl] sulfonyl] -1H-1,2,4-triazole-1-carboxamide; CAS # 181274-17-9 ) is a sulfonyl urea / sulfonylaminocarbonyltriazolinone postemergent herbicide proposed for use in spring wheat, durum wheat, and winter wheat. It is currently registered in Canada for use on spring wheat only.

### B. Target Pests

Table 2. Target weeds for flucarbazone-sodium on proposed new use sites.

| Weeds controlled | Weeds suppressed |
|---|---|
| Wild oats (*Avena fatus*) | Yellow foxtail (*Pennisetum glaucum*) |
| Green foxtail (*Setaria viridis*) | Ryegrass spp. (*Lolium spp.*) |

### C. Formulation Type

Flucarbazone-sodium is formulated as Everest™70%, a water dispersible granular herbicide, either as a dry granule (EPA Reg. No. 3125-LGL) or as a water dispersible packet (EPA Reg. No. 3125-LGU). It is labeled that it must be tank-mixed with a non-ionic surfactant (0.25% v/v), and it can be tank-mixed with a broadleaf weed herbicide and micronutrients, if needed. Tank mix partners are 2,4-D amine or ester, metsulfuron-methyl, bromoxynil, and MCPA ester or amine.

### D. Method, Rate, and Timing of Application

The proposed use is as a single ground spray application to wheat and weed species at the 1-leaf to 6 total leaves growth stage; the maximum application rate is 0.61 oz of the formulated product/acre, which is equivalent to 0.027 lb ai/acre.

## III. INTEGRATED ENVIRONMENTAL RISK CHARACTERIZATION

The use of flucarbazone-sodium poses a risk to non-target plants from runoff. Since this herbicide is to be applied only by ground equipment, flucarbazone-sodium drifting to nearby non-target plants does not presently approach a level of concern. However, if the use of aerial application is to be granted for flucarbazone-sodium at a future date, non-target plants nearby and afar may be at risk.

Although the proposed label restricts use of flucarbazone-sodium to ground application, its use on winter wheat, spring wheat, and durum wheat could contaminate surface water due to spray drift from treated areas after application. Flucarbazone-sodium is soluble, mobile, and resistant to hydrolysis and photodegradation on soil; laboratory aerobic soil metabolism half-lives are greater than 2 months at 20°C. Data from laboratory studies indicate that the flucarbazone-sodium sulfonamide and sulfonic acid degradates are also mobile and resistant to microbial metabolism. In terrestrial field dissipation studies, the sulfonamide degradate has been found at greater than the LOQ at more than a year postapplication, suggesting the likelihood of accumulation of flucarbazone-sodium residues with repeated applications.

Environmental fate data indicate that flucarbazone-sodium can be readily transported in runoff. As stated above, flucarbazone-sodium residues are mobile and resistant to hydrolysis and photodegradation on soil, as well as being persistent. Photodegradation of any flucarbazone-sodium residues reaching natural waters could occur slowly in the surface layer (laboratory half-life of 40 days), but no data are available to estimate its persistence in deeper, aerobic water layers. Data suggest that degradation in anaerobic waters will occur slowly, with a half-life comparable to that in aerobic soil.

Endangered and threatened plant species growing near wheat fields may be affected by the use of flucarbazone-sodium applied at labeled rates from runoff and spray drift. Although some wheat-growing areas are arid and runoff may not often occur, this will not negate the potential risk to endangered plant species since a one-in-10-year runoff scenario may affect these species.

Because the proposed use of flucarbazone-sodium is for all types of wheat, and wheat is widely grown throughout the U.S., use of this chemical may impact many endangered plant species. A listing of the plant species can be provided at a later time.

The following issues create uncertainty in the assessment of risk posed by this chemical:

1. The Agency does not have acceptable data on the metabolism of flucarbazone-sodium in aerobic water/sediment systems. Supplemental data provided on its persistence in pond water in the absence of sediment showed that greater than 75% of the parent remained unchanged after a year of incubation. In determining EECs for assessing risk to aquatic plants, in accordance with current EFED guidance, the GENEEC input for the aerobic aquatic half-life was estimated by assuming it was twice that of the aerobic soil half-life. If flucarbazone-sodium is indeed resistant to metabolism in aerobic water/sediment systems, EECs would be underestimated.

2. A major issue associated with the ground water concern is the relative insensitivity of the analytical methods for soil and water and the inability to detect concentrations of concern. In the case of water, methods have been provided only for the parent, for which the Limit of Quantitation (LOQ) is 1.0 µg/L; the LOQ for parent and degradates in soil is 1.0 µg/kg soil. Based on reported analytical results from all five terrestrial field dissipation studies, both parent and degradates apparently leached through the soil. However, because a limit of detection was not provided, it is not possible to estimate the amount of flucarbazone-sodium that could reach vulnerable ground water.

3. Flucarbazone-sodium is a member of the sulfonylurea class of herbicides whose mode of action in plants is inhibition of amino acid synthesis. EFED is concerned about sulfonylurea herbicides having an adverse reproductive effect on non-target plants at levels several orders of magnitudes below the labeled rates of application. Currently, EPA does not have data on flucarbazone-sodium to assess the reproductive impact of this chemical.

4. The laboratory and field persistence data (half-lives no greater than 2 months) plus the Risk Quotient (5.9 for 1:1 acre runoff to adjacent field) suggest that flucarbazone-sodium should persist for no more than about 5-6 months at phytotoxic levels in the field. Yet the label indicates that oats, lentils and mustard crops should not be planted the following year after application of flucarbazone-sodium due to phytotoxicity concerns. Therefore, there is reason to believe that a degradate of flucarbazone-sodium may be phytotoxic. The Agency currently does not have terrestrial plant phytoxicity data on the degradates of flucarbazone-sodium.

5. The Agency does have phytotoxicity data from the sulfonamide degradate on duckweed, which is an aquatic weed. The data shows some phytotoxicity (4.85 ppm ai) but the degradate is not as phytotoxic as the parent (12.3 ppb ai). Although the degradate has much less phytotoxicity than the parent, EFED can not rule out the possibility that the phytotoxicity of the degradate would be comparable to that of the parent when terrestrial plants are tested. Therefore, EFED will continue to request phytotoxicity testing of the degradate on terrestrial plants; plants tested should include lentils and mustard, as well as oats and buckwheat.

## IV. ENVIRONMENTAL FATE ASSESSMENT

### A. Chemical Profile

| | |
|---|---|
| Common Name: | Flucarbazone-sodium |
| Trade Names: | Everest™ |
| Manufacturer's Code Numbers: | EPA Est. 3125-MO-1 |
| Chemical Name: | Flucarbazone-sodium |
| IUPAC Name: | 4,5-dihydro-3-methoxy-4-methyl-5-oxo-N-[2-[(trifluoromethoxy)phenyl] sulfonyl] -1H-1,2,4-triazole-1-carboxamide |
| CAS Number: | 181274-17-9 |
| Chemical Class: | Sulfonyl urea / sulfonylaminocarbonyltriazolinone |
| Mode of Action: | ALS inhibition |
| Formulation: | |
| | Active Ingredient: 70% |
| | Inert Ingredients: 30% |
| Molecular weight: | 418.3 g/mol |
| Aqueous solubility: | 30 g/L @ pH 5 (30000 ppm) |
| | 35 g/L @ pH 6 (35000 ppm) |
| | 50 g/L @ pH 7 (50,000 ppm) |
| Vapor pressure: | 7.5 x $10^{-12}$ mm Hg; < $10^{-9}$ Pa (20°C) |
| Henry's Law constant: | < 1.4× $10^{-16}$ atm. $m^3$/mol (calculated) |
| Octanol/Water Partition Coefficient: | log $K_{ow}$ = 2.29 (pH 2); 0.16 (pH 7.5) |
| Dissociation constant: | pKa of acid: 3.0 (1.9 from 44848903) |

### B. Persistence

The primary mechanism for degradation of flucarbazone-sodium in the laboratory is microbial metabolism in soil. Flucarbazone-sodium is a disubstituted sulfonyl urea, with one substituent being a trifluoromethoxy-phenyl ring, and the other being an H-1,2,4-triazole ring. The initial transformation step is microbially mediated hydrolysis of the urea moiety, followed by further metabolism of the resulting substituent moieties. The trifluoromethoxy-phenyl moiety is more persistent than the triazole moiety, and it is not incorporated into unextractable residues to as great an extent as is the triazole moiety. The immediate products of the hydrolysis of the urea are N,O-dimethyltriazolinone (NODT) and trifluoromethoxybenzene sulfonamide. NODT then degrades to N-methyltriazolinone (NMT); NMT then becomes incorporated into the unextractable residues in the soil or is metabolized to $CO_2$. The sulfonamide transforms slowly to the sulfonic acid, which also degrades slowly; very little of this moiety is metabolized to $CO_2$. Another pathway is the hydrolysis of the methoxy side group on the triazole ring of the parent; the degradate formed is O-desmethyl flucarbazone-sodium, which rapidly hydrolyzes to NMT.

Aerobic metabolism half-lives at 20°C in a North Dakota soil using separate labeling in the two rings are comparable, being 64 and 67 days. In comparison, flucarbazone-sodium degraded in a Canadian soil with an initial half-life of 76 days (the decline curve was biphasic with th einflection point being 61 days; the secondary half-life was 266 days). Half-lives in anaerobic sediment/water systems were 66 to 104 days, with the same degradates formed as under aerobic conditions. No data are available for flucarbazone-sodium degradation in aerobic sediment/water systems. Supplemental information on the behavior of flucarbazone-sodium from a non-guideline study conducted in aerobic natural waters in the absence of sediment would indicate that transformation is microbially mediated but very slow (half-lives > 1 year). Abiotic hydrolysis and photodegradation on soil do not contribute significantly to degradation of flucarbazone-sodium; however, flucarbazone-sodium degrades slowly (half-life approximately 70 days) if photosensitizers (such as dissolved organic matter) are present in natural waters. The major persistent degradate in all studies is the sulfonamide, which is apparently converted very slowly to the sulfonic acid. The degradate O-desmethyl flucarbazone-sodium may be formed in greater quantities, but it is not persistent and rapidly hydrolyzes to NMT .

The results of the field studies support the observations of the laboratory studies. In three terrestrial field dissipation studies conducted in Canada, flucarbazone-sodium applied to bare soil dissipated with half-lives of 9.5 to 15.5 days in the top 7.5 cm after June applications. However, the sulfonamide degradate was persistent in the surface layer (still present at greater than 1.0 µg/kg soil up to 500 days postttreatment), suggesting the likelihood of accumulation with repeated applications. In a terrestrial field dissipation study performed in North Dakota, when applied to 6" wheat in June, the half-life of flucarbazone-sodium in the top 3" was 22 days; the parent and the sulfonamide were still present at greater than the LOQ at 367 days postapplication. When applied to 4" wheat in April on a sandy Washington soil, the flucarbazone-sodium half-life was 8 days in the top 12" of the soil; by 6 months postapplication, parent was no longer detected, but the sulfonamide was still detected at less than the LOQ at 364 days postapplication.

### C. Mobility

In both batch equilibrium and column leaching studies, flucarbazone-sodium and its degradates (other than NMT, which was strongly sorbed) were mobile (adsorption $K_d$'s much less than 1 for the parent and adsorption $K_{oc}$'s for parent and degradates less than 50).

In the field studies, flucarbazone-sodium and its stable degradates were reported as not being present at greater than 1.0 µg/kg soil (the LOQ for the analytical method) >30 cm in the soil; rainfall was greater than or at the 30-year average. However, based on reported analytical results from all five terrestrial field dissipation studies, these residues were apparently detected at greater depths. However, a limit of detection was not provided, so it is not possible to determine the amount of flucarbazone-sodium that could reach vulnerable ground water.

### D. Bioaccumulation

The Agency does not have any bioaccumulation data for flucarabazone-sodium. However, the octanol-water partition coefficient ($K_{ow}$ ) can be used to estimate whether a chemical will tend to accumulate in the tissues of aquatic organisms, with higher values indicating a greater tendency. Within the range of environmental pHs, parent flucarbazone-sodium divides about equally between the two phases (log $K_{ow}$ = 0.16 at pH 7.5; 1.4x more in octanol than in water); for the sulfonamide degradate, the log $K_{ow}$ is 1.11 (measured value, roughly 13x more in octanol than in water). The degradates NMT and NDOT are expected to remain in the water phase (calculated $K_{ow}$s < 0). Guidance presented in the Pesticide Reregistration Rejection Rate Analysis for Environmental Fate (1993) indicates that a $K_{ow}$ of 1000 for a chemical would require that a bioaccumulation test be performed. Based on this information, neither flucarbazone-sodium nor its degradates are expected to bioaccumulate in aquatic organisms, and a bioaccumulation in fish study is not required.

### E. Volatilization

Volatilization is not expected to be a route of dissipation for flucarbazone-sodium in the environment. Flucarbazone-sodium has a very low vapor pressure ($7.5 \times 10^{-12}$ mm Hg; < $10^{-9}$ Pa) and a very low Henry's Law constant (< $1.4\times 10^{-16}$ atm. $m^3$/mol [calculated]). Based on this information, flucarbazone-sodium is essentially non-volatile, and any residues dissolved in water will show very little tendency to move to the air.

## V. AQUATIC EXPOSURE AND RISK ASSESSMENT

### A. Toxicity Summary

Flucarbazone-sodium is practically non- toxic to freshwater fish on an acute basis (96-hour $LC_{50}$'s >96.7 ppm). With chronic exposure, flucarbazone-sodium reduces fish growth at 2.75 ppm, with an NOAEC established at 1.25 ppm. Flucarbazone-sodium is practically non-toxic to freshwater invertebrates ($EC_{50}$ > 109 ppm). With chronic exposure, flucarbazone-sodium does not reduces reproduction of aquatic invertebrates at 115 ppm (NOAEC). Flucarbazone-sodium is toxic to aquatic vascular plants, (duckweed $EC_{50}$ = 12.3 ppb). It appears to be practically non-toxic to nonvascular aquatic plants (algae and diatoms) with $EC_{50}$ ranging from 5,570 ppb to 115,000 ppb.

Toxicity testing with degradation products of flucarbazone-sodium has not been conducted.

A detailed compilation of ecotoxicity data is provided in Appendix A.

### B. Aquatic Exposure Summary

The Tier I screening model GENEEC was used to generate EECs of flucarbazone-sodium in surface water resulting from application to wheat.

Table 3. GENEEC Inputs, Flucarbazone-sodium (parent only)

| Parameter | Input | Source/Rationale |
|---|---|---|
| Solubility (ppm) | 44000 | Product Chemistry data |
| Aerobic soil $t_{1/2}$ (days) | 76 | 90% upper-bound confidence limit of mean half-life of 64, 67, and 76 days (MRIDs 44848903, 44848904, and 44848905, respectively) |
| Aerobic aquatic $t_{1/2}$ (days) | 152 | No acceptable aerobic aquatic metabolism data were available. Therefore, since there were no data and the hydrolysis rate is stable, per current EFED guidance, use 2x aerobic soil metabolism half-life as input value. |
| Hydrolysis $t_{1/2}$ (days) | 0 | Compound is stable to hydrolysis (MRID 44848851) |
| $K_{oc}$ | 11 | Lowest non-sand $K_{oc}$ of 11 in Drummer silty clay loam (2.6 % OC; MRID 44848912) |
| Application rates (lb a.i./Acre) | 0.027 | Label - max. annual rate (wheat) |

Using the GENEEC model and available environmental fate data for flucarbazone-sodium, EFED calculated the following Tier 1 Estimated Environmental Concentrations (EECs) for residues of flucarbazone-sodium in surface water after application to wheat:

| | |
|---|---|
| Acute or peak EEC: | 1.42 µg/L |
| Chronic (21-day average) EECs: | 1.36 µg/L |
| Chronic (56-day average) EECs: | 1.25 µg/L |

## C. Quantitative Risk Assessment

### Freshwater Fish

Acute and chronic risk quotients were calculated for freshwater fish based on the acute and chronic toxicity of parent flucarbazone-sodium to the rainbow trout **(Table 4).**

**Table 4.** Acute and chronic risk quotients for freshwater fish from the use of flucarbazone-sodium at 0.027 lbs. ai/A.

| Use Site, Application Method | Species | $LC_{50}$ (ppb)[b] | NOAEC (ppb) | EEC[a] Peak (ppb) | EEC[a] 56-Day Ave. (ppm) | Acute RQ ($EEC/LC_{50}$) | Chronic RQ (EEC/NOAEC) |
|---|---|---|---|---|---|---|---|
| Wheat, ground application | rainbow trout | >96700 | 1250 | 1.42 | 1.25 | <0.1 | <1 |

[a] EECs from section B1.

[B] Toxicity value from Appendix A

The risk quotients for wheat do not exceed any aquatic acute or chronic levels of concern for freshwater fish. **Therefore, use of flucarbazone-sodium on wheat is not expected to pose any acute or chronic risk to freshwater fish at the proposed application rate of 0.027 lbs. ai/A.**

### Freshwater Invertebrates

Acute and chronic risk quotients were calculated separately for freshwater invertebrates based on the acute and chronic toxicity of flucarbazone-sodium to the waterflea (*Daphnia magna*).

**Table 5.** Acute and chronic risk quotients for freshwater invertebrates from the use of flucarbazone-sodium at 0.027 lbs. ai/A.

| Use Site, Application Method | Species | $EC_{50}$ (ppb) | NOAEC (ppb) | EEC[1] Peak (ppb) | EEC[1] 21-Day Ave. (ppb) | Acute RQ ($EEC/LC_{50}$) | Chronic RQ (EEC/NOAEC) |
|---|---|---|---|---|---|---|---|
| Crop, ground application | waterflea | >109,000 | >115,000 | 1.42 | 1.36 | <0.1 | <1 |

[1] EECs from section B.1
[2] Toxicity Values are from Appendix A

The acute and chronic risk quotients for wheat do not exceed any levels of concern for freshwater water invertebrates. **Therefore, use of flucarbazone-sodium on wheat is not expected to pose any acute or chronic risk to freshwater invertebrates at the proposed application rate of 0.027 lbs. ai/A.**

### Aquatic Plants

Non-target aquatic plant species may be exposed to pesticides from direct application, spray drift and/or runoff from treated areas. Risk quotients for non-endangered vascular and non-vascular aquatic plants, exposed to total flucarbazone-sodium residues, are shown in Table 6.

**Table 6.** Acute risk quotients for vascular and non-vascular aquatic plants (nonendangered species) exposed to runoff from the use of Flucarbazone-sodium at 0.027 lbs. a.i./A..

| Use Site, Application Method | Max. Use Rate (lb ai/A) | Species | $EC_{50}$ (ppb) | EEC[1] (ppb) | RQ ($EEC/EC_{50}$) |
|---|---|---|---|---|---|
| Wheat, ground application | 0.027 | Duckweed | 12.3 ppb | 1.42 | 0.11 |
| | | Algae or diatom | 2510 ppb | 1.42 | <1 |

[1] EECs from section B.2

**For wheat, risk quotients for flucarbazone-sodium do not exceed the level of concern for either non-endangered aquatic vascular or non-vascular plants.**

### D. Ecological Incidents Involving Aquatic Species

None has been reported.

### E. Threatened and Endangered Species

Threatened and endangered terrestrial plants may be affected from the labeled use of flucarbazone-sodium via runoff and spray drift.

Risk quotients do not approach the Agency's level of concern for Endangered species of aquatic invertebrates and fishes. Therefore, minimal risk is expected to endangered species of aquatic invertebrates and fish.

There are no known endangered or threatened non-vascular aquatic plants. Risk quotients for threatened and endangered vascular aquatic plants, exposed to total flucarbazone-sodium residues, are shown in **Table 7.**

**Table 7.** Acute risk quotients for vascular and non-vascular aquatic plants (endangered species) exposed to runoff from the use of Flucarbazone-sodium at 0.027 lbs. a.i./A.

| Use Site, Application Method | Max. Per Season Rate (lb AI/A) | Species | NOAEC[1] (ppb) | EEC[2] (ppb) | RQ (EEC/NOAEC) |
|---|---|---|---|---|---|
| Wheat, ground application | 0.027 | Duckweed (*Lemna gibba*) | 5.3 | 1.42 | 0.27 |

[1]Toxicity values are from Appendix A.
[2] EECs from section B.2

For wheat, risk quotients for flucarbazone-sodium do not exceed the level of concern for endangered aquatic vascular plants. **Therefore, use of flucarbazone-sodium on wheat is not expected to pose any risk to nontarget endangered aquatic plants.**

## VII. DRINKING WATER ASSESSMENT

### A. Surface Water EECs

Parent Flucarbazone-sodium:

Based on GENEEC modeling (see Table 3), the acute surface water expected environmental concentration (EEC) for flucarbazone-sodium parent only is 1.42 µg/L; the chronic surface water value for parent only for use in HED's drinking water assessment therefore is 1.25 µg/L.

Total Flucarbazone-sodium Residues:

In the animal enforcement analytical method, residues of the parent and all metabolites preceding the sulfonamide degradate are converted to the sulfonamide moiety before quantification. Because of this, EFED was requested to provide estimates of the exposure to the total residues of flucarbazone sodium containing the sulfonamide moiety. In order to do this, EFED summed the amounts of the parent and its sulfonamide degradate found in two aerobic soil metabolism studies (MRIDs 44848903 and 44848905) and estimated a first-order degradation half-life from these values. This resulted in calculated half-lives for total residues of greater than one-year. Therefore, the conservative assumption was that total residues were stable, and the input to GENEEC for the metabolism of flucarbazone was set to 0. No other input values were changed.

Based on the GENEEC screening model, the acute surface water expected environmental concentration (EEC) for total flucarbazone-sodium residues is 1.45 μg/L; the chronic surface water value for use in HED's drinking water assessment is 1.44 μg/L.

Limitations of this analysis:

There are certain limitations imposed when Tier I EEC's are used for drinking water exposure estimates. The single 10 hectare field with a 1 hectare pond used in the model does not reflect the dynamics in a watershed large enough to support a drinking water facility. A basin serving a drinking water facility would likely not be planted completely to a single crop nor be completely treated with a pesticide. Additionally, treatment with the pesticide would likely occur over several days or weeks, rather than all on a single day. This would reduce the magnitude of the concentration peaks, but also make them broader, reducing the acute exposure but perhaps increasing the chronic exposure. The fact that the simulated pond has no outlet is also a limitation as water bodies in this size range would have at least some flow through (rivers) or turnover (reservoirs). In spite of these limitations, a Tier I EEC can provide a reasonable upper bound on the concentration found in drinking water if not an accurate assessment of the true concentration. The EEC'S have been calculated so that in any given year, there is a 10% probability that the maximum average concentration of that duration in that year will equal or exceed the EEC at the site. Risk assessment using Tier I values can capably be used as refined screens to demonstrate that the risk is below the level of concern.

**B. Groundwater EECs**

Parent Flucarbazone-sodium:

The estimated ground water concentration for flucarbazone-sodium after application to wheat is 0.2 μg/L. This estimate was derived using the EFED model SCI-GROW, using the input values listed in Table 10 and assuming application at the maximum annual rate of 0.027 lb a.i. per acre.

Table 10. SCI-GROW input parameters[1]

| Parameter | Input | Source/Rationale |
|---|---|---|
| Aerobic soil $t_{1/2}$ (days) | 69 | Mean of 69 days from individual half-lives of 64, 67, and 76 days. MRIDs 44848903, 44848904, and 44848905, respectively. |
| $K_{oc}$ | 12 | Median value (of five) in Drummer silty clay loam (2.6 % OC). MRID 44848912 |
| Application rate (lb a.i./Acre) | 0.027 | Maximum permitted yearly application |

[1] Parameters were selected in accordance with the Proposed Interim Guidance for Input Values document, dated April 6, 2000.

Limitations of this analysis:

SCI-GROW provides a screening concentration or an estimate of likely ground water concentration if the pesticide is used at the maximum allowed label rate in areas with ground water that is exceptionally vulnerable to contamination. In most cases, a majority of the use area will have ground water that is less vulnerable to contamination than the areas used to derive the SCI-GROW estimate.

<u>Total Flucarbazone-sodium Residues</u>:

Because the degradates of flucarbazone sodium are resistant to aerobic metabolism in soil, their environmental characteristics lie outside the range of values from which SCI-GROW was developed. It was therefore not appropriate in this case to use SCI-GROW to estimate EECs for total residues of flucarbazone sodium. Instead, the concentration of total flucarbazone residues in soil porewater of the top 1-foot of soil immediately postapplication was estimated to be approximately 50 ppb.

Limitations of this analysis:

The EEC calculated above would be an upper limit to the amount of chemical that could be found in the soil porewater. Residues reaching ground water would be of lower concentration due to dispersion during leaching through the soil. However, repeated applications would result in accumulation over time.

### C. Drinking Water EEC Summary

**Groundwater**

<u>Acute and chronic estimated concentrations: parent only (SCI-GROW)</u>

@ 0.027 lb a.i./acre/yr: 0.2 µg/L (wheat)

Upper limit of total flucarbazone-sodium residues
in soil porewater of the top 1-foot of soil:

@ 0.027 lb a.i./acre/yr: 50 µg/L (wheat)

**Surface Water**

Acute and chronic estimated concentrations: parent only (GENEEC)

| | | |
|---|---|---|
| Acute | (0.027 lb a.i./acre/yr): | 1.42 µg/L (wheat) |
| Chronic | (0.027 lb a.i./acre/yr): | 1.25 µg/L (wheat) |

Acute and chronic estimated concentrations: total residues (GENEEC)

| | | |
|---|---|---|
| Acute | (0.027 lb a.i./acre/yr): | 1.45 µg/L (wheat) |
| Chronic | (0.027 lb a.i./acre/yr): | 1.44 µg/L (wheat) |

### D. Monitoring Data

Because it is a new chemical proposed for registration in the United States, flucarbazone-sodium is not one of the analytes in the Pesticides in Ground Water Database (EPA, 1992), which includes data from 1971 through 1991. No other monitoring information is available about flucarbazone-sodium residues in ground water or surface water.

## VII. TERRESTRIAL EXPOSURE AND RISK ASSESSMENT

### A. Toxicity Summary

On an acute and subacute dietary basis, Flucarbazone-sodium is practically non-toxic to birds (northern bobwhite $LD_{50}$ >2000 mg ai/kg-bw; $_{LC\ 50}$>4621 ppm). In addition, Flucarbazone-sodium is practically non-toxic to mammals (rat $LD_{50}$>5000 mg ai/kg-bw).

### B. Terrestrial Exposure Summary

The model of Hoerger and Kenega (1972), as modified by Fletcher *et al.* (1994) was used to estimate pesticide concentrations on selected avian or mammalian food items. This model predicts the maximum concentrations that may occur immediately following a direct application at 1 lb ai/A. For 1 lb ai/A applications, concentrations on short grass, tall grass, broadleaf plants, and fruits are predicted to be as high as 240, 110, 135, and 15 ppm, respectively. The predicted maximum concentration for broadleaf plants and fruits are used to represent maximum concentrations that may occur on small and large insects, respectively. Linear extrapolation is then used to estimate maximum terrestrial EEC's for single applications at other application rates.

**Table 11** shows the EEC on avian food items from a single application of Flucarbazone-sodium at 0.027 lbs. a.i./A..

**Table 11.** Expected Environmental Concentrations on Food Items for a Single Exposure To Terrestrial Wildlife.

| Site, Application Method | Application Rate (lbs ai/A) | Terrestrial EEC (ppm) | | | |
|---|---|---|---|---|---|
| | | Short Grass | Tall Grass | Broadleaf Plants & Small Insects | Fruit & Large Insects |
| Crop, application method | 0.027 | 6.48 | 2.97 | 3.6 | 0.4 |

## C. Quantitative Risk Assessment

Acute risk quotients for birds were calculated based on the results of the dietary toxicity tests with the northern bobwhite and mallard, both of which determined that the $LC_{50}$'s were greater than 4621 ppm ai. For all uses, acute risk quotients were very small (<0.01) for all types of wildlife food items. Therefore, risk to birds resulting from acute effects are predicted to be minimal **(Table 12).**

Minimal adverse effects are expected to avian reproduction because the NOAEC (223 ppm) is greater than the maximum possible exposure by a factor of greater than 30X.

**Table 12.** Acute risk quotients for birds from a single application of 0.027 lbs a.i./A.

| Site, Method of Application | Appl. Rate (lbs AI/A) | Wildlife Food Items | Maximum EEC (ppm) | $LC_{50}$ (ppm) | Acute RQ ($EEC/LC_{50}$) |
|---|---|---|---|---|---|
| Wheat,ground | 0.027 | Short grass | 6.48 | >4621 | <0.5 |
| | | Tall grass | 2.97 | >4621 | <0.5 |
| | | Broadleaf plants/Insects | 3.60 | >4621 | <0.5 |
| | | Seeds | 0.40 | >4621 | <0.5 |

## D. Exposure and Risk to Terrestrial Plants

The EFED does separate risk assessments for nontarget plants inhabiting terrestrial and semi-aquatic sites. Terrestrial sites are generally well drained sites. Semi-aquatic sites are low-lying areas that can be wet, although they may be dry during certain times of the year. Non-target plants inhabiting the terrestrial and semi-aquatic sites are exposed to pesticides from runoff, drift, and volatilization. These sites differ, however, in that terrestrial sites are assumed to be subjected to sheet runoff, whereas semi-aquatic sites are assumed to be subjected to channelized runoff.

The sheet runoff scenario assumes a 1-acre treated field and a 1-acre adjacent area in which non-target plants are exposed from sheet runoff. The channelized runoff scenario assumes a 10-acre treated field and a 1-acre adjacent, low-lying area where nontarget plants are growing. The EFED assumes that runoff will expose nontarget plants to a fixed percentage of the application rate. This percentage is estimated based on the water solubility of the active ingredient (World Wildlife Fund, 1992):

| Water Solubility | % Runoff Assumed |
|---|---|
| < 10 ppm | 1% |
| 10 - 100 ppm | 2% |
| > 100 ppm | 5% |

Since the solubility of flucarbazone-sodium is 44,000 ppm and the herbicide was not incorporated into the soil, the percent runoff for exposure to plants is assumed to be 5% of the amount applied.

Exposure from spray drift was assumed to be 1% and 5% of the application rate for ground and aerial applications, respectively. Exposure from spray drift is compared to toxicity observed in the vegetative vigor test to assess risk from foliage exposure. Spray drift exposure is also added to runoff exposure, and the total loading to soil in nontarget areas is compared to toxicity results of the seedling emergence test to assess risk from soil exposure. The following table gives estimated exposure values for spray drift and total loading to nontarget soils.

**Table 13:** Estimated Environmental Concentrations (EECs) in lb a.i./A For Well Drained and Semi-Aquatic Areas for a Single Application of Flucarbazone-sodium.

| Site/ Application Method and Rate in lb a.i./A | Minimum Incorp. Depth (cm) | Runoff Value[1] | Sheet Runoff (lb a.i./A)[2] | Channelized Runoff (lb a.i./A)[3] | Drift (lb a.i./A)[4] | Total Loading to Adjacent Area (lb a.i./A)[5] | Total Loading to Semi-aquatic Area (lb a.i./A)[6] |
|---|---|---|---|---|---|---|---|
| Wheat/ Unincorp ground/0.027 | 0 | 0.05 | 0.0013 | 0.013 | 0.0003 | 0.0016 | 0.0133 |

[1] Based on a water solubility of greater than 100 ppm.
[2] Application rate x runoff value for unincorporated applications
[3] Sheet runoff x 10 (Runoff from 10 treated acres flow into a distant low-lying acre.)
[4] 1% of application rate for ground
[5] Sheet runoff + drift
[6] Channelized runoff + drift

The $EC_{25}$ value of the most sensitive crop species (i.e. canola) in the seedling emergence study is compared to runoff exposure to determine the risk quotient (EEC/toxicity value). The $EC_{25}$ value of the most sensitive species in the vegetative vigor study (i.e., onions) is compared to the drift exposure to determine the acute risk quotient. EECs and acute high risk quotients for non-target plants in terrestrial and semi-aquatic areas based on a single application are tabulated in **Table 14.**

**Table 14.** Acute High Risk Quotients from a Single Application for Terrestrial Plants in Dry and Semi-Aquatic Areas Based On a Canola Seedling Emergence Dry Weight $EC_{25}$ of 0.00027 lb a.i./A and a Onion Vegetative Vigor Dry Weight $EC_{25}$ of 0.00034 lb a.i./A.

| Site, Method and Rate of Application (lb a.i./A) | Seedling Emerg. $EC_{25}$ (lb a.i./A) | Vegetat. Vigor $EC_{25}$ (lb a.i./A) | EEC: Drift (lb a.i./A) | EEC: Total Loading to Adjacent Area (Sheet Runoff + Drift) | EEC: Total Loading to Semi-aquatic Area (Channelized Runoff + Drift) | RQ: Runoff to Dry Area (Emerg.)[1] | RQ: Runoff to Semi-aquatic Area (Emerg.)[2] | RQ: Drift to Both Areas (Veget. Vigor)[3] |
|---|---|---|---|---|---|---|---|---|
| Wheat/ Unincorp. Ground/ 0.027 | 0.00027 | 0.00034 | 0.0003 | 0.0016 | 0.0133 | 5. 9 | 4 9.0 | 0.9 |

[1] Sheet runoff + drift ÷ seedling emergence $EC_{25}$
[2] Channelized runoff + drift ÷ seedling emergence $EC_{25}$
[3] Drift ÷ vegetative vigor $EC_{25}$

The terrestrial plant RQ for run-off to well-drained areas is 5.9 while the RQ for terrestrial plants in semi-aquatic areas, exposed to channelized run-off and drift, is 49 . These RQs indicate that LOCs for seedling emergence are exceeded at proposed single application rates equal to or above 0.027 lbs a.i./A.. RQs, based on drift, to both dry and semi-aquatic areas is 0.88 and indicate that LOC for vegetative vigor are not exceeded at a proposed single application rate of 0.027 lbs. a.i./A. **In conclusion, ground applications of flucarbazone-sodium on wheat poses risk to nearby nontarget terrestrial plants due to exposure from runoff.**

Currently, EFED does not perform chronic risk assessments for terrestrial plants.

<u>Calculations of Phytotoxic Limits in Water Resources</u>

The following calculation was used to estimate the ground water or surface water concentration in overhead irrigation water that would result in sufficient exposure to cause adverse effects on non-target plants (vegetative vigor $EC_{25}$ value):

62.36 lb water/ft$^3$ x 43,560 ft$^2$/acre x 0.167 ft depth (two inches) =
453,639 lb water irrigated/acre

The above calculation assumes that two inches of irrigation water are used. The amount of water required to irrigate an acre with two inches of water is 453,639 lbs.

Assuming the vegetative vigor $EC_{25}$ is 0.00036 lb ai/A, the concentration of flucarbazone-sodium in two inches of irrigation water required to deliver this $EC_{25}$ dose is:

[(0.00036 lb ai/A) / 453,639 lb water/A] x $10^9$ ppb= **0.792 ppb (792 ppt)**

It is likely that surface water contamination (about 1.42 ppb) from the flucarbazone-sodium will exceed the level of concern (792 ppt).

**The current analytical method has a level of quantification of 1.0 ppb. The sensitivity of the analytical method must include the phytotoxic level of concern for irrigation water (0.792 ppb) in order to identify the presence of flucarbazone-sodium when damage to nontarget plants has occurred. Phytotoxicity damage can occur at concentrations undetectable in irrigation water by current methods. This is unacceptable. The level of detection must be established at several times below the level of quantification (0.792 ppb).**

**E. Insects**

Flucarbazone-sodium is considered to be practically non-toxic to honey bees (LD>200 µg/bee.

**F. Ecological Incidents Involving Terrestrial Species**

No incidents have been reported.

**G. Threatened and Endangered Terrestrial Species**

Use of flucarbazone-sodium on wheat is expected to pose a risk to threatened or endangered species of terrestrial plants near wheat fields. The registrant has a responsibility to protect threatened or endangered plant species from exposure to flucarbazone-sodium. A list of protected species will be forth coming at a later date.

One option for the registrant to help protect threatened or endangered species of plants is to join an industry/EPA task force on endangered species protection. This will fulfill part of the registrant's responsibility for protecting the plant species.

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## Appendix A

## Ecotoxicity Data

### 1. Toxicity to Terrestrial Animals

#### a. Birds, Acute and Subacute

Table A1 summarizes acute and subacute dietary testing of the toxicity of flucarbazone-sodium to birds. These studies indicate that flucarbazone-sodium is practically nontoxic to birds on an acute oral basis, and slightly toxic to practically nontoxic to birds on a subacute dietary basis. The test guidelines 71-1 and 71-2 have been fulfilled.

Table A1. Acute Oral Toxicity to Birds

| Species | Study Type | % ai | $LD_{50}$ (mg/kg) or $LC_{50}$ (ppm) | Toxicity Category | MRID No. Author/Year | Study Classification[1] |
|---|---|---|---|---|---|---|
| Northern bobwhite *(Colinus virginianus)* | Acute oral | 98.9 | $LD_{50}$>2000 | Practically nontoxic | 448489-39 Toll, 1995 | Core |
| Northern bobwhite *(Colinus virginianus)* | Subacute dietary | 97.5 | $LC_{50}$>4646 | Slightly toxic to practically nontoxic | 448489-41 Handcock, 1998 | Core |
| Northern bobwhite *(Colinus virginianus)* | Subacute dietary | 98.9 | $LC_{50}$>4621 | Slightly toxic to practically nontoxic | 448489-40 Handcock, 1997 | Core |
| Mallard *(Anas platyrhynchos)* | Subacute dietary | 97.7 | $LC_{50}$>4969 | Practically nontoxic | 448489-43 Handcock, 1998 | Core |
| Mallard *(Anas platyrhynchos)* | Subacute dietary | 98.9 | LC>4969 | Practically nontoxic | 448489-42 Handcock, 1997 | Core |

[1] Core (study satisfies guideline). Supplemental (study is scientifically sound, but does not satisfy guideline)

#### b. Birds, Chronic

Table A2 summarizes testing of reproductive toxicity of flucarbazone-sodium to birds. These studies indicate that flucarbazone-sodium affects mallards between 223 and 1121 ppm ai (LOAEC). The test guideline 71-4 is fulfilled.

Table A2. Reproductive Toxicity to Birds

| Species | % ai | NOAEC (ppm ai) | Endpoints Affected | MRID No. Author/Year | Study Classification[1] |
|---|---|---|---|---|---|
| Northern bobwhite *(Colinus virginianus)* | 98.9 | 1311 | none | 448489-45 Hancock, 1998 | Core |
| Mallard *(Anas platyrhynchos)* | 98.9 | 223 | Adult body weight, hatching of fertile eggs, and number of three-week embryos per pen. | 448489-44 Handcock, 1998 | Core |

[1] Core (study satisfies guideline). Supplemental (study is scientifically sound, but does not satisfy guideline)

Test guideline 71-4 is fulfilled.

### c. Mammals, Acute and Chronic

Wild mammal testing is required on a case-by-case basis, depending on the results of lower tier laboratory mammalian studies, intended use pattern and pertinent environmental fate characteristics. In most cases, rat or mouse toxicity values obtained from the Agency's Health Effects Division (HED) substitute for wild mammal testing. These toxicity values are reported in Table A3. These studies indicate that flucarbazone-sodium is practically non-toxic to small mammals on an acute oral basis and the reproductive NOAEL = 287 mg/kg-bw.

Table A3. Toxicity to Mammals

| Species | Study Type | % ai | Toxicity Value(s) | Affected Endpoints | MRID/Acc. No. |
|---|---|---|---|---|---|
| Rat (*Rattus norvegicus*) | Acute Oral | technical | $LD_{50}$ > 5000 mg/kg (M)<br>$LD_{50}$ > 5000 mg/kg (F) | none | 44848716 |
| Rat (*Rattus norvegicus*) | 2 year reproduction | technical | NOAEL = 287 mg/kg/day for males and 340 mg/kg/day for females | based on reduced pup weights, decreased liver weight in male pups, marbled liver, air filled stomach | 44848745, 44848746, 44848747 |

### d. Insects

A honey bee acute contact study was conducted using flucarbazone-sodium technical (98.2% ai). Flucarbazone-sodium did not cause any mortality or observed adverse effects when tested at concentrations as high as 200 μg/bee. The acute contact $LD_{50}$ is >200 μg/bee, classifying flucarbazone-sodium as practically nontoxic to the honey bee. This study is classified as core and fulfills the guideline requirement 141-1. (S. Schmitzer, 1998, MRID 448489-33)

## 2. Toxicity to Aquatic Animals

### a. Freshwater Fish and Invertebrates, Acute

Table A5 summarizes acute testing of the toxicity of flucarbazone-sodium to freshwater fish and aquatic invertebrates. These studies indicate that flucarbazone-sodium is practically nontoxic to freshwater fish and freshwater invertebrates on an acute basis. The test guidelines 72-1 and 72-2 have been fulfilled.

Table A5. Acute Toxicity to Freshwater Fish and Invertebrates

| Group (Test Species) | % ai | 96-hour $_{LC50}$ (ppm ai) | Toxicity Category | MRID No. Author/Year | Study Classification |
|---|---|---|---|---|---|
| Cold water fish (Rainbow trout, *Oncorhynchus mykiss*) | 98.9 | >96.7 | Practically nontoxic | 448489-36 Browers, 1995 | Core |
| Warm water fish (Bluegill sunfish, *Lepomis macrochirus*) | 98.9 | >99.3 | Practically nontoxic | 448489-37 Browers, 1995 | Core |
| Invertebrate (Waterflea, *Daphnia magna*) | 98.9 | >109 | Practically nontoxic | 448489-34 Browers, 1996 | Core |

## b. Freshwater Fish and Invertebrates, Chronic

Table A6 summarizes the testing of chronic toxicity of flucarbazone-sodium to freshwater fish and invertebrates. The fish early life stage study shows that flucarbazone-sodium is a teratogen to fish at concentrations of 2.75 mg ai/L and greater. The most common type of deformity observed was curvature of the spine (scoliosis and kyphoscoliosis), which occurred at concentrations of 6.01 mg ai/L and higher. A few cases of fish with missing or deformed eyes were observed at concentrations 2.75 mg ai/L and above. Fish with enlarged or divided yolk sacs were also observed at concentrations of 12.9 mg a.i./L and greater. There were no significant effects observed in percent hatching, fry survival or growth. Based on a study with the waterflea, the threshold concentration at which flucarbazone-sodium begins to cause observable adverse effects on the growth and reproduction of freshwater invertebrates is greater than 115 mg ai/L. The test guidelines (72-4a) and (72-4b) have been fulfilled (MRID 44848938 and 44848935).

Table A6. Early Life-Stage Toxicity to Freshwater Fish under Flow-through Conditions

| Group (Test Species) | % ai | NOAEC (ppm ai) | LOAEC (ppm ai) | Endpoints Affected | MRID No. Author/Year | Study Classification |
|---|---|---|---|---|---|---|
| Fish (Rainbow trout, *Oncorhynchus mykiss*) | 97.3 | 1.25 | 2.75 | Malformations (malformed eyes, curvature of the spine) | 448489-38 Hall, 1998 | Core |
| Invertebrate (Waterflea, *Daphnia magna*) | 98.9 | 115 | Not determined (>115) | None | 448489-35 Bowers, 1996 | Core |

## c. Estuarine and Marine Fish and Invertebrates, Acute

Acute toxicity testing with estuarine/marine fish and invertebrates using the TGAI is not required for flucarbazone-sodium because wheat is not a crop that is typically grown in areas where contamination of these environments can occur.

### 3. Toxicity to Plants

### i. Terrestrial Plants

Terrestrial plant testing (Tier II tests (GLN 123-1)) is required for flucarbazone-sodium because it is a herbicide. The required testing consists of seedling emergence and vegetative vigor tests with ten species. Six of the species must be dicotyledonous and represent at least four families. One of these species must be soybean (*Glycine max*) and a second must be a root crop. The remaining four species must be monocotyledonous and represent at least two families. One of these species must be corn (*Zea mays*).

Tier II tests measure the response of plants, relative to a control, at five or more test concentrations. Results of Tier II toxicity testing on the TEP material are tabulated below.

Table A7. Nontarget Terrestrial Plant Seedling Emergence Toxicity (Tier II)

| MRID No. Author/Year | % ai | Species | $EC_{25}$ ($10^{-5}$ lbs ai/A) | NOAEL ($10^{-5}$ lb ai/A) | Most Sensitive Endpoint* | Study Classification |
|---|---|---|---|---|---|---|
| 448489-29 Hancock and Hansen, 1998 | 67.8 | Monocot - Onion | 28 | 22 | Dry weight | Core |
| | | Monocot–Rye | 110 | 66 | Dry weight | Core |
| | | Monocot–Oat | 260 | 66 | Dry weight | Core |
| | | Monocot–Corn | 600 | 200 | Phytotoxicity rating | Core |
| | | Dicot–Sugar Beet | 72 | 66 | Dry weight | Core |
| | | Dicot–Canola | 76 | 22 | Dry weight | Core |
| | | Dicot–Flax | 170 | 66 | Dry weight | Core |
| | | Dicot–Sunflower | 470 | 66 | Phytotoxicity rating | Core |
| | | Dicot–Soybean | 1600 | 600 | Phytotoxicity rating | Core |
| | | Dicot–Buckwheat | 1600 | 600 | Phytotoxicity rating | Core |

* Based on the $EC_{25}$.

For Tier II seedling emergence, onion is the most sensitive monocot tested and the most sensitive species overall. Canola is the most sensitive sensitive dicot tested. The guideline (123-1) is fulfilled (MRID 44848929).

Table 8A. Nontarget Terrestrial Plant Vegetative Vigor Toxicity (Tier II)

| MRID No. Author/Year | % ai | Species | $EC_{25}$ ($10^{-5}$ lbs ai/A) | NOAEL ($10^{-5}$ lb ai/A) | Most Sensitive Endpoint* | Study Classification |
|---|---|---|---|---|---|---|
| 448489-29 Hancock and Hansen, 1998 | 67.8 | Monocot—Onion | 36 | 22 | Dry weight | Core |
| | | Monocot–Oat | 45 | 22 | Dry weight | Core |
| | | Monocot–Corn | 170 | 66 | Dry weight | Core |
| | | Monocot–Rye | 270 | 220 | Dry weight | Core |
| | | Dicot–Buckwheat | 45 | 22 | Dry weight and shoot height | Core |
| | | Dicot–Canola | 77 | 22 | Dry weight | Core |
| | | Dicot–Sugar beet | 210 | 66 | Dry weight | Core |
| | | Dicot–Sunflower | 290 | 66 | Dry weight | Core |
| | | Dicot–Soybean | 330 | 66 | Phytotoxicity rating | Core |
| | | Dicot–Flax | 620 | 200 | Shoot height | Core |

* Based on the $EC_{25}$.

For Tier II vegetative vigor, onion is the most sensitive monocot tested and the most sensitive test species overall. Buckwheat is the most sensitive dicot tested. The guideline (123-1) is fulfilled (MRID 448489-29).

These studies show that flucarbazone-sodium is toxic to plants at extremely low doses. For example, an application rate of 36 x $10^{-5}$ lb ai/A is predicted to cause 25% reduction in plant growth of the onion. This rate corresponds to a deposition rate of only 0.0036 µg of active ingredient per square centimeter of plant surface, or 0.36 g of active ingredient applied to a hectare of field. The phytotoxic potency of sodium flucarbazone-sodium is similar whether exposure occurs through the roots (as in the seedling emergence study) or through deposition on the foliage (as in the vegetative vigor study). The test species varied in sensitivity to flucarbazone-sodium by over an order of magnitude in both the seedling emergence and vegetative vigor studies. However, there is not a clear pattern to the selectivity of the phytotoxicity among terrestrial plants. Both monocotyledon and dicotyledon plants may be sensitive to this herbicide.

### 2. Aquatic Plants

The table below summarizes testing of acute toxicity of flucarbazone-sodium to aquatic plants and algae. The results indicate that this herbicide is more toxic to vascular aquatic plants than to algae and diatoms. Duckweed was the most sensitive test species, with an $EC_{50}$ and NOEAC of 12.3 ppb and 5.3 ppb, respectively.

Table A9. Toxicity to Aquatic Plants and Algae (Tier II)

| Groups (Test Species) | % ai | $EC_{50}$ (ppb ai) | NOAEC/ $EC_{05}$ (ppb ai) | MRID No. Author/Year | Study Classification |
|---|---|---|---|---|---|
| Vascular plants (Duckweed, *Lemna gibba)* | 100 | >4,850 | 4850 | 44845951 Hall, 1999 | supplemental |
| Vascular plants (Duckweed, *Lemna gibba)* | 97.3 | 12.3 | 5.3 | 44848950 Bowers, 1998 | Core |
| Green algae (*Kirchneria subcapitata*) | 98.9 | 5,570 | 2,510 | 44848946 Dobbs, 1996 | Core |
| Marine diatom (*Skeletonema costatum*) | 97.5 | >89,200 | 89,200 | 44848949 Bowers and Lam, 1998 | Core |
| Freshwater diatom (*Navicula pelliculosa*) | 97.7 | >115,000 | 115,000 | 44848948 Hall, 1998 | Core |
| Blue-green algae (*Anabaena flos-aquae*) | 97.5 | 13,300 | 5,430 | 44848947 Bowers, 1998 | Core |

Another acute toxicity study was conducted with the duckweed (*Lemna gibba*), a floating vascular aquatic plant, in which plants were exposed to flucarbazone-sodium via foliar deposition, simulating spray drift (MRID 448489-28). The study was conducted with the 70 WG formulation (68.0% a.i.) This study determined an $EC_{50}$ of 1.12 g ai/ha (100 x $10^{-5}$ lb/A) for effects on frond number and $EC_{50}$ of 1.76 g ai/ha (157 x $10^{-5}$ lb/A) for effects on frond dry weight. The NOAEC was determined to be 0.17 g ai/ha (15.2 x $10^{-5}$ lb ai/A) for frond number. The NOAEC was not established for effects on frond dry weight, but the $EC_5$ was determined to be 0.09 g ai/ha (8.04 x $10^{-5}$ lb ai/A). This study provides information that is useful for risk assessment, but it is not a test guideline requirement in the United States.

# Appendix B

## Environmental Fate Data

## Appendix C

## Ecological Incident List

NO ECOLOGICAL INCIDENTS WERE REPORTED

## Appendix D

### Detailed Risk Quotient Analysis

Risk characterization integrates exposure and ecotoxicity data to evaluate the likelihood of adverse effects. For ecological effects, the Agency accomplishes this integration using the quotient method. Risk quotients (RQs) are calculated by dividing exposure estimates by acute and chronic ecotoxicity values.

RQ = EXPOSURE / TOXICITY

RQs are then compared to the Office of Pesticide Programs's levels of concern (LOCs) to assess potential risk to nontarget organisms and the need to consider regulatory action. Calculation of a RQ that exceeds the LOC indicates that a particular pesticide use poses a presumed risk to nontarget organisms. LOCs currently address the following categories of presumed risk: (1) **acute high** -- potential for acute risk is high and regulatory action beyond restricted use classification may be warranted, (2) **acute restricted use** -- the potential for acute risk is high, but may be mitigated through restricted use classification, (3) **acute endangered species** - threatened and endangered species may be adversely affected, and (4) **chronic risk** - the potential for chronic risk is high and regulatory action may be warranted.

The ecotoxicity values used in the acute and chronic risk quotients are endpoints derived from required laboratory toxicity studies. Ecotoxicity endpoints derived from short-term laboratory studies that assess acute effects are: (1) $LC_{50}$ (fish and birds), (2) $LD_{50}$ (birds and mammals), (3) $EC_{50}$ (aquatic plants and aquatic invertebrates) and (4) $EC_{25}$ (terrestrial plants). The ecotoxicity endpoints derived from long-term laboratory studies that is used to assess chronic effects is the NOAEC. The table below gives formulas for calculating RQ's and gives LOC's for various risk presumptions.

| Risk Presumption | RQ | LOC |
|---|---|---|
| | Terrestrial and Aquatic Animals | |
| Acute High Risk | $EEC^1/LC_{50}$ | 0.5 |
| Acute Restricted Use | $EEC/LC_{50}$ | 0.2 |
| Acute Endangered Species | $EEC/LC_{50}$ | 0.1 |
| Chronic Risk | EEC/NOAEC | 1.0 |
| | Terrestrial and Semi-Aquatic Plants | |
| Acute High Risk | $EEC/EC_{25}$ | 1.0 |
| Acute Endangered Species | EEC/NOAEC or $EC_{05}$ | 1.0 |
| | Aquatic Plants | |
| Acute High Risk | $EEC/EC_{50}$ | 1.0 |
| Acute Endangered Species | EEC/NOAEC or $EC_{05}$ | 1.0 |

[1] abbreviation for Estimated Environmental Concentration