

US EPA ARCHIVE DOCUMENT

8/19/94

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY  
WASHINGTON, D.C. 20460

OFFICE OF  
PREVENTION, PESTICIDES AND  
TOXIC SUBSTANCES

**MEMORANDUM**

**SUBJECT:** EFED Recommendations and Mitigation Measures for Linuron

(Chemical # 035506) Case # 0047

**FROM:** Betsy Grim *Betsy Grim 8-19-94*  
Science Analysis and Coordination Staff  
Environmental Fate and Effects Division

**THRU:** *for* Evert K. Byington, Chief *Mary Frankenberg 8/19/94*  
Science Analysis & Coordination Staff,  
Environmental Fate and Effects Division

**TO:** Esther Saito, Acting, Chief  
Reregistration Branch,  
Special Review & Reregistration Division

**Use Profile**

Linuron is an herbicide used for both pre- and post-emergent control of a variety of annual grasses and broadleaf weeds. It is used on the following food/feed sites: asparagus, carrots, celery, field corn, sweet corn, cottonseed, parsley, parsnips, potatoes, sorghum, soybeans, and drill-planted winter wheat. Nonfood sites include non-agricultural rights-of-way/fencerows/hedgerows, non-agricultural uncultivated areas/soils, ornamental herbaceous plants, and poplar (forest/shelterbelt).

Maximum application rates range from 1.5 - 4.0 lbs a.i./A on the various food/feed crops. Maximum rates range from 1.5 - 3 lbs a.i./A for the nonfood sites. Formulation types include wettable powders, water dispersable granules (dry flowable), emulsifiable concentrates, and flowable concentrates. Ground sprays with boom sprayers appear to be a common application method (5/15/92 LUIS report). In addition, aerial application is currently permitted for Gemini products (EPA Reg Nos. 352-443 and 352-544).

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## Levels of Concern Exceedances

### Ecological Effects

1. **Concern for Birds.** The Level of Concern (LOC) for the avian restricted use category is exceeded on short grass at the 3 and 4 lbs a.i./A rates. LOCs are exceeded for the avian endangered species category. Avian chronic LOCs are exceeded for all rates evaluated.

2. **Concern for Mammals.** LOCs are exceeded for the mammalian high acute, restricted use, endangered species, and chronic effects categories for all rates evaluated when using the least shrew as a representative species. LOCs are not exceeded when determinations are made using the rat.

3. **Concern for Fish.** LOCs are exceeded for the fish restricted use and endangered species categories with the rights-of-way (ROW) use, based on determinations made on runoff to a wetland area. Direct application to a wetland area would result in exceedance of all LOC categories. Determinations made using a 4 lbs a.i./A crop rate with a pond model exceeds the endangered species LOC. Fish chronic effects cannot be fully evaluated since a NOEL was not determined. Known effect levels would be exceeded for the ROW use and the 4 lbs a.i./A crop rate.

4. **Concern for Aquatic Invertebrates.** LOCs are exceeded for aquatic invertebrate high risk, restricted use, and endangered species categories for the ROW use (based on determinations made for both runoff and direct application to wetlands). The restricted use and endangered species LOCs are exceeded at all other sites and rates evaluated (pond model). Chronic effects cannot be evaluated at this time due to inconsistencies between acute and chronic testing.

5. **Concern for Plants.** Risk to terrestrial plants cannot be assessed due to the lack of adequate data. High risk is likely, based on the herbicidal properties of linuron. High risk and endangered plant LOCs are exceeded for aquatic plants with the ROW use, based on the one available  $EC_{50}$ . When the data base is complete, further uses may exceed LOCs.

### Endangered Species

LOCs for endangered species are exceeded in some instances for acute effects to birds, wild mammals, aquatic organisms and nontarget plants.

Endangered species LOCs are exceeded for chronic effects to birds, wild mammals, and aquatic organisms.

### **Ground Water**

**Ground-water quality.** Linuron has been detected in ground water in Georgia, Missouri, Virginia, and Wisconsin. Considering the widespread use of linuron and its environmental fate characteristics, EFED is concerned about the degradation of water quality that might occur in linuron use areas.

**Human health.** Linuron residues have been detected in ground water at levels which approach the estimated lifetime Health Advisory. To date, no information is available about the degradates in ground water, but additional information on the persistence and mobility of the degradates has been requested in this document. If the toxicity of the three degradates is similar to the parent, the combined concentrations of parent linuron and its degradates in ground water may exceed the levels of concern for human health.

### **Surface Water**

Linuron is not currently regulated under the Safe Drinking Water Act (SDWA). Therefore, a MCL (Maximum Contaminant Level) and HA (Health Advisory) have not been established and water supply systems have not been required to sample and analyze for linuron. However, EFED has estimated a relatively low lifetime health advisory for linuron of 6.0 ug/L. Although the available data suggest that the average annual linuron concentration will generally be well below 6 ug/L, these data do not necessarily include sampling from watersheds that drain high linuron use areas. The relatively low to intermediate soil to water partitioning of linuron indicates that the primary treatment processes employed by most water supply systems to remove suspended sediment may not always be completely effective in removing linuron. Consequently, EFED does have some moderate concerns over potential risks of linuron to surface water source supply systems.

### **Risk Reduction Measures**

#### Risk Reduction Measures to mitigate ecotoxicological concerns

1. Reduce Maximum Application Rate. A maximum application rate of 0.1 lb a.i./A, with use limited to a single application, would appear to get below currently known LOCs based on available acute and chronic data (e.g., not including fish chronic endpoint where a NOEL is not available). A variety of

additional data, including additional plant studies and chronic aquatic studies, are required to complete a risk assessment.

2. Prohibit aerial application. Available information indicates that aerial application to soybeans is permitted according to the Gemini labels (EPA Reg. Nos. 352-443 and 352-544). Prohibiting this aerial application would reduce the potential for drift to nontarget plants and water bodies. EFED would still need the above data to assess effects.

#### Risk Reduction Measures to mitigate ground water concerns

Because linuron exceeds certain Levels of Concern for groundwater, EFED recommends the following:

1. Linuron has been detected in ground water. Therefore, all product labels should carry the following advisory:

"This chemical is known to leach through soil into ground water under certain conditions as a result of agricultural use. Use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in ground-water contamination."

2. EFED recommends that prospective ground-water monitoring studies be conducted for linuron. In order to determine the potential of this chemical to leach to ground water, an adequate number of studies should be conducted to characterize linuron use. Study areas should include those with coarse-textured soils low in organic matter, and those more representative of typical linuron use areas.

3. Linuron meets the persistence and mobility triggers for possible classification as a restricted use chemical under the proposed "Restricted Use" rule for ground-water concerns. EFED recommends that linuron be considered for classification as a restricted use chemical based on ground-water concerns.

4. Linuron has been detected in ground water up to 80 percent of the estimated Health Advisory as a result of normal agricultural use. The registrant should determine the areas that are vulnerable to ground-water contamination by linuron, and recommend label restrictions.

5. The registrant and EPA will agree, as a condition of reregistration eligibility, to establish criteria for additional mitigation, suspension, and voluntary cancellation as a consequence of monitoring study results.

### **Additional label restrictions recommended for ground water**

Linuron has been detected in ground water as a result of normal agricultural use. Therefore EFED recommends that the registrant should determine the areas that are vulnerable to ground-water contamination by linuron, and recommend label restrictions.

### **Risk Reduction Measures to mitigate surface water concerns**

As a precaution for protecting human health, EFED recommends that reregistration of linuron be contingent upon the registrants agreeing to fund limited monitoring programs for linuron in surface source water supply systems which drain watersheds which typically receive high linuron applications. The funding could possibly include or completely consist of reimbursement of selected water supply systems for including linuron in the analyses of samples collected in compliance with the requirements of the SDWA. The numbers and locations of the systems for which monitoring would be funded can be negotiated as well as the duration of the monitoring programs.

EFED recommends the following label restriction based on surface water concerns:

"Linuron can contaminate surface water through spray drift from ground spraying. Under some conditions, linuron may also have a high potential for runoff into surface water (via both dissolution in runoff water and adsorption to eroding soil), for several weeks post-application. These include poorly draining or wet soils with readily visible slopes toward adjacent surface waters, frequently flooded areas, areas over-laying extremely shallow ground water, areas with in-field canals or ditches that drain to surface water, areas not separated from adjacent surface waters with vegetated filter strips, and highly erodible soils cultivated using poor agricultural practices such as conventional tillage and down the slope plowing."

### **Risk Reduction Measure to Mitigate Spray Drift Concerns**

For products that are aerially applied the following labeling should be on the product:

## Label Language

### **Aerial Spray Drift Management**

#### **SPRAY DRIFT MANAGEMENT**

##### **AVOIDING SPRAY DRIFT IS THE RESPONSIBILITY OF THE APPLICATOR.**

The interaction of many equipment-and-weather-related factors determine the potential for spray drift. The applicator is responsible for considering all these factors when making decisions.

The following drift management requirements must be followed to avoid off-target movement from aerial applications to agricultural crops:

1. Do not apply when gusts or sustained winds exceed 15 mph.
2. The boom length must not exceed 3-4 of the wing or rotor length (i.e. The distance of the outer most nozzles on the boom must not exceed 3.4 the length of the wingspan or rotor).
3. Do not apply at a height greater than 10 feet above the top of the target plants unless a greater height is required for aircraft safety.
4. Nozzles must always point backward and never be pointed downwards more than 45 degrees.
5. Do not apply during a temperature inversion.

For additional information on preventing drift, refer to the Aerial Drift Reduction Advisory Information.

#### Aerial Drift Reduction Advisory Information

##### **INFORMATION ON DROPLET SIZE**

The most effective way to reduce drift potential is to apply large droplets. The best drift management strategy is to apply the largest droplets that provide sufficient coverage and control. Applying larger droplets reduces drift potential, but will not prevent drift if applications are made improperly, or under unfavorable environmental conditions (See Wind, Temperature and Humidity, and Temperature Inversions).

## **CONTROLLING DROPLET SIZE**

- o Volume - Use high flow rate nozzles to apply the highest practical spray volume. Nozzles with higher rated flows produce larger droplets.
- o Pressure - Do not exceed the nozzle manufacturer's recommended pressures. For many nozzle types lower pressure produces larger droplets. When higher flow rates are needed, use higher flow rate nozzles instead of increasing pressure.
- o Number of nozzles - Use the minimum number of nozzles that provide uniform coverage.
- o Nozzle Orientation - Orienting nozzles so that the spray is released parallel to the airstream produces larger droplets than other orientations and is the recommended practice.
- o Nozzle Type - Use a nozzle type that is designed for the intended application. With most nozzle types, narrower spray angles produce larger droplets. Consider using low-drift nozzles. Solid stream nozzles oriented straight back produce the largest droplets and the lowest drift.
- o Boom length - For some use patterns, reducing the effective boom length to less than 3/4 of the wingspan or rotor length may further reduce drift without reducing swath width.

## **APPLICATION HEIGHT**

Making applications at the lowest height that is safe reduces exposure of droplets to evaporation and wind.

## **SWATH ADJUSTMENT**

When applications are made with a crosswind, the swath will be displaced downwind. Therefore, on the up and downwind edges of the field, the applicator must compensate for this displacement by adjusting the path of the aircraft upwind. Swath adjustment distance should increase, with increasing drift potential (higher win, smaller drops, etc.).

## **WIND**

Drift potential is lowest between winds speeds of 3 - 10 mph. However, many factors, including droplet size and equipment type determine drift potential at any given speed. Application should be avoided below 3 mph due to variable wind direction and high inversion potential. NOTE: Local terrain can influence wind patterns. Every applicator should be familiar with local wind patterns and how they affect spray drift.

## **TEMPERATURE AND HUMIDITY**

When making applications in low relative humidity, set up equipment to produce larger droplets to compensate for evaporation. Droplet evaporation is most severe when conditions are both hot and dry.

## **TEMPERATURE INVERSIONS**

Applications must not occur during a temperature inversion because drift potential is high. Temperature inversions restrict vertical air mixing, which causes small suspended droplets to remain in a concentrated cloud. This cloud can move in unpredictable directions due to the light variable winds common during inversions. Temperature inversions are characterized by increasing temperatures with altitude and are common on nights with limited cloud cover and light to no wind. They begin to form as the sun sets and often continue into the morning. Their presence can be indicated by ground fog; however, if fog is not present, inversions can also be identified by the movement of smoke from a ground source or an aircraft smoke generator. Smoke that layers and moves laterally in a concentrated cloud (under low wind conditions) indicates an inversion, while smoke that moves upward and rapidly dissipates indicates good vertical air mixing.

## **SENSITIVE AREAS**

The pesticide should only be applied when the wind is blowing away from adjacent sensitive areas (e.g. residential areas, bodies of water, known habitat for threatened or endangered species, non-target crops).

### **Value of the Additional Information**

**Environmental Fate.** The environmental data base for only the parent linuron is essentially complete. Information on the persistence, mobility and dissipation pathways of several primary degradates of linuron is not currently available; therefore the environmental fate assessment must be considered incomplete and tentative. At this time, two data requirements in the environmental fate guidelines are not fulfilled for linuron: Leaching/adsorption/desorption(163-1) and Terrestrial field dissipation (164-1). In addition to the above two data requirements that are unfulfilled, EFED recommends that prospective ground-water monitoring studies (166-1) be conducted to determine the environmental fate of linuron in both vulnerable and representative use conditions.

#### **o 163-1 Leaching/adsorption/desorption**

This study did not satisfy the data requirements because information on the mobility of the major linuron degradates formed under anaerobic conditions (desmethoxy linuron, desmethoxy monolinuron, norlinuron) is not currently available. The additional

data required will be used to assess the mobility of the primary degradates of linuron and may be applied to complete computer simulation modeling for the fate and transport of the primary degradates.

o 164-1 Terrestrial field dissipation

Additional data required for the terrestrial field dissipation studies are necessary to assess the rates and pathways of dissipation of parent linuron and its primary degradates. Two studies were reviewed; MRID# 41734201, 41734202 and provided partially acceptable or supplemental information on the field dissipation of linuron in California and Delaware. The data requirement is not fulfilled because the patterns of formation and decline of total linuron residues could not be assessed and field test procedures and analytical methodology were not completely described. The California study may be upgradable if additional information on study methods and early soil sample results can be provided; however, the Delaware study can not be upgraded because the consistent presence of linuron in the control plot confounds accurate assessment of the pattern of formation and decline of total linuron residues. A new study is needed to satisfy the data requirement.

o Additional requirements

In addition to the above two data requirements that are unfulfilled, EFED recommends that prospective ground-water monitoring studies (166-1) be conducted to determine the environmental fate of linuron in both vulnerable and representative use conditions. Information obtained from the environmental fate studies indicates the potential for linuron to leach to ground water is limited by sorption and microbial degradation. Increased mobility of linuron may occur under specific environmental 2 conditions.

**Ecological Effects.**

GDLN NO.	TYPE OF TEST	REPLACEMENT VALUE
71-2 (a,b)	Avian dietary LC <sub>50</sub> (tech) 2 species	LOW
72-2 (a)/(b)	(a) Aquatic invertebrate LC <sub>50</sub> (TGAI) and or (b) life-cycle	HIGH
72-3 (d,e,f)	Acute marine/estuarine (TEP)	HIGH
72-4 (a)	Fish early life stage both rainbow trout and sheepshead minnow	HIGH
72-4 (b)	Invertebrate life-cycle (mysid shrimp)	HIGH
123-1 (a)	Seed germination/seedling emergence (10) species	HIGH
123-1 (b)	Vegetative vigor (10) species	HIGH
123-2	Aquatic plant growth 4 additional species	HIGH

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**A low replacement value** is assigned when there is a low probability that a new test will effectively challenge/change significantly previous assumptions, previously-determined levels of risk and/or decrease the overall level of uncertainty of adverse effects when other, core, scientifically sound and similar type of tests to the one under consideration are in the data base.

**A medium replacement value** is given to a test when the new results have some probability of altering previous assumptions or levels of risk and/or because it is likely to have a higher value in completing a toxicological data base that would otherwise be somehow incomplete for this type of test and, therefore, vulnerable to sound scientific challenge.

**A high replacement value** is given to a test when without a new test it would be impossible and scientifically incorrect to make assumptions and a determination of the level of risk involved. Furthermore, without a replacement test the level of uncertainty will remain high and the ecotoxicological data base will be incomplete and totally vulnerable to scientific challenge.

#### **Value of the additional data**

##### **1) Acute Data**

**Avian: 71-2 (a,b)** At present, EEB is using avian LC<sub>50</sub> values extrapolated by USFWS (United States Fish and Wildlife Service) from a 50 percent to a 100 percent active ingredient formulation. With submission of core studies on technical material, this would not be necessary. Some toxicity in formulation testing may be due to ingredients other than the active ingredient. Other formulations may be more or less toxic, depending on their ingredients. Technical testing allows prediction of the toxicity due to the active ingredient across all formulations.

**Marine and Estuarine: 72-3 (d,e,f)** At present, EFED is using the technical material for determining risk to marine and estuarine organisms. Because of the ROW (right-of-way) use, there could be direct exposure to the aquatic environment by the formulated product. TEP testing will enable EFED to assess the risk of specific formulation(s) actually used on ROWs. The sheepshead minnow was the most sensitive test species in the TGAI testing. Four formulation types are used on ROW (EC, FC, DF, WP) according to the 5/15/92 LUIS report. A 54 percent active ingredient DF formulation was previously found to be roughly twice as toxic to the bluegill as might be predicted based on testing with the active ingredient alone.

**Seed germination: 123-1 (a), 123-1 (b), 123-2** At present, EFED has valid test data on only one of five required aquatic plant species and none of the ten required terrestrial plant species. As an herbicide, EEB assumes linuron is toxic to plants. However, a plant risk assessment cannot be performed without the phytotoxicity data.

## 2) Chronic data

**Fish early life: 72-4 (a)** At present, EFED does not know at what level linuron will not have adverse effects on fish, since a NOEL (No Observable Effects Level) was not determined in fish testing. Submission of a core study will enable us to determine this level, and thus determine what maximum application rate of linuron could be used without producing residues capable of causing the kinds of chronic effects evaluated under current test protocols.

**Aquatic invertebrate: 72-2 (a) or (b)** At present, EFED has chronic invertebrate data that appear inconsistent with acute data: chronic effects were not seen until levels higher than those causing acute effects. Also, invertebrates were more sensitive than fish in acute tests, but appear considerably less sensitive in the chronic test. Any available information that would help explain this inconsistency will help EEB determine whether a new chronic study, a new acute study, or both will be needed.

**Marine and Estuarine: 72-4 (a) (b)** At present EFED has no chronic marine/estuarine data with which to conduct a risk assessment. Due to the use patterns and environmental fate characteristics of linuron, marine estuarine exposure can be expected from use on cotton, corn/sweet corn, forestry, soybeans, vegetables, and wheat (3/8/93 EEB policy memo). Conditions indicating chronic testing include: 1)  $LC_{50}$  value  $< 1$  mg/l; 2)  $EEC \geq 0.01 LC_{50}$ ; 3) aquatic half-life  $> 4$  days. Freshwater fish were substantially more sensitive chronically than acutely. Since the marine/estuarine fish was more sensitive than the freshwater fish in acute tests, it may well be the most sensitive chronically as well. Sheepshead minnow and mysid shrimp should be tested.

### **Labeling Requirements for Manufacturing- Use Products**

The following label statement is required on all manufacturing-use products:

"This pesticide is toxic to fish and aquatic invertebrates. Do not discharge effluent containing this product into lakes, streams, ponds, estuaries, oceans, or public water unless this product is specifically identified and addressed in an NPDES permit. Do not discharge effluent containing this product to sewer systems without previously notifying the sewage treatment plant authority. For guidance, contact your State Water Board or Regional Office of the EPA".

## **Labeling Requirements for End-Use Products**

For terrestrial uses except rights-of-way:

"This pesticide is toxic to fish and aquatic invertebrates. Do not apply to water or to areas where surface water is present, or to intertidal areas below the mean high water mark. Do not apply when weather conditions favor drift from treated areas. Do not contaminate water when disposing of equipment wash water or rinsate."

For rights-of-way:

"This pesticide is toxic to fish and aquatic invertebrates. Do not contaminate water when disposing of equipment washwaters or rinsate."

### **Ground Water Label Advisory**

"This chemical is known to leach through soil into ground water under certain conditions as a result of agricultural use. Use of this chemical in areas where soils are permeable, particularly where the water table is shallow, may result in ground-water contamination."

### **Spray-Drift Label Advisory**

#### **Label Language**

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### **Labeling for Endangered Species**

The Endangered Species Protection Program is expected to become final in 1994. Limitations on the use of linuron will be required to protect endangered and threatened species, but these limitations have not yet been defined, and may be formulation specific. OPP anticipates that consultation with the Fish and Wildlife Service will be conducted in accordance with the species-based priority approach described in the Program. After completion of consultation, registrants will be informed if any required label modifications are necessary. Such modifications would most likely consist of the generic label statement referring pesticide users to use limitations contained in county bulletins.

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