Fosamine ammonium inhibits growth in woody plants and some herbs. It apparently prevents dormant tissues from becoming active and growing again, but its exact mode of action is not understood. When applied in late summer or early fall, effects are generally not visible until the following spring when treated vegetation fails to bud-out. Pine species can be treated during spring and summer, and their growth will be inhibited shortly thereafter. Few studies on the environmental fate and toxicity of fosamine ammonium have been conducted by independent researchers. This lack of research may be due, in part, to the relatively low toxicity and rapid microbial degradation of this herbicide. Fosamine ammonium is highly water soluble, but appears to bind readily with at least some soils. It is readily degraded by soil microbes and has a half-life in soils ranging from one to two weeks, which limits its movement. It is not readily degraded by abiotic chemical reactions or photolysis, but low pH and high temperatures have been shown to facilitate its breakdown. It is stable in water, but is generally degraded rapidly by microbes in aquatic sediments. Fosamine is only very slightly toxic to birds, mammals, fish, and aquatic invertebrates.
Fosamine

**Herbicide Details**

**Chemical Formula:** ethyl hydrogen (aminocarbonyl) phosphonate

**Trade Names:** Krenite S® and Krenite UT®

**Manufacturer:** Du Pont Agricultural Products

**Use Against Natural Area Weeds:** Fosamine is commonly used for brush control in rights-of-way, parklands, conifer plantations, and reforested areas. It is usually applied one to two months before autumn leaf-drop. On TNC preserves, fosamine has been used with varying levels of success to control leafy spurge (*Euphorbia esula*) and crown vetch (*Coronilla varia*). It was moderately effective against leafy spurge on the Paul Bunyan Savanna in Minnesota, at Pine Butte Preserve in Montana, and several preserves in South Dakota. On the Bluestem Prairie and Pembina Preserves in Minnesota, however, Brian Winter reports that fosamine provided only moderate to poor control of leafy spurge, and also caused severe damage to native grasses and forbs.

**Mode of Action:** Fosamine ammonium functions as a plant growth regulator. It is sometimes referred to as a “dormancy enforcer,” but its specific mechanism of action has not been identified. There is some evidence that it inhibits mitosis in susceptible plants. Deciduous plants treated with fosamine ammonium fail to refoliate and die, without going through the “brown out” caused by many other herbicides. When applied to deciduous plants two months prior to leaf drop, the compound is absorbed with little or no apparent effect. In the following spring, buds either fail to open at all, or produce only spindly, miniature leaves. Evergreen plants such as pines show response soon after application.

**Dissipation Mechanisms:**

**Summary:** Fosamine ammonium is degraded primarily by microbial metabolism. It is not readily degraded by sunlight or un-catalyzed chemical processes. Fosamine ammonium’s average half-life in soils is one to two weeks. It is adsorbed by at least some soils, but has the potential to be mobile in the environment. It does not readily volatilize.

**Volatilization**
Fosamine is not highly volatile (T. Lanini, pers. obs.). The potential to volatilize, however, increases with increasing temperature, increasing soil moisture, and decreasing clay and organic matter content (Helling et al. 1971).

**Photodegradation**
Fosamine ammonium is not readily degraded by sunlight. However, increases in UV exposure, temperature, and a decline in pH can increase its photolytic degradation rates (Han 1979). Photosensitizers (photodegradation catalysts) did not enhance degradation rates.
**Microbial Degradation**
Fosamine ammonium is degraded readily by microbes in soils and aquatic sediments (Han & Krause 1979). Han (1979) found that 45-75% of fosamine ammonium in soils was microbially degraded within 90 days. Soil conditions that favor microbial metabolism, such as increased soil temperature, moisture, and organic content, will enhance degradation of fosamine ammonium.

**Adsorption**
Fosamine ammonium is highly water-soluble but appears to bind readily with at least some soils. Han (1979) found adsorption rates of fosamine ammonium varied with soil type. Adsorption coefficient values, K, ranged from 0.7 in sandy loam to >20 in silt loam. Increasing organic matter or clay content generally increases adsorption values. Adsorption to soils and rapid microbial degradation are considered responsible for the poor uptake of fosamine ammonium by plant roots (Weigel et al. 1978).

**Chemical Decomposition**
Fosamine ammonium is relatively stable and not readily degraded in neutral to basic waters (pH 7 to 9). In acidic waters (pH 5 and less), small amounts of fosamine ammonium can be hydrolyzed to carbamoylphosphonic acid, but only at low concentrations (<5 ppm - Han 1979).

**Behavior in the Environment**
*Summary:* Fosamine ammonium is rapidly degraded by soil microbes. Treated soils are generally free of detectable residues within one year. Fosamine ammonium binds with some soils, preventing it from moving extensively in the environment. In water, fosamine ammonium is stable and can be persistent, and in plants, it is rapidly hydrolyzed to the acid form and does not readily degrade further.

**Soils**
Because fosamine ammonium is rapidly metabolized by soil microbes, it does not persist in soils. Reported half-lives in the field and laboratory range from one to six weeks, and some research suggests a half-life of only one to two weeks (Han 1979). Fosamine ammonium’s metabolite carbamoylphosphonic acid (CPA) also has a short half-life. Han (1979) found that in field tests, CPA was completely eliminated from soils within three to six months. Radio-labeled carbon studies indicated that the herbicide was dissipated by natural degradation, not runoff in water (Han 1979).

Fosamine ammonium also does not appear to leach extensively. Han (1979) found that after one year and 165 cm of rainfall, 93% of the residual radio-labelled carbon from fosamine ammonium was recovered within the top 10 cm of the soil. Even in fine sand soils, 62% of the radio-labelled carbon was found in the top 10 cm after six months and 40 cm precipitation (Han 1979). Fosamine ammonium may also form insoluble salts or complexes with soil minerals, which prevent it from leaching (Han 1979).

**Water**
Adsorption to soil particles likely prevents significant amounts of fosamine ammonium from leaching or otherwise moving into nearby waterways, even though it is highly soluble in water. Once it enters an aquatic system, however, fosamine ammonium is stable and can be persistent.
It is readily degraded by microbial activity in aquatic sediments, however, which eventually eliminates it from natural water bodies. Han (1979) found the factors that can affect the degradation of fosamine in water, in order of importance, are low pH (< 5), high temperatures (25º C vs. 15º C), and UV exposure.

**Vegetation**

Fosamine ammonium is slowly absorbed through leaf tissue (WSSA 1994). On average, only 50% of the applied herbicide is absorbed and translocated throughout the plant. It is believed that tolerant species do not translocate the herbicide as well as susceptible species do (WSSA 1994). Once in the plant, the salt is rapidly hydrolyzed to the parent acid, which is further degraded to its metabolite, carbamoylphosphonic acid, within several weeks.

**Environmental Toxicity**

**Birds and Mammals**

Fosamine ammonium is only “very slightly toxic” to birds and mammals. The oral LD50 is 24,400 mg/kg for rats and 10,000 mg/kg for bobwhite quail and mallard ducks (Hernandez et al. 1974). No chronic toxic effects in adults or birth defects in offspring were reported (Chrzanowski et al. 1979). The dermal toxicity of fosamine, however, falls under the EPA Category II, indicating the second most severe level of acute toxicity for studies using laboratory animals. Fosamine is also an eye irritant.

Animals given the highest one subchronic oral dose in one study lost weight and exhibited some effects to the kidney and bladder (EPA 1995). Chrzanowski et al. (1979) reported that fosamine ammonium was eliminated from the rats’ bodies within 72-hours. An average of 79% of the herbicide administered was excreted unchanged, while 13% was excreted as a hydrolyzed metabolite.

**Aquatic Species**

The toxicity of fosamine ammonium to fish and aquatic invertebrates is low (EPA 1995). The LC50 (96-hour) is 1,000 ppm for rainbow trout and fathead minnow, and 670 ppm for bluegill sunfish (Hernandez et al. 1974). There is no evidence that fosamine bioaccumulates in fish (EPA 1995).

**Other Non-Target Organisms**

The presence of 10 ppm of fosamine ammonium in three soil types did not alter fungal or bacterial populations (Han & Krause 1979). In agar plates, however, fosamine ammonium concentrations above 100 ppm had detrimental impacts on some fungi.

**Application Considerations:**

Because fosamine ammonium is a salt formulation, it does not easily penetrate the leaves of mature plants, especially those with glossy or waxy leaves (Hernandez et al. 1974). It is best applied to the leaves of young plants, to cut stumps and new sprouts, and to notches made in the trunk (hack and squirt - Barring 1982; Hernandez et al. 1974). When used on more mature vegetation, it should be applied generously and evenly and allowed to set for at least 24 hours. Rainfall shortly after application will wash it off and minimize its impact (Hernandez et al. 1974).
According to Barring (1982), fosamine ammonium’s impact can be unreliable, especially on pines. The manufacturers claim that plant response depends on the timing of application and the species being treated (Weigel et al. 1978). Herbaceous plants are said to “not respond significantly”, perennials “may be repressed”, and broadleaf evergreens are “usually not affected” (Hernandez, et al. 1974). Only the areas of susceptible plants that are directly treated exhibit a response, and for this reason, fosamine ammonium can be used as a trimming agent.

Semington (1977), a DuPont representative, made a number of application suggestions for best results:

1. Timing of application: For best results, apply fosamine ammonium in the late summer or early fall (within 2 months of leaf-drop for deciduous species).
2. Adequate use rates: The minimum recommended rates for dense stands of brush >6 feet high, is 8 lb (2 gal) / acre. A rate of 3 gal / acre may be best for taller brush and tough to control species.
3. Addition of a surfactant: Because fosamine ammonium does not penetrate leaves readily, addition of a surfactant can improve results. DuPont recommends Du Pont Surfactant WK, Tween 20 or Renex 30 by ICI, and Triton X-100 by Rohm and Haas at 0.25% by volume.
4. Spray concentrations: For ground applications, Du Pont recommends 1-1.5% concentration in water. More resistant species may not be killed but may be significantly repressed.
5. Complete coverage without drenching: To facilitate penetration to short brush, use smaller nozzles and higher pressures to disperse the spray.
6. Effects of hard water: “Hard” water (water high in calcium and magnesium) may bind fosamine ammonium molecules and lessen the effectiveness of the herbicide. To “soften” the water, sodium gluconate technical can be added and dissolved in water at 4 oz per 100 gals prior to adding the herbicide. Sodium gluconate can be purchased under the trade names Fisons and Premier.
7. Inclement weather: Because of the solubility of fosamine ammonium, best results are achieved when no rain occurs within one day of application. Foliage should be dry at time of application.

Safety Measures:
Fosamine can cause irritation to the skin and eyes, and inhalation can result in irritation of the upper respiratory passages. Ingestion of high doses may cause nausea, headache, or weakness. Care should be taken to avoid splashing or other exposure to skin and eyes.

Human Toxicology:
Fosamine is only slightly toxic to mammals, but excessive contact with the skin may initially cause skin irritation with discomfort or rash. The EPA classifies fosamine ammonium in Toxicity Category II for acute dermal exposure (second most severe), but regards it as mildly toxic for acute oral ingestion and acute inhalation. Inhalation and ingestion of high doses may result in nonspecific discomfort, nausea, headache, or weakness. Fosamine ammonium can irritate the eyes, causing discomfort, tearing, or blurring of vision.
References


Date Authored: April 2001