Imazapyr Fact Sheet

Herbicide Basics

Chemical formula: 2-(4,5-dihydro-4-methyl-4-(1-methylethyl)-5-oxo-1H-imidazol-2-yl)-3-pyridinecarboxylic acid
Trade Names: Arsenal®, Chopper®, and Stalker®
Pesticide Classification: herbicide
Herbicide Family: Imidazolinone
Target Species: grasses, broadleaves, vines, brambles, brush, and trees
Forms: acid & salt
Formulations: Arsenal®: imazapyr (27.6%), and inert ingredients (72.4%), Chopper®: imazapyr (22.6%), isopropylamine (5.4%), and other inert ingredients (72%)
Mode of Action: Amino acid synthesis inhibitor
Water Solubility: 11,272 ppm.
Average Water Half-life: 4 days
Sorption potential: low
Bioaccumulation Potential: low
Primary degradation mech: Slow microbial metabolism and photolysis
Average Soil Half-life: 25-141 days
Mobility Potential: high
Aquatic Animal Toxicity: low in toxicity to invertebrates and practically non-toxic to fish, birds and mammals
Avian Acute Oral LD_{50} for mallard duck: >2,150 mg/kg
Avian Subacute Dietary Toxicity LC_{50} for mallard duck: >5,000 mg/kg
LC50 for rainbow trout: >100 mg/L

Manufacturer: BASF (American Cyanamid Co. merged with BASF)

Purpose

The Washington State Department of Agriculture (WSDA) has identified a need to control smooth cordgrass, (*Spartina spp.*) an invasive, non-native weed that has begun to dominate many of Washington's most productive tide flat areas. It is important to understand imazapyr's non-target organism toxicity, and estimate potential exposure to ecological receptors relevant to the estuarine environments where the herbicide may be applied in order to characterize risks from exposure to individual species and ecosystems where Spartina is known to occur in the state,

Toxicological Profile

Imazapyr (Arsenal®, Chopper®, Stalker®, Assault®, Contain®) is from the herbicide family imidazolinone, known as non-selective herbicides for control of weeds, broadleaved herbs, and woody species Imazapyr was first registered under the commercial formulation of isopropylamine salt called Arsenal® in 1984 and again with the formulation Chopper® in 1993 (Cyanamid Ltd. 1997).
The herbicide is commonly found in two forms: weak acid and isopropylamine salt (49 percent water solution), although commercial products are almost solely the isopropylamine salt form (Figure 1).

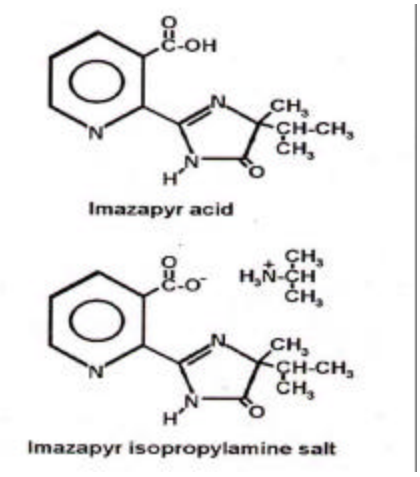

Figure 1. Chemical structures of the two forms of imazapyr.

Environmental Fate

- **Movement**: transport within the environment (e.g. through soils, water, plants) of the weak acid is determined through the pH of the host system. Imazapyr can be highly mobile or persistent in soils, dependent on soil characteristics.
- **Adsorption**: Imazapyr can be strongly adsorbed by soils, but the adsorption coefficient varies for different types of soil
- **Persistence and Degradation:** The primary source of degradation for imazapyr is microbial metabolism. The primary form of degradation in water is photodegradation with a half-life of approximately 2 days. Degradation decreases with increasing pH. Due to its rapid photodegradation by sunlight, water contamination by imazapyr is generally not of concern. Degradation via volitization of imazapyr was minimal in field studies, however degradation increased with the following environmental parameters:
  - Increased temperatures (15°C to 30°C)
  - Increased soil moisture (5 to 75 percent of field capacity)
  - Decreased clay and organic matter content
- **Solubility:** Imazapyr is soluble in water

Mode of Action:

- Imazapyr kills plants by preventing the synthesis of certain amino acids produced by plants but not animals. Thus
- Imazapyr is an amino acid synthesis inhibitor and kills plants by inhibiting the production of the branched-chain aliphatic amino acids which are required for DNA synthesis and growth.
- Treated plants usually die slowly.
- Imazapyr is primarily adsorbed through plant tissue, but can also be adsorbed through roots in the soil. Plants stop growth initially in the roots and continue in the above ground portions, with complete death occurring approximately one month after treatment, depending on environmental conditions (Cox 1996).
- Animals do not synthesize their own three branched-chain aliphatic amino acids, but obtain them by eating plants and other animals; therefore adsorption of the compound is not possible during aerial or spot application to soils.
- Imazapyr is a slow-acting inhibitor (several weeks) and generally is most effective during axillary budding (post-emergent) (Hanlon and Langeland 2000).

Ecological Effects

A substantial amount of testing of imazapyr products has been conducted to evaluate its efficacy to target plants, and potential toxicity to non-target organisms.

- **Fish:** Exposure for fish can occur via direct contact to surface water that may contain the herbicide due to runoff after ground application. However, imazapyr was undetectable in the initial tidal exchange waters following the direct application of the compound to estuarine sediments in field tests by the Washington State University. Bioaccumulation of imazapyr in aquatic organisms is low, therefore the potential of exposure through ingestion of exposed aquatic invertebrates or other food sources to fish is reduced. Toxicity to fish is considered practically non-toxic (insignificant) based on tests conducted using standardized EPA protocols. The 96-hour LC_{50} for the compound was recently established in rainbow trout fry exposed to the Arsenal formulation of the herbicide as 77,716 ppm, or 22,305 ppm as the active ingredient. Sub-lethal tests with Chinook salmon smolts exposed to Arsenal at concentrations up to 1600 ppm showed no significant differences from the control population for plasma sodium or gill ATPase.

  When applied with surfactants, the toxicity increases relative to the neat product but is still considered insignificant based on EPA guidelines. Toxicity associated with the compound appears Tests conducted by the University of Washington with Arsenal and the surfactants Hasten or Agri-dex revealed average 96-hr LC_{50}'s of 113 and 479 ppm, respectively. The EPA considers chemicals yielding toxicity at concentrations greater than 100 ppm to be "practically non-toxic"

- **Aquatic Invertebrates:** Exposure for aquatic invertebrates occurs through direct contact to surface water that may contain the herbicide due to runoff after ground application. Bioaccumulation of imazapyr in aquatic organisms is low; therefore the potential of exposure through ingestion of exposed phytoplankton or other food sources is also low.

- **Herbicide Use**

  Imazapyr (Arsenal) is currently registered for experimental use only as part of the integrated pest management program of noxious aquatic weeds exercised by the Washington State Department of Agriculture (WSDA). The integrated pest management program involves mechanical, chemical and biological control methods for invasive noxious weeds. Efficacy tests with Imazapyr have shown it to be effective at lower application rates than Rodeo (glyphosate), which is currently registered for aquatic use statewide and has higher toxicity. The proposed application rate is 6 pints/acre of the formulated product, mixed with surfactant and water at an application rate of 5 gallons per acre.

Examples of Target Species Effectively Controlled by Imazapyr.

Common Name	Scientific Name
Giant Reed	*Arundo donax* L.
Buttonbush	*Cephalanthus occidentalis*
Purple Loosestrife	*Lythrum salicaria* L.
Melaleuca	*Melaleuca quinquenervia* (Cav.) Blake
Torpedo Grass	*Panicum repens* L.
Common Reed	*Phragmites australis* (Cav.) Trin. ex Steud.

Common Name	Scientific Name
Brazilian Peppertree	*Schinus terebinthifolius* Raddi
Giant Foxtail	*Setaria magna* Griseb.
Tamarisk or Salt Cedar	*Tamarix* spp.
Cattails	*Typha* spp.
Para Grass	*Urochloa mutica* (Forsk.) T.Q. Nguyen

Source: ACOE 2003

There are a number of weeds that have developed resistance to imazapyr (Table b).

Table b. Plants resistant to the use of Imazapyr.

Common Name	Scientific Name
Rigid ryegrass	*Lolium rigidum*
Kochia	*Kochia scoparia*
Common chickweed	*Stellaria media*
Russian thistle	*Salsola iberica*
Perennial ryegrass	*Lolium perenne*
Annual sowthistle	Sonchus oleraceus
Brassicaceae spp.	*Arabidopsis thaliana*
Algae spp.	*Chlorella emersonii*

Source: Cox 1996