5. PRODUCTION, IMPORT/EXPORT, USE, AND DISPOSAL

5.1 PRODUCTION

Atrazine is produced by a continuous process where isopropylamine is reacted with cyanuric acid under basic conditions, forming 2,4-dichloro-6-isopropylamino-s-triazine, which is then reacted with monoethylamine and dilute caustic to form atrazine. The approach allows for continuous product recovery, solvent recycling, and waste removal (IARC 1999; UDC 1977). The triazine herbicides were first synthesized in 1955 (Kroschwitz and Howe-Grant 1995) and atrazine was first registered for use by the Ciba-Geigy Corporation in 1958 (Ribaudo and Bouzaher 1994). It has been used over the last 40 years as an effective broad-leaf herbicide in corn, sorghum, and sugar cane, and has also been used for other crops and for nonspecific treatment of weeds along railway right of ways and highways. Some of the latter uses have been curtailed to lessen atrazine release into surface waters.

Atrazine is designated as a restricted use pesticide (RUP), and is not available to the general public. RUPs are, by law, for retail sale to, and for use by, only certified applicators or persons under their direct supervision, and only for those purposes covered by the applicator's certification. Atrazine received this classification on January 23, 1990 (Fishel 2000). Current trade names for atrazine include Aatrex®, Atranex, Atred, Gesaprim®, Primatol, and Vectal (Trochimowicz et al. 2001). Atrazine is available in different formulations, including suspension concentrates, wettable powders, flowable liquids, and water-dispersible granules (HSDB 2002).

There are 24 facilities that manufacture or process atrazine (Table 5-1). The amounts manufactured or processed range from 1,000 to 9,999 pounds in Georgia to very large formulation activities (1,000,000–9,999,999 pounds) in Alabama, Mississippi, and Missouri. Facilities in Arkansas and Iowa also process atrazine in large amounts (up to 9,999,999 pounds), but Louisiana houses facilities that process the greatest amounts of atrazine (up to 49,999,999 pounds), with activities including production, processing, manufacturing, reaction, sale and distribution, and other ancillary uses.

Table 5-2 shows the six companies that are registered to produce products containing atrazine. Most of these companies produce a technical-grade atrazine, with a purity ranging from 95.2 to 97%, although higher purity atrazine can be produced (>99%) (EPA 1983). The technical-grade compound may contain

Table 5-1. Facilities that Produce, Process, or Use Atrazine

State[a]	Number of facilities	Minimum amount on site in pounds[b]	Maximum amount on site in pounds[b]	Activities and uses[c]
AL	1	1,000,000	9,999,999	6
AR	2	10,000	9,999,999	2, 3, 7, 12
FL	4	10,000	999,999	7, 8, 12
GA	1	1,000	9,999	7
IA	3	100,000	9,999,999	1, 3, 7, 9
IL	2	10,000	999,999	7, 12
LA	1	10,000,000	49,999,999	1, 3, 4, 7, 9, 12, 13, 14
MI	1	100,000	999,999	7
MO	2	1,000,000	999,999,999	2, 4, 7, 9
MS	1	1,000,000	9,999,999	2, 3, 4, 7, 9
NE	3	1,000	9,999,999	1, 4, 7, 9, 12
OH	3	100	999,999	7, 12

Source: TRI01 2003

[a]Post office state abbreviations used
[b]Amounts on site reported by facilities in each state
[c]Activities/Uses:

1. Produce
2. Import
3. Onsite use/processing
4. Sale/Distribution
5. Byproduct
6. Impurity
7. Reactant
8. Formulation Component
9. Article Component
10. Repackaging
11. Chemical Processing Aid
12. Manufacturing Aid
13. Ancillary/Other Uses
14. Process Impurity

Table 5-2. Registered Atrazine Manufacturing-use Products[a]

Formulation	EPA registration number	Registrant
97% T	100-529	Novartis Crop Protection, Inc. (formerly Ciba-Geigy Corp.)
97% T	19713-7	Drexel Chemical Company
92.15% T[b]	19713-375	Drexel Chemical Company
97% T[b]	34704-784	Platte Chemical Company, Inc.
97% T	35915-63[c]	Oxon Italia S.P.A.
97.2% T	11603-32	Agan Chem Mfg. Ltd.
95.2% T	67604-1	Sanachem (PTY) Ltd.

[a]Adapted from EPA 2001a
[b]Repackaged from an EPA-registered product.
[c]Transferred May 23, 1988 from Ida, Inc. (EPA Reg No. 54115-63), which was transferred October 13, 1987 from Axon Corporation.

T = technical

three classes of impurities, namely dichlorotriazines, hydroxytriazines, and tris(alkyl)aminotriazines. These impurities have not been quantified in the available literature.

5.2 IMPORT/EXPORT

Data on import and export of atrazine are limited. The most recent import and export data available are for the year 1972 (HSDB 2002); a negligible amount was imported, and exports were reported as 9.08×10^6 kg (19,000,000 pounds). Bason and Colborn (1998) did not provide any 1990 export information for atrazine.

5.3 USE

Atrazine is the most heavily used pre- and postemergence herbicide in the United States (Trochimowicz et al. 2001). It is used for the control of grasses and broad-leafed weeds, and is primarily used on corn, sorghum, sugarcane, macadamia nuts, and conifer tree crops; over 65% of the corn crop acreage in the United States is treated with atrazine (USDA 1993). Atrazine has been used in this capacity as a broad leaf herbicide for the last 35 years (IARC 1999). It should be used at the appropriate application rates, which have been reduced to 1.4–2.0 pounds per acre (Johnson et al. 1996). The EPA has estimated that 31–35 million kg of active ingredient atrazine were used on agricultural crops in the years 1987, 1993, and 1995 (IARC 1999).

More specific information is available from a National Center for Food and Agricultural Policy document that reported trends in pesticide use between 1992 and 1997 (NCFAP 2000). Atrazine use showed a slight (3%) increase in use from 1992 to 1997. In 1992, 73,315,295 pounds (33 million kg) were used, and in 1997, 74,560,407 pounds (34 million kg) were used (NCFAP 2000). Corn and sugarcane crops received significant increases in atrazine treatment in 1997 as compared to 1992; sugarcane crops received 503,000 more pounds and corn crops received 2,037,000 more pounds. Sorghum crops, in contrast, were treated with 1,065,000 pounds less in 1997 as compared to 1992. This, however, was likely related to much less sorghum being planted in 1997 as compared to 1992 (NCFAP 2000). It should be noted, however, that in some areas, corn growers decided to replace atrazine pre- and posttreatments with other products. This decision was a result of restrictions placed on the use of atrazine, such that the application rate restrictions reduced effectiveness on certain weeds (NCFAP 2000).

There are seven EPA registered manufacturing-use products, as shown in Table 5-2.

Atrazine usage rates have been relatively constant since monitoring began, but are beginning to decrease. In 1993, 4,955,300 pounds (2,247,093 kg) of atrazine were used on 45,333,000 acres (18,346,014 hectares) of corn in the United States (Ribaudo and Bouzaher 1994); the maximum reported usage was in 1976, when 9,034,000 pounds (4,097,796 kg) of atrazine were used in all agricultural applications. Of that, 8,379,000 pounds (3,800,689 kg) were applied to corn. Also in 1976, the largest number of acres was treated with atrazine, with 61,750,000 total acres (24,989,883 hectares) being treated. More than 92% of the total acreage treated with atrazine (56,863,000 acres; 23,012,141 hectares) were corn crops (Ribaudo and Bouzaher 1994). Atrazine is a restricted use pesticide and is only available to applicators who meet appropriate requirements of the state and federal government.

5.4 DISPOSAL

Atrazine and waste containing atrazine are considered toxicity class III—slightly toxic by the EPA (Extoxnet 1996). It does not require any special hazardous waste disposal procedures, according to EPA Resource Conservation and Recovery Act listings, either by specific listing or due to reactivity, ignitability, corrosivity, or toxicity, as it is not considered a hazardous waste. However, atrazine is included in the Priority Group 1 of pesticide tolerances that will be examined first under the Food Quality Protection Act (FQPA) tolerance reassessment (62 FR 42020) (FEDRIP 1998).

Disposal may be achieved by different means. Atrazine is completely degraded by wet oxidation (HSDB 2002), and 99% of atrazine is decomposed when burned in a polyethylene bag. Increasing combustion temperatures by use of a hydrocarbon fuel would appear to be suitable for small quantities of waste, but larger quantities would require the use of a caustic wet scrubber to remove nitrogen oxides and hydrochloric acid from the resulting combustion gases. The recommended method of atrazine disposal is to react atrazine wettable powders with sufficient 10% (weight/volume) aqueous sodium hydroxide to ensure a pH of >14. The solution may be heated to increase the rate of hydrolysis. When completely hydrolysed, the resulting solution should be diluted with excess water and washed into the sewer (HSDB 2002).