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FACT SHEET #32

Cornell University Program on
Breast Cancer and Environmental Risk Factors
in New York State (BCERF)

Pesticides and Breast Cancer Risk, An Evaluation of Alachlor*

Alachlor is an herbicide used to control weeds primarily in agricultural crops, including corn and soybeans. While there does not appear to be evidence that alachlor causes breast cancer in humans, alachlor has been found to cause other types of cancer in laboratory animals. More research is being done to determine if alachlor exposure is a cancer risk for humans. This fact sheet provides information on the cancer risk of alachlor, its regulation by federal agencies, the fate of alachlor in the environment, ways to minimize exposure, and where more studies are needed.

Why was alachlor chosen for evaluation?

Alachlor was chosen for review because of its widespread use in agriculture, and evidence that it can cause cancer in laboratory animals. Alachlor also was recommended for review by the New York State (NYS) Department of Environmental Conservation because of concerns about the potential for alachlor and its breakdown products to contaminate water supplies.

What is alachlor and how is it used?

Alachlor is an herbicide used to control the growth of a variety of grasses (like crabgrass) and broadleaf weeds on agricultural crops, especially corn and soybeans. It is also used to control weeds on peanuts, sorghum, dry beans and lima beans, and to a lesser extent on sugarcane, sunflowers and tobacco. It is also used for weed control on ornamental plants grown in nurseries. Up until the late 1980s, alachlor was one of the most heavily used herbicides in the US. The use of alachlor has declined dramatically in the last dozen years (see "Chemical Information" box).

Does alachlor cause breast cancer in humans?

Currently, no studies have evaluated whether exposure to alachlor effects the risk of developing breast cancer in humans. A few studies have looked at the risk of dying of breast cancer in alachlor-exposed women. Researchers have found that women who worked in a factory that made alachlor did not have a higher risk of dying from breast cancer, but very few women were enrolled in this study. Because of the low numbers of women, it is difficult to make a meaningful conclusion about this study. These women should continue to be followed, since breast cancer can take many years to develop. A study in Minnesota compared breast cancer death rates in farming regions

** This fact sheet was based on the technical report "Critical Evaluation of Alachlor's Breast Cancer Risk," by Suzanne M. Snedeker, Ph.D.*

to rates in a mostly urban part of the state. The risk of dying from breast cancer was not any higher in women who lived in the farm regions, including areas that grew corn and soybeans, than in urban areas of the state. However, this ecological study did not evaluate actual exposure to alachlor or to other pesticides.

Does alachlor cause breast cancer in laboratory animals?

Alachlor does not cause mammary (breast) tumors in laboratory rats. One study did report a higher number of mammary tumors in female mice that were fed alachlor over long periods of time. But this only occurred when the animals were fed very high, toxic levels of alachlor that caused many of the animals to become sick, and some to die. When alachlor was fed to the mice at levels that were not considered to be toxic, the alachlor-treated mice did not develop more mammary tumors than the mice that were not fed alachlor.

Does alachlor cause other types of cancer?

There is some limited evidence that alachlor affects the risk of developing or dying from other types of cancers. In one study conducted in men employed in an alachlor manufacturing plant, researchers reported a slightly higher risk of dying from chronic myeloid leukemia (a cancer of the blood). Another study did not find a higher risk of developing multiple myeloma (a cancer of the blood making cells in the bone marrow) in male farm workers exposed to alachlor compared to non-farm workers.

Lung tumors in mice, and stomach, thyroid and nasal tumors in rats, have been observed in laboratory animals fed high levels of alachlor for long periods of time. Some of the ways animals handle alachlor in their bodies may influence the development of certain tumors. For instance, some types of rats can convert alachlor into a form that causes a toxic reaction in their noses. This toxic reaction may be an important step in the development of nasal tumors in these rats. However, in other animals like mice and monkeys, this toxic reaction may occur very slowly or not at all. Nasal tumors did not develop in mice or monkeys when treated with alachlor. Researchers are currently investigating how alachlor causes cancer in laboratory

Chemical Information, Usage and Trade Names for Alachlor

Type of pesticide: herbicide (weed killer)

Herbicide family: chloroacetamide

Chemical name: 2-chloro-2',6'-diethyl-N-(methyoxymethyl)acetanilide

First manufactured: in 1969

CAS registry number: 15972-60-8

Breakdown products found in water:
alachlor ethanesulfonic acid (ESA)
alachlor oxalonic acid (OA)
2,6-diethylanaline

History of agricultural usage in US:

Year	Pounds of active ingredient
1987	55-60 million pounds per year
1993	45-50 million pounds per year
1995	19-24 million pounds per year

Agricultural use in New York State:

1990-93	610 thousand pounds per year

Some common trade names (manufacturer)**:
Alanex® (Makhteshim-Agan); Cropstar®, Lasso®, Micro-Tech®, Partner® (Monsanto Co.); Strike® (Luxan B.V.); Sanachlor® (Sanachem)

***Note: Trade names are used herein for convenience and for informational purposes only. No endorsement of products is intended, and no criticism of unnamed products is implied.*

animals, and whether these laboratory findings are important in determining the potential cancer risk to humans.

Are there other ways alachlor can affect cancer risk?

Synthetic chemicals that can mimic the action of the hormone estrogen may increase breast cancer risk or affect reproduction. There is little evidence that alachlor is an estrogen mimic in humans or other mammals. Tests using human breast tumor cells did not find that alachlor could act like estrogen. No studies have tested alachlor's ability to act like estrogen in laboratory rats or mice. However, alachlor has been found to be a weak estrogen mimic in some wildlife species, including the American alligator. Researchers believe that alachlor may have the potential to disrupt hormonal pathways that could affect reproduction in certain wildlife species.

Mutagens are chemicals that can cause changes in a cell's genetic code (DNA). Mutagens can increase the risk of forming cancerous tumors. Most tests have found that alachlor is not a mutagen. But some breakdown products of alachlor (see "What is a breakdown product?" box) are weak mutagens.

What is the current regulatory status of alachlor?

Since alachlor has been found to cause tumors in laboratory animals, the Environmental Protection Agency (EPA) has designated alachlor as a "Restricted Use Pesticide". Only applicators with special training and certification can apply alachlor to crops. A special method of transferring alachlor from the package to the machine that applies alachlor to the field must be used. This method helps minimize exposure of alachlor to farm workers handling and applying this pesticide.

Products containing alachlor are not permitted to be used in Nassau and Suffolk counties on Long Island in NYS. This restriction was requested by one of the primary manufacturers of alachlor products (Monsanto), because of concern of the potential for alachlor to contaminate water supplies in this region.

Are the levels of alachlor regulated in drinking water and in food?

EPA sets limits on the amount of alachlor allowed in public drinking water supplies. This amount is called the "maximum contaminant level" (MCL). The MCL for alachlor has been set at no more than two micrograms per liter of water (one microgram is one

What is a breakdown product?

Breakdown products form when a chemical degrades and breaks down. Many herbicides (weed killers) degrade as a result of exposure to sunlight or to bacteria in the soil. Some breakdown products bind tightly to the soil. Other breakdown products can travel down through the soil and contaminate ground water (wells). Or breakdown products can be washed off the soil by a rain storm and contaminate surface water (creeks, rivers or reservoirs). Other names for breakdown products are transformation products or degradation products.

Three of the most common breakdown products for alachlor are alachlor ethanesulfonic acid (ESA), alachlor oxanlic acid (OA), and 2,6-diethylanaline. These breakdown products have been detected in water supplies, sometimes at levels higher than alachlor.

millionth of a gram, and one liter is approximately one quart). EPA has not set MCLs for the breakdown products of alachlor (see "What is a breakdown product?" box).

People may potentially be exposed to very small amounts of alachlor by eating food containing residues of alachlor. EPA has set limits on the maximum level of alachlor allowed in food for human consumption or in animal feed. These maximum levels are called "tolerances". This includes tolerances for beans, corn, eggs, milk, peanuts, sorghum, soybeans, and beef, poultry, goat and horse meat. The Food and Drug Administration (FDA) and the US Department of Agriculture are the federal agencies that monitor the levels of alachlor residues in domestic and imported foods. Foods that exceed the tolerances can be seized or destroyed by local or federal government officials. Alachlor was not detected in any of the US foods or imported foods sampled by the FDA in their 1998 pesticide residue food monitoring program. FDA also samples foods that typically make up the diet of Americans. They did not find any alachlor residues on the foods sampled in the last nine years of these "market basket" diet surveys.

Is alachlor found in soil?

The alachlor that is applied to fields to prevent weed growth in crops stays in the soil from several weeks to several months. Some of the alachlor is lost from soil into the air, and some alachlor on the surface of the soil is degraded by the action of sunlight. Most of the alachlor applied to crops is broken down by bacteria in the soil. See the "What is a breakdown product?" box for some examples of alachlor breakdown products.

Are alachlor and its breakdown products found in water?

Alachlor has been found only in a small percentage of the US well water samples tested, while alachlor has been detected at a greater frequency in samples taken from surface water (streams, rivers or reservoirs). The typical percentage of samples with detectable levels of alachlor range from 0% to 7.5% of the well water samples, and from 10% to 96% of the surface water samples. These percentages reflect the findings of large scale studies conducted by the US Geological Survey (USGS) that estimated levels of alachlor and other herbicides in water basins throughout the US, and the results of smaller, regional studies conducted in midwestern, northeastern and southern states. In most studies the levels of alachlor detected were low, usually below one microgram per liter. This level is less than half of EPA's MCL of two micrograms per liter of water.

In contrast, several studies have found alachlor breakdown products more frequently and at much higher levels than alachlor. For example, in a study conducted in Iowa the breakdown product ESA was detected in 65.1% of the well water samples while alachlor was detected in 7.5% of the samples. Levels of ESA were 23 times higher (14.5 micrograms/liter) than alachlor levels (0.63 micrograms per liter) (Kolpin et al., Ground Water, vol. 35, pp. 679-688, 1997). These data and other studies suggest that while levels of alachlor are relatively low in water supplies, levels of some breakdown products may persist and be at much higher levels than alachlor.

Similar trends were observed in studies of alachlor and its breakdown products in wells and waterways of NYS. In an USGS sponsored study of pesticides in surface water samples collected throughout NYS, alachlor was detected in 50% of the samples taken from 64 rivers and stream sites during June to July of 1997 (Phillips et al., USGS WRIR 98-4010). Levels of alachlor breakdown products were not monitored in this study. In another USGS study, the detection of alachlor and its breakdown products in NYS Suffolk County wells was infrequent (less than 10% of the samples). Levels of alachlor did not exceed 0.2 micrograms per liter, but maximum levels of the alachlor break down product ESA were as high as 40

micrograms per liter (Phillips et al., USGS WRIR 99-4095). A recent study conducted from October 1997 to March of 1999 by the Suffolk County Department of Health Services collected well water samples from areas on Long Island that were especially vulnerable to pesticide contamination. Alachlor was not detected in any of the 405 well water samples collected from Nassau County, while 1.1% of the samples (21 samples out of 1,901) from Suffolk County had detectable levels of alachlor. Of these 21 samples, ten had levels of alachlor that exceeded the EPA's MCL of two micrograms per liter for alachor.

Who might be exposed to alachlor and its breakdown products?

People who are most likely to be exposed to these chemicals include those who:

- are involved in the manufacture of alachlor
- handle, mix or apply alachlor to treat crops
- handle or wash work clothing that came in contact with alachlor
- drink water contaminated with alachlor or alachlor break down products

Where are more studies needed?

- Studies evaluating cancer incidence and mortality in workers exposed to alachlor should continue and be expanded to include a greater number of workers.
- Further studies are needed to determine how alachlor causes tumors of the thyroid gland, lung, stomach and nasal passages in rodents, and the relevance of these findings to human cancer risk.
- Further studies are needed to monitor groundwater, surface water and tap water for alachlor and its breakdown products.
- EPA should consider conducting studies that will aid in setting MCLs for alachlor breakdown products ESA, OA, and 2,6-diethylanaline in public drinking water supplies.

How can I minimize my exposure to alachlor and its breakdown products?

- Always follow manufacturers' instructions on how to mix and apply alachlor containing products.
- Product labels specify the types of protective equipment and clothing, and transfer equipment to be used when handling and applying alachlor.
- Use hand wash stations often during the day if you work with products containing alachlor. This includes each time work gloves are removed, and just before the gloves are put on again to resume work.
- Don't bring alachlor into the home on work clothes or boots. Soiled clothing or boots should not be worn in living or food preparation areas. Work clothing should be laundered separately from all other clothing. Soiled work clothing should be laundered before wearing the clothes again.
- If you live in an area where alachlor is in use and you have a private well, you should have your water tested on an annual basis. Please refer to BCERF Fact Sheet #7B on: *Reducing Potential Cancer Risks from Drinking Water; Part II: Home Water Treatment Options*, for information on water treatment systems that are available to remove pesticides from drinking water.

What kinds of research are being done?

The Agricultural Health Study is a large scale study being conducted in Iowa and North Carolina. This study is investigating whether exposure to pesticides, including alachlor, increases the risk of different types of cancer in male and female farm workers.

Researchers from the University of Cincinnati are studying how alachlor causes nasal tumors in rats, especially how cells progress from a pre-cancerous state to cancerous tumors.

An extensive bibliography on *Alachlor and the Risk of Breast Cancer* is available on the BCERF web site: http://www.cfe.cornell.edu/bcerf/

Prepared by Suzanne Snedeker, Ph.D.
BCERF Research Project Leader

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Program on Breast Cancer and Environmental Risk Factors (BCERF)
College of Veterinary Medicine
Cornell University
Box 31
Ithaca, NY 14853-5601

Phone: (607) 254-2893
Fax: (607) 254-4730
email: breastcancer@cornell.edu
WWW: http://envirocancer.cornell.edu