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### Pre-emergence Weed Control

Cooperative Extension, South Dakota State University

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## Pre-emergence Weed Control

Competition of annual weeds, such as foxtails, barnyard grass, lamb's quarters, Russian thistle, and numerous other broad-leaved and grassy annuals for plant nutrients have caused large crop losses to farmers in South Dakota. Clean seed, proper seedbed preparation, good rotations, and soil management practices are the basic methods of controlling weeds in crops.

Postemergence application of herbicides has been used as another weed control method for the past 15 years, and pre-emergence application of herbicides has become increasingly more important during the last few years. They are particularly useful in row crops. Approximately 5 million acres of row crops are grown in South Dakota annually.

### PRE-EMERGENCE HERBICIDES

Chemicals that are effective for controlling weeds when applied before the weeds emerge are called "pre-emergence herbicides." Some are applied before planting the crop (pre-plant) and others are applied after seeding. They are sold as liquids or powders to be applied as sprays, and some are applied in granular form. Several chemicals must be incorporated into the soil.

Approximately 50 chemicals have been tested in South Dakota as pre-emergence herbicides. Those that are recommended for trial use are simazine,\* atrazine,\* amiben,\* CDAA,\* CDAA-T,\* Avadex,\* TCA,\* and Tillam.\*

Two chemicals that may be recommended in the future are propazine\* and prometryne.\* Information on trade names, formulation, amount of active ingredient, and cost of chemical is given in table 1.

#### Effects of Rainfall and Soil Conditions

The effectiveness of pre-emergence application of herbicides will vary with moisture conditions, soil type, temperature, and the amount of organic matter in the soil. Most of the chemicals listed are absorbed by the roots of plants. Therefore, each chemical must be worked into the soil with machinery or leached into the soil with rain where it will be in contact with the roots of weed seedlings.

**Rainfall.** Research data indicate that atrazine, simazine, CDAA, CDAA-T, and TCA must be leached into the soil with rain or sprinkler irrigation. Mechanical incorporation is useful only when the rainfall received is slightly below the minimum required. Tillam and Avadex, on the other hand,

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## PRE-EMERGENCE weed control in crops

*Cooperative Extension Service*



must be incorporated into the soil with disk, harrow, or similar implement.

Rainfall can not be forecast accurately enough to predict whether these chemicals will give effective weed control in your area for the coming season. However, rainfall data over a 10-year period at each of 30 locations in eastern South Dakota will give some indication how often you might expect effective weed control.

Rainfall data for a 4-week period around corn planting time during 1952 to 1961 for 10 weather stations in the eastern East-River counties, for 10 stations in the central East-River counties, and 10 stations in the western East-River counties were analyzed separately. The results indicate that the rainfall patterns in the three areas were sufficiently similar at corn planting time so that one could expect each chemical to be effective as often in one area as another. Therefore, the data from the 30 locations were included in one analysis for all the area east of the Missouri River. The number of

\*Simazine—common name for 2-chloro-4,6-bis (ethylamino)-s-triazine.

Atrazine—common name for 2-chloro-4-ethylamino-6-isopropylamino-s-triazine.

Amiben—common name for 3-amino-2,5-dichlorobenzoic acid.

CDAA—common name for 2-chloro-N,N-diallylacetylacetamide.  
CDAA-T—common name for 2-chloro-N,N-diallylacetylacetamide plus trichlorobenzyl chloride.

Avadex—trade name for 2,3-dichloroallyl diisopropylthiolcarbamate.

TCA—common name for Trichloroacetic acid.

Tillam—trade name for propyl ethyl-n-butylthiolcarbamate.  
Propazine—common name for 2-chloro-4,6-bis (isopropylamino)-s-triazine.

Prometryne—proprietary name for 2-methylmercapto-4,6-bis (isopropyl amino)-s-triazine.

years that rainfall would have been adequate to cause atrazine, simazine, and CDAA to be effective during the 10-year period 1952-1961 is shown in figure 1.

The results indicate that rainfall will be adequate to activate atrazine and give good weed control 8 years out of 10—there should be almost enough rainfall on the ninth year. Mechanical incorporation may improve results in this year to give good

weed control 9 of 10 years. Simazine should be effective 5 years out of 10 without mechanical incorporation and 2 or 3 years more with incorporation. CDAA or CDAA-T should be effective about half the time.

**Soil conditions.** Soil is the media through which pre-emergence herbicides kill weeds. Therefore different types of soil or soil conditions affect weed control in different ways. Higher rates of atrazine

Table 1. Pre-emergence Herbicides Recommended for Trial Use in South Dakota

Herbicide			Cost of chemical		
Common name	Trade name	Formulation	Amount of active ingredient	Product	Active ingredient per pound
Atrazine	Atrazine 80W	Wettable powder	80%	\$2.85 per lb.	\$3.56
Atrazine	Atrazine 20G	Granules	20%	\$0.81 per lb.	\$4.05
Atrazine	Atrazine 10G	Granules	10%	\$0.47 per lb.	\$4.70
Simazine*	Simazine 80W	Wettable powder	80%	\$2.85 per lb.	\$3.56
Simazine*	Simazine 4G	Granules	4%	—	—
CDAA	Randex	Liquid	4 lb. per gal.	\$7.80 per gal.	\$1.95
CDAA	Randex	Granules	20%	\$0.44 per lb.	\$2.20
CDAA-T	Randex T	Liquid	3.1 lbs. CDAA/gal.	\$8.90 per gal.	\$2.87
CDAA-T	Randex T	Granules	11.7% CDAA	\$0.39 per lb.	\$3.30
Amiben	Amiben	Liquid	2 lbs. per gal.	\$10.40 per gal.	\$5.20
None	Avadex	Liquid	4 lbs. per gal.	\$10.60 per gal.	\$2.65
None	Tillam 6-E	Liquid	6 lbs. per gal.	\$24.00 per gal.	\$4.00
None	Tillam 10	Granules	10%	\$0.48 per lb.	\$4.80
TCA	Numerous	Granules (Dissolve in water)	80% or 83%	\$0.44 per lb.	\$0.56

\*Not readily available in South Dakota.

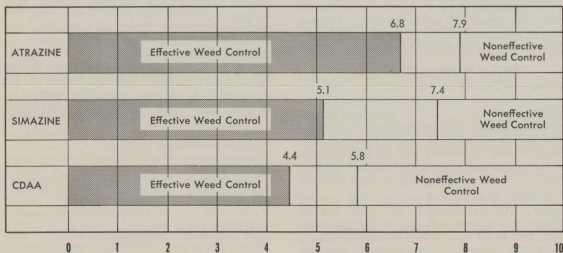


Figure 1. Number of years that rainfall was adequate to cause atrazine, simazine, and CDAA to give effective weed control without mechanical incorporation and with incorporation in eastern South Dakota during 1952-61.

or simazine are needed on heavy soils or high organic matter soils than on light soils or low organic matter soils to get effective weed control. Amiben is less effective on heavy gumbo or muck soils. CDAA and CDAA-T generally give better weed control on heavy soils than on light soils. Effective weed control with CDAA or CDAA-T sprays is more likely to occur if application is made to warm (60° to 65° F.), dry soil.

Loose, dry soil is preferred for herbicides than must be incorporated into the soil, such as Avadex or Tillam.

### Chemicals

**Atrazine and simazine.** Both chemicals control most annual grasses, numerous broad-leaved annuals, and quackgrass. Good control is obtained if either chemical is applied to wet soil or if sufficient rain falls within 2 weeks after application. Only fair results can be expected if the rain is not received until the third week. One-half to three-fourths inch of rain is required to activate atrazine and 1 inch is needed for simazine.

Atrazine is more soluble in water than simazine which enables atrazine to move downward into the soil faster than simazine with the same amount of moisture. Atrazine has a shorter residual (weed killing) period than simazine. This shorter residual period is an advantage when little moisture is received, but is a disadvantage when greater amounts of rainfall occur as weed control does not last the entire season.

Both chemicals can be used in corn or in several species of trees and shrubs (not lilacs) without injuring the crop. However, residues of these chemicals used in corn one year generally damage small grain planted the next year. Soybeans are less sensitive than small grain, but may be damaged too.

Sprays and granules of either chemical are equally effective when the same amount of active ingredient is applied. However, granules are more difficult to apply with present day equipment. Granules with lower percentage (atrazine 10%) active ingredients are less difficult to apply accurately than those with a higher percentage (atrazine 20%).

Atrazine is readily available from retail dealers and is better than simazine for use in corn. Simazine can be ordered by most dealers and may be slightly superior to atrazine for use in shelterbelts.

**CDAA and CDAA-T.** Both chemicals control most annual grasses and CDAA-T controls several broad-leaved annuals. Good control is obtained with sprays of either chemical if it is applied to warm soil (60° to 6° F.) and if a minimum of one-half to three-fourths inch of rain is received during the

first week after application. Both chemicals are relatively volatile and relatively soluble in water. Therefore, they must be leached into the soil before they volatilize, but heavy rain (2½ inches) may leach sprays beyond the root zone of weed seedlings.

Granules are effective over a wider range of conditions. They are effective if applied to cool soil, they are not rendered ineffective by heavy rains, and they do not volatilize as quickly as sprays.

CDAA can be used in corn, soybeans, and sorghum, and CDAA-T can be used in corn and sorghum without damaging the crop. They seldom control weeds for more than 2 or 3 weeks, but there is no carry-over effect on the crop planted the next year.

**Amiben.** Most annual grasses and numerous broad-leaved annuals are controlled by this chemical. Little is known about the influence of temperature, rainfall, or soil type on the effectiveness of this chemical; however, it appears to be more effective if one-half to 1 inch of rain falls before weeds emerge. Spray applications control weeds for 6 weeks to 3 months, but there are no reports of damage to a crop seeded the next year. It can be used in soybeans or trees without damaging the crop.

**TCA.** Foxtails, barnyard grass, and several species of broad-leaved weeds are controlled by this chemical. It is more effective if applied to wet soil or if treatment is followed shortly by a good rain or sprinkler irrigation. It is applied as a spray and can be used in sugar beets without damaging the crop seriously. There is no carry-over effect on the crop seeded the following year.

**Avadex.** This chemical normally reduces the stand of wild oats 75 to 100%. It can be used in sugar beets, flax, barley, or durum wheat. It must be incorporated into the soil with a harrow and may be applied immediately before or immediately after seeding.

Preliminary research data indicate that Avadex is absorbed by shoots of wild oats and by the roots of wheat. Therefore, a layer of chemical should be above the planted grain, where shoots of wild oats must grow through it, but above the area where crop roots will come in contact with it.

**Tillam.** Most annual grasses and numerous broad-leaved annuals are controlled with this chemical. It must be incorporated into the soil immediately with a disk or similar implement. Effectiveness is reduced if incorporation can not be done the day of treatment. There is no carry-over effect on the succeeding crop.

**Propazine and Prometryne.** Both chemicals are similar to atrazine and simazine. Both appear to be less injurious to sorghum and soybeans than atrazine or simazine and both can be safely used on corn. Propazine has given good weed control in other states, but has been less effective than atrazine in South Dakota tests. Prometryne has given good weed control in South Dakota tests and appears to have a shorter period of residual effect. It gives promise of being useful for use in corn and sorghum and possibly soybeans without having any carry-over effect on the next year's crop.

#### WEED CONTROL IN CROPS

The chemical applied pre-emergence depends on the crop being treated and the weed being controlled.

##### Corn

Atrazine, simazine, CDAA, or CDAA-T may be used to control weeds in corn.

**Atrazine and simazine.** Use 2 to 3 pounds of active ingredient of either herbicide per acre to control foxtails, barnyard grass, pigweeds, mustards, lamb's quarters, Russian thistle, kochia, and other annuals. An over-all application of atrazine replaces the first cultivation, and an over-all treatment with simazine replaces all but the layby cultivation.

However, the cost of the chemical and the carry-over effect make it impractical to use an over-all application. Treatment of a 12- to 14-inch band over each row reduces the cost for chemical. Two cultivations are needed to kill the weeds between the rows. Therefore, the most practical treatment is 2½ pounds active ingredient of atrazine per acre on the area treated, applied in bands over the row, followed with cultivation in mid-June and at layby time. Sprays may be applied with an applicator similar to the one shown in figure 2 and granules with an applicator similar to the one shown in figure 3.

A minimum of one-half to three-fourths inch of rain for atrazine and 1 inch for simazine is required during the first 2 to 3 weeks after treatment to activate the chemicals. Mechanical incorporation is helpful when slightly less than the minimum amount of rain falls.

Therefore, it is advisable to use a harrow or rotary hoe if no rainfall occurs within 10 to 14 days after treatment. Such an operation will control weed seedlings that have started to grow during the dry spell. Atrazine will then kill later emerging weeds even though the first rainfall is delayed for as much as 3 weeks.



Figure 2. Corn planter equipped with sprayer attachment for band application of pre-emergence herbicides. (Photo courtesy of Century Engineering Company.)

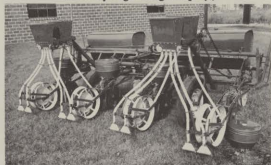


Figure 3. Corn planter equipped with attachments for application of granules of fertilizer, insecticide, and pre-emergence herbicides. Note different placement in soil for each chemical. (Photo courtesy of Gandy Company Inc.)

Do not use either chemical if you plan to raise small grain on the field next year. The chemical will kill the grain as illustrated in figure 4.

**CDAA and CDAA-T.** Use 4 pounds of active ingredient per acre of CDAA to control grassy annuals or CDAA-T to control most of the weeds controlled by atrazine. Both chemicals will replace the first cultivation. Two cultivations are required to give good weed control and they will control weeds between rows. Therefore, there is no point in making over-all applications. Treat 12- to 14-inch bands over the rows.

Granules are effective if applied to warm or cool soils, but sprays are ineffective if the soil is wet or cool (below 60° to 65° F.) Granules are also more effective than sprays if rain is not received for 10 days or 2 weeks after treatment. Band applicators are shown in figures 2 and 3.

**Increased yields.** Pre-emergence herbicides more



Figure 4. Carry-over effect from band application of atrazine killed bands of small grain seeded 1 year after treatment.

than pay for themselves through higher corn yields under some conditions, but not under others. Weeds reduce crop yields early in the growing season. If they can be controlled with cultivation early, the use of pre-emergence herbicides does not prevent yield reduction by weed competition. However, wet weather at the time of the first cultivation often prevents good weed control with the cultivator, and pre-emergence herbicides are very helpful.

In one extreme case during an abnormal corn year of 1958 at Brookings, pre-emergence herbicides resulted in much higher yields. Wet weather at the time of the first cultivation delayed the operation. Continued wet weather and advanced weed growth made it impossible to control the weeds by the first and second cultivations. During July and August there was no rain and weed competition reduced yields considerably. Pre-emergence herbicides controlled the weeds early and there was no competition during July and August. Plots cultivated three times produced 12 bushels of corn per acre, but plots sprayed with simazine and cultivated twice yielded 51 bushels per acre. These results were obtained during an abnormal year, but they illustrate the need for early weed control.

### Sorghum

Sorghum is more sensitive than corn to the presently available chemicals. However, early weed control is more important in sorghum because it grows slowly for the first couple of weeks after emergence.

CDAA and CDAA-T. These are the best chemicals for use as pre-emergence herbicides in sorghum. They are used as described for corn.

**Prometryne, atrazine, and propazine.** Prometryne gave good weed control without damaging the crop in one South Dakota test. Similar results were obtained in other states and this chemical is on the market for use in sorghum seed fields.

Atrazine is as effective for controlling weeds in sorghum as it is in corn. However, it sometimes damages sorghum. Propazine has not damaged sorghum in a limited number of tests, but it has not consistently given good weed control.

### Soybeans

Early season weed control in this crop is very important. Soybeans are good weed competitors if they germinate first. However, soybeans do not germinate when the soil is cool, but some weeds do. Consequently, some weeds get the upper hand.

**Amiben.** Numerous broad-leaved and grassy annuals can be controlled with this chemical. Use 3 pounds of active ingredient per acre on the area treated. The beans are sometimes stunted, but yield is seldom reduced. Good weed control is obtained if one-half to 1 inch of rain falls the first week to 10 days after application. The chemical is ineffective if no rain falls, but the soil contains enough moisture to cause weeds to germinate. However, if the top layer (1 to 1½ inches) of soil is too dry to cause weed seeds to germinate, satisfactory weed control will be obtained after a good rain, even though it may be 2 or 3 weeks after treatment.

An over-all application frequently makes it unnecessary to cultivate, but band treatments require two cultivations to kill weeds between the rows.

**CDAA.** Use as described for corn. Do not use CDAA-T on soybeans.

### Sugar Beets

Increasing interest in sugar beet production in eastern South Dakota has increased interest in chemical weed control in this crop. Hand labor requirements of sugar beet production are higher than for other crops. The use of pre-emergence chemicals can help cut production costs considerably. Three herbicides recommended for sugar beet pre-emergence weed control in South Dakota are TCA, Tillam, and Avadex.

**TCA.** This is the best chemical for control of annual grassy weeds (except wild oats). It also gives some control of annual broad-leaved weeds.



Apply as a spray at the rate of 6 pounds acid equivalent per acre. It can be applied in 7-inch bands over the rows at planting time, but over-all treatment with a regular field sprayer shortly after planting is preferred. A good rain or sprinkler irrigation is required to activate the chemical. However, abnormally heavy rains and cool soil may cause poor weed control.

**Tillam.** This chemical controls many species of annual weeds. Apply 4 pounds per acre treated before planting. Work the chemical into the soil with a disk or similar implement immediately after spraying. It is applied as an over-all treatment.

**Avadex.** This chemical controls wild oats. Apply at the rate of 1½ pounds per acre on the area treated. Spray as an over-all treatment on smooth soil surface just before planting. Incorporate the herbicide into the soil with a harrow.

#### **Flax, Spring Wheat, and Barley**

Flax is a poor "weed fighter." Therefore, it is important that flax be given a good start ahead of weeds early in the growing season. Likewise, wheat and barley yields are often reduced by weed competition early in the season. Wild oats can become a serious menace if they are not controlled within the first 3 weeks after emergence. There is only one pre-emergence herbicide suitable for use in these crops.

**Avadex.** The use of this chemical in flax, barley, and wheat is discussed in a fact sheet entitled "Control and Elimination of Wild Oats."

#### **APPLICATION OF HERBICIDES**

With the introduction of pre-emergence herbicides came new methods of application.

##### **Band Vs. Over-all Treatment**

It often is economically advantageous to apply pre-emergence herbicides in band treatments over the seed row to corn and other crops (figures 2 and 3). Cultivation will control the weeds between rows. The actual area treated will be treated at the same rate as an over-all (broadcast) treatment, but the over-all acreage will have less total chemical applied.

##### **Spray Vs. Granular Application**

The use of pre-emergence herbicides as wettable powders and liquid emulsions in making spray requires the use of 20 to 40 gallons of water per acre treated. For this reason some will prefer the use of granular material and avoid having to mix the chemical with water.

South Dakota tests have not shown any differences between the effectiveness of granular and liquid formulations. However, there is some evidence that the granular form of CDAA or CDAA-T is not affected by wet soil before treatment or heavy rains immediately after application to the extent the liquid forms are.

Granules cost more per acre than sprays (table 1) and they are more difficult to apply accurately. Few people are accustomed to applying small amounts of granules but many have sprayed. Sprayers have been manufactured for years, but granular applicators are relatively new machines. Consequently, more imperfections have been removed from sprayers. Inexperienced users have difficulty calibrating present-day granular applicators accurately. However, users are gaining experience and manufacturers are making improvements in the machinery each year.

#### **Herbicide-Insecticide-Fertilizer Mixtures**

In corn, insecticides are placed near the seed below the soil surface. Therefore, the chemical is dropped immediately behind the planter shoe. Granular fertilizer is placed to one side and below the seed so that the chemical does not damage corn seeds. Liquid fertilizer may be placed with the seed like an insecticide. Consequently, liquid fertilizers and liquid insecticides may be applied together, but granular forms must be applied separately.

Pre-emergence herbicides must be applied to the entire field or in bands over the rows. They can not be placed as deeply in the soil as fertilizer or insecticides. Consequently herbicides (sprays or granules) must be applied separately from fertilizers or insecticides. Figure 3 illustrates that three attachments are required to apply granules of the three types of chemicals to three different places in the soil.

#### **Calibration of Sprayers and Granular Applicators**

Calibration of applicators is described in a fact sheet entitled "Chemical Control of Weeds in Crops."

The following are several hints for successful application of pre-emergence herbicides whether granular or spray.

1. For spray application, use flat, fantype nozzles for application, not cone type. In spray band applications, where spray patterns do not overlap, special nozzle tips. These special nozzle tips will give a rectangular shaped pattern instead of one with tapered edges that are given by a normal flat spray nozzle.
2. Flexible metal delivery tubes on granular applicators should not be too long on an uneven flow of granular material will result.
3. Check air-tight plastic delivery tubes periodically for clogging of granular material when used under humid conditions.

Pre-emergence herbicides can do a safe, economical weed control job for you. Remember to use them on a trial basis on your farm until you are satisfied with the particular chemical you choose. One last reminder—read the label and apply the recommended rate.