PURDUE UNIVERSITY

PURDUE EXTENSION WEED SCIENCE

www.btny.purdue.edu/weedscience/

WS-31-**W**

Glenn Nice

Bill Johnson

Tom Bauman

Purdue Extension Weed Science

Amine or Ester, Which is Better?

The spring is often synonymous with "burndown" to producers in Indiana. Around this time we sometimes get the question, "what is the difference between amine and ester formulations of 2,4-D?" This is a good question for there are some subtle differences. However, I will start with what the two formulations have in common.

Common Characteristics

The amine and ester of 2,4-D are both formulations of one of the oldest and widely used herbicide families. 2,4-D belongs to a group of herbicides called phenoxy-carboxylic acids. This group of herbicides was developed in the mid-1940s by the military for vegetation control. In 1945, Imperial Chemical Industries Ltd. reported using a phenoxy to control wild mustard (Klingman and Ashton 1982). The compounds in this herbicide group act on susceptible plants in the way the plant's growth hormones work. That is why this group and others like it are often referred to as auxin-like herbicides or growth regulator herbicides; auxins being plant hormones involved in growth.

Figure 1. Fused brace roots of corn. This corn plant is susceptible to lodging.

I have often heard it said that, "growth regulator herbicides grow the plant to death." In some ways that is correct; a growth regulator induces unorganized growth in the plant. This growth can crush the vascular system of the plant, blocking it off from nutrients, sugars, and water. Although this group of herbicides has been around for a long time, the specific details of how they work is still being determined. This is partially due to the fact that growth hormones have many effects in plants and many binding places in the plant's physiology.

One characteristic about 2,4-D is that it is used to control annual, biennial, and perennial broadleaf weeds, but has little effect on grasses. It is this selectivity that makes 2,4-D one of the most popular herbicides for use in lawns. However, 2,4-D can injure grass crops if applied at specific times. Although labeled for use in corn, sorghum, and wheat, 2,4-D can damage corn by causing brittle stems or fused brace roots (Figure 1) and may reduce yield when applied late in the growing season. Use of 2,4-D after jointing in wheat can induce malformed seed heads, thus reducing yield.

Herbicides with 2,4-D are often implicated in noticeable drift situations. This is partly due to the fact that many broadleaf plants can be sensitive to 2,4-D, even at low rates. Such sensitive broadleaf plants include, but are not limited to, soybeans, tomatoes, grapes, and maples. Characteristic symptoms of 2,4-D drift are leaf puckering and strapping (Figure 2). Larger amounts of 2,4-D can twist and bend the stems (Figure 3). In some cases, drift is a result of 2,4-D volatility, the herbicide's ability to turn into a vapor and move off site. This is how the amine and ester formulations can differ.

Amine or Ester, Which is Better?

May 25, 2004 (revised)

PURDUE EXTENSION WEED SCIENCE

www.btny.purdue.edu/weedscience/

Figure 2. Soybean leaves strapped from 2,4-D damage.

Figure 3. Tomato plant showing stem damage from 2,4-D.

Differences

Two major formulations of 2,4-D are amine salts and esters. These two formulations tend to differ in several aspects.

The first difference is that ester formulations have higher vapor pressures and tend to volatilize more than amines. Many people use amine formulations when there is concern of volatilization around sensitive plants. Volatility can increase in hot, dry weather. Several ester formulations are referred to as "low volatile" esters. Such formulations are generally formulated as long chain esters that make the molecule less volatile. Even so, esters are generally more volatile than amines.

Secondly, amine formulations may provide slightly less weed control. Ester formulations are often referred to as being "hotter," meaning that they display more activity on plants. This is not always a good thing, for in the wrong instances this can lead to crop injury. Esters are more active on plants because they are more soluble in the plant's cuticle. Thus, plants more readily absorb esters than amines. Amine formulations are more water soluble and are less efficient at moving from the leaf surface, across the cuticle, and into the leaf. The cuticle is a layer of waxes and lipids that help protect the plant against desiccation and invading pathogens. Cuticles can also give some level of protection from herbicides by inhibiting their movement into the leaf. Esters are lipid soluble and move through the cuticle more efficiently. Also, because hard water is so common in Indiana, it is worth noting that amine formulations can precipitate out of solution in hard water. However, most 2,4-D amine herbicides have additives designed to reduce precipitation. Oddly enough, once in the plant, the plant converts the amine or ester into the active acid. It is the acid that interferes with growth and eventually can kill susceptible plants.

The Weed Science Society of America publishes a Herbicide Handbook, which gives many of the chemical and physical properties of different herbicides, including 2,4-D. Properties of 2,4-D and some comparisons showing some differences between amine and ester formulations can be found in this book.

For herbicide label information go to

www.cdms.net
or
www.greenbook.net

Amine or Ester, Which is Better?

May 25, 2004 (revised)

What Products Contain 2,4-D

There are many products containing 2,4-D available on the market. From home used "Weed and Feed" products for your lawn to agchemicals used in crop production or right-of-way vegetation control. It would take a catalog to list all or the 2,4-D products available. The Indiana Office of the State Chemist lists over 129 products that contain some formulation of 2,4-D. Some labels have small differences in how they can be used depending on product, so carefully read the labels before use. Herbicides containing 2,4-D are labeled for use in several crops in Indiana.

Using 2,4-D In Corn

In corn, 2,4-D can be applied before planting to control vegetation, before crop emergence or post-emerge to control weeds that emerge after planting. However, it may not be understood that in a pre-plant application most labels recommend that you wait seven to 14 days before planting, depending on the rate used. This waiting period prevents possible seed damage from 2,4-D contact. Most labels recommended that you plant seed more than one inch deep to avoid contact between 2,4-D and the seed. If you wish to use 2,4-D after planting, some labels recommend that you wait three to five days after planting to allow the soil to settle in the seed furrow to minimize the chance of seed contact with 2,4-D before emergence. Post-emergence applications can be done up until the corn reaches eight inches, after that height, drop nozzles or direct application methods will have to be used. 2,4-D should not be applied when corn starts to tassle. The specific application time may vary between labels.

Using 2,4-D with Soybean

Use of 2,4-D with soybeans is restricted to pre-plant applications only. If 0.5 lb ae/A of ester (approx. 1 pt/A of most products) is used, then you have to wait seven days before planting. Often, amine formulations require a 15 day wait between application and planting. If more than 0.47 lb ae/A of either formulation is used, then the waiting period goes up to 30 days. Agriliance's 2,4-D product E99 allows for 15 days before planting with rates more than 0.5 lb ae/A. As with corn, deeper planting is required. Some labels recommend a depth of 1.5 inches, others two inches. Many 2,4-D products are not labeled for soybean use at all.

Using 2,4-D with Small Grains

Use of 2,4-D with small grains requires applications between tillering but before the joint stage. However, the potential for injury increases the closer the application is to the boot stage.

PURDUE EXTENSION WEED SCIENCE

www.btny.purdue.edu/weedscience/

Amine or Ester, Which is Better?

May 25, 2004 (revised)

Using 2,4-D with Sorghum

In sorghum, 2,4-D can be broadcast from six to eight inches tall and with drop nozzles when it is eight to 15 inches tall. Slight increases in rates can be used when drop nozzles are used.

Using 2,4-D with Grass Pastures

2,4-D is one of the most commonly used herbicides for broadleaf weed control in grass pastures. Amine formulation labels frequently mention that grass pastures should have established root systems before use to reduce crop injury. If seed from the pasture grass is desired, don't apply 2,4-D when the grass is entering the boot or milk stage, otherwise seed production can be adversely affected. Some labels suggest not applying 2,4-D when heads are developing. Most labels require a wait of seven days after a 2,4-D application before dairy cows can graze, 30 days before cutting, and three days before meat animals grazing on grasses treated with 2,4-D can be sent to slaughter.

References:

Anderson, W.P. 1996. Weed Science Principles and Applications 3rd edition. pp.193-197 West Publishing Company, New York.

Klingman, G.C. and F.M. Ashton. 1982. Weed Science Principles & Practices. 2nd edition. pp. 204-205. John Wiley & Sons, New York

PURDUE EXTENSION WEED SCIENCE

www.btny.purdue.edu/weedscience/

Information listed here is based on research and outreach extension programming at Purdue University and elsewhere.

The use of trade names is for clarity to readers of this site, does not imply endorsement of a particular brand nor does exclusion imply non-approval. Always consult the herbicide label for the most current and update precautions and restrictions. Copies, reproductions, or transcriptions of this document or its information must bear the statement 'Produced and prepared by Purdue University Extension Weed Science' unless approval is given by the author.

Amine or Ester, Which is Better?

May 25, 2004 (revised)

Table 1. Control* with 2,4-D alone

Weed	Control Rating	Application Timing
Alfalfa	fair to good	spring application
Annual smartweed	fair to good	spring
Annual morningglory	excellent	in growning season POST
Bull thistle	good	best in first year's growth
Cocklebur	excellent	in growing season POST
Common burdock	excellent	in growing season POST
Common lambsquarters	excellent	spring
	excellent	in growing season POST
Common ragweed	excellent	spring
	excellent	in growing season POST
Dandelion	Fair to good	efficacy can increase if subjected to a frost in the fall
Deadnettle	poor to good	spring or fall
Field pennycress	excellent	fall or spring
Giant ragweed	excellent	spring
	excellent	in growing season POST
Hairy vetch	fair to good	fall
	good to excellent	spring
Henbit	poor to good	spring of fall
Jimsonweed	fair	in growing season POST
Marestail / horseweed	good to excellent	fall
	fair to good	spring
Musk thistle	excellent	best first year's growth
Mustard	excellent	fall
	good to excellent	spring
Pigweed	excellent	in growing season POST
Plantain	excellent	
Prickly lettuce	good to excellent	spring or fall
Red clover	poor to good	fall
	fair to good	spring
Shepherd's purse	excellent	fall
	good to excellent	spring
Sunflower	excellent	in growing season POST
Teasel	fair	best first years growth
Velvetleaf	good	in growing season POST
Waterhemp	good	in growing season POST
Wild parsnip	good	in growing season POST

*Control ratings taken from the 2004 Weed Control Guide for Ohio and Indiana (www.btny.purdue.edu/WS/WS-16).