UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
WASHINGTON D.C., 20460

NOV 25 2013

OFFICE OF CHEMICAL SAFETY
AND POLLUTION PREVENTION

MEMORANDUM

SUBJECT: BEAD Chemical Profile for Registration Review: Flucarbazone-sodium (114009)

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Product Review Panel date: May 22, 2013

SUMMARY

Flucarbazone-sodium is registered for use on spring wheat, including durum, and winter wheat, grasses grown for seed, on conifers (plantations/nurseries), and on ornamental lawns and turf. Based on available usage information, flucarbazone-sodium may play a relatively important role

in the control of weeds in spring wheat production, where about ten percent of the crop is treated annually. In winter wheat, only about one percent of the crop is treated annually, suggesting that flucarbazone-sodium plays a relatively minor role in weed control. However, recent data show that use in winter wheat may be increasing over the past several years. While many weed species have developed resistance to ALS-inhibiting herbicides such as flucarbazone-sodium, the fairly consistent use of this herbicide in wheat production for the past several years does not suggest that growers are having any particular resistance problems at this time that would deter them from using it.

Flucarbazone-sodium may play a role in resistance management as a tank mixed product. Furthermore, as a post-emergence herbicide used in wheat production, it can provide growers with useful options if pre-plant or pre-emergence herbicides do not provide adequate control of weeds. Growers can use this herbicide as a post-emergence application to control competing weeds present in wheat fields such as wild oats, foxtails, and other grass and broadleaf weed species. However, there are several alternatives to flucarbazone-sodium that can be applied as post-emergence treatments for the control of similar weeds.

BEAD does not have any information to assess the pest management role of flucarbazone-sodium in grass grown for seed or in conifer and turf.

INTRODUCTION

The Biological and Economic Analysis Division (BEAD) Chemical Profile (BCP) provides an overview of the pest management roles and quantitative usage information for flucarbazone-sodium. The BCP includes summaries of previous BEAD products and available public and/or private use and usage data for flucarbazone-sodium to describe the role of this chemical in pest management. Additional information on use is available in the flucarbazone-sodium PRD Label Data Report and the Screening Level Usage Analysis. Information provided in this BCP may be used by stakeholders (e.g., users and registrants), OPP risk assessors and risk managers, and the general public during the Registration Review process of this pesticide. The document is based on information and data available to BEAD as of October 2013.

Flucarbazone-sodium was first registered in the U.S. in 2000. This herbicide is designated as a reduced risk herbicide. Flucarbazone-sodium belongs to the Sulfonylaminocarbonyltriazolinone group of herbicides (Weedscience.org, 2013) and it is a systemic herbicide used for the post-emergence control of wild oat, green foxtail, and other grass and broadleaf weeds found in crop production fields and other sites described under the use sites. According to the Weed Science Society of America (WSSA) mechanism of action classification, flucarbazone-sodium belongs to the group 2 herbicides. The mechanism of action of this group of herbicides is inhibition of the enzyme acetolactate synthase (ALS) enzyme which is also called the acetohydroxyacid synthase (AHAS). Inhibition of this enzyme interferes with the biosynthesis of branched-chain amino acids such as valine, leucine, and isoleucine and initiates a cascade of events leading to the death of susceptible weeds.

USE SITES

Agricultural Use Sites
Flucarbazone-sodium is registered for use in spring wheat, including durum, winter wheat, grasses grown for seed, and conifers (plantations/nurseries).

Non-Agricultural Use Sites
Flucarbazone-sodium is registered for use on ornamental lawns and turf, including golf courses.

COMMON FORMULATIONS AND APPLICATION METHODS

Flucarbazone-sodium is formulated as water dispersible granules, emulsifiable concentrate, and soluble concentrate. Use in grass grown for seed is limited to soluble concentrate and use in conifers and turf is limited to the emulsifiable concentrate. This chemical is applied as broadcast and spot treatment. According to the information provided on the product label of Everest® herbicide, aerial and ground applications are recommended as the application methods of this herbicide.

HISTORY OF BEAD ASSESSMENTS FOR FLUCARBAZONE-SODIUM

BEAD has not previously assessed the benefits associated with the use of flucarbazone-sodium.

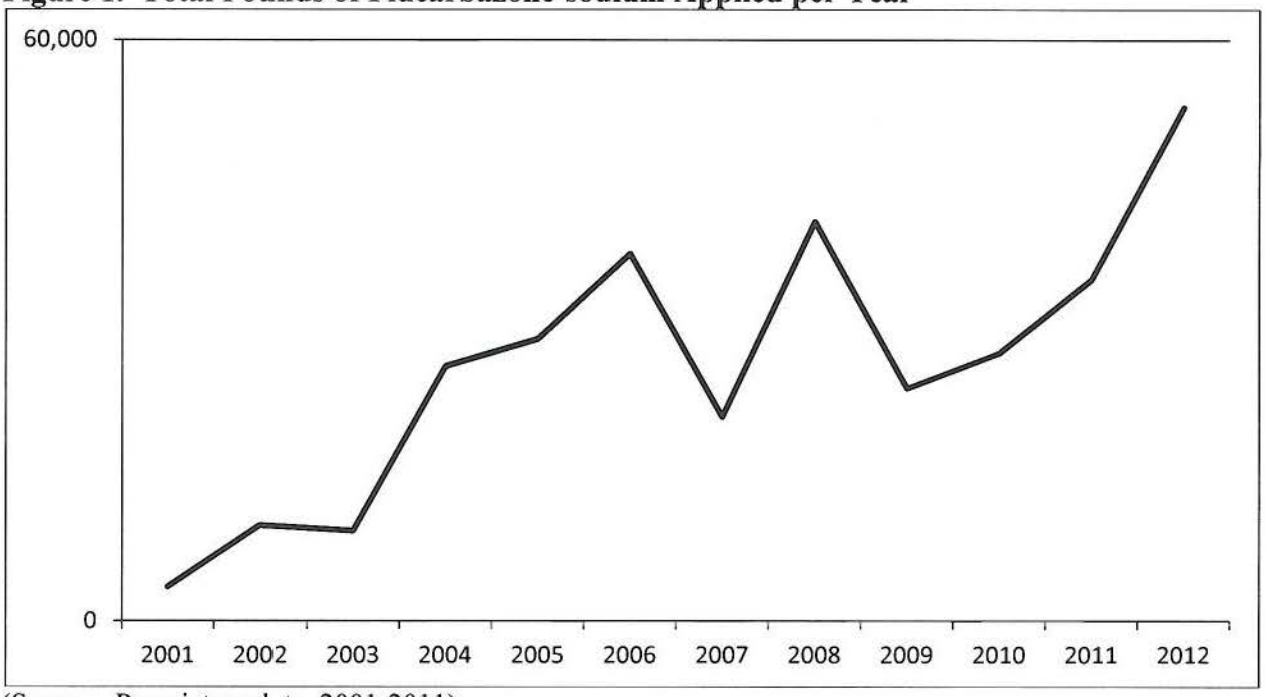
USAGE

Based on private market pesticide usage data from 2008-2012, flucarbazone-sodium's annual agricultural usage averaged 36,000 pounds of active ingredient (A. I.) treating an average of 2.4 million acres, for an average application rate of 0.015 pounds A.I. per acre. Use in grass seed, conifer, and turf production is not included in this estimate as usage survey data do not cover these sites.

USE TRENDS

Figure 1 shows the overall trend of flucarbazone-sodium use from 2001 through 2012. Use has risen steadily since registration in 2000. Use fluctuated around an average of 30,000 pounds A.I. applied per year in the latter half of the decade, but recent data suggests the upward trend may continue (Proprietary data, 2001-2012). Thus, the average use reported here may underestimate future use.

Figure 1. Total Pounds of Flucarbazone-sodium Applied per Year



(Source: Proprietary data, 2001-2011)

During this timeframe, spring wheat accounted for the largest percentage of usage in terms of total pounds of A. I. applied and total area treated. See Table 1 below. The average application rate of 0.015 lb A.I. per acre is approximately the same for both winter and spring wheat. Less than 0.5 percent of the total amount was applied to fallow and barley according to survey data. These are not registered use sites and the survey results could indicate misuse, response errors in the survey, or reflect the respondents' interpretation of the question (*e.g.*, fallowed land to be planted with wheat).

Table 1. Flucarbazone-sodium's Top Crops in Terms of Avg. Lbs. Applied & TAT (2008-2012)

Crop	*Pounds Applied (A.I)*	*Total Acres Treated*
Wheat, Spring	77.0%	77.8%
Wheat, Winter	22.3%	21.9%

(Source: Proprietary data, 2008-2012)

Over the 2004 to 2011 time period, about five percent of U.S. wheat acreage was treated each year, on average, with flucarbazone-sodium (BEAD, 2011). According to data from the U.S. Department of Agriculture (NASS, 2010), flucarbazone-sodium has been used on less than one percent of the U.S. winter wheat acreage. Use is somewhat more prevalent on spring wheat, with less than five percent of durum wheat treated and between seven and nine percent of acres in other spring wheat.

As seen on Table 2 below, flucarbazone-sodium's top states in terms of both pounds (lbs.) applied and total area treated (TAT) are North Dakota, Montana, and Minnesota. These three states accounted for about 80 percent of total acres planted to spring wheat in the U.S. between 2009 and 2011 (NASS, 2012). There is substantial acreage of winter wheat in Montana as well.

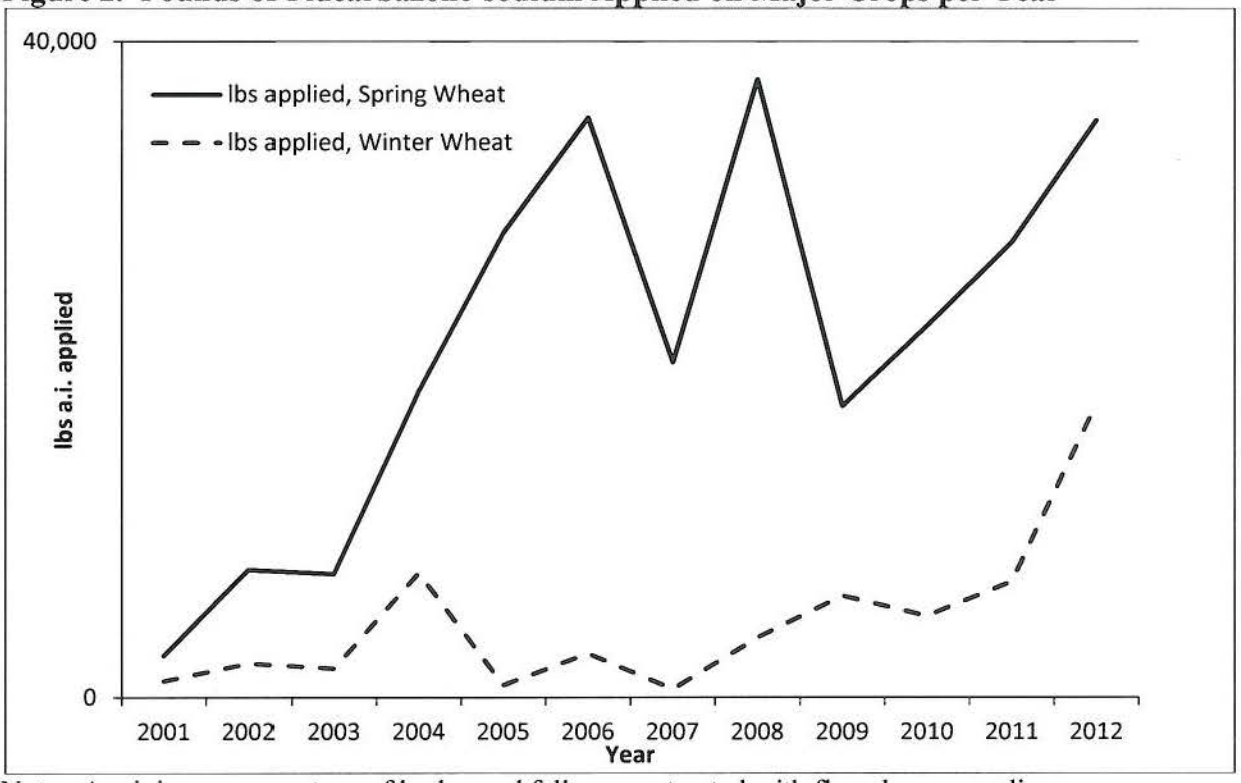
Table 2. Flucarbazone-sodium's Top States in Terms of Avg. Lbs. Applied & TAT (2008-2012)

STATE	*Pounds Applied*	*Total Acres Treated*
North Dakota	63.0%	63.4%
Montana	15.0%	13.5%
Minnesota	5.8%	6.8%

(Source: Proprietary data, 2008-2012)

Figure 2 depicts flucarbazone-sodium's agricultural usage, in terms of pounds applied, for winter and spring wheat (proprietary data, 2001-2012). Since about 2005, use in spring wheat has fluctuated from year to year, but does not appear to be trending up or down while use in winter wheat has been stable or increasing, especially in the most recent year data are available.

Figure 2. Pounds of Flucarbazone-sodium Applied on Major Crops per Year

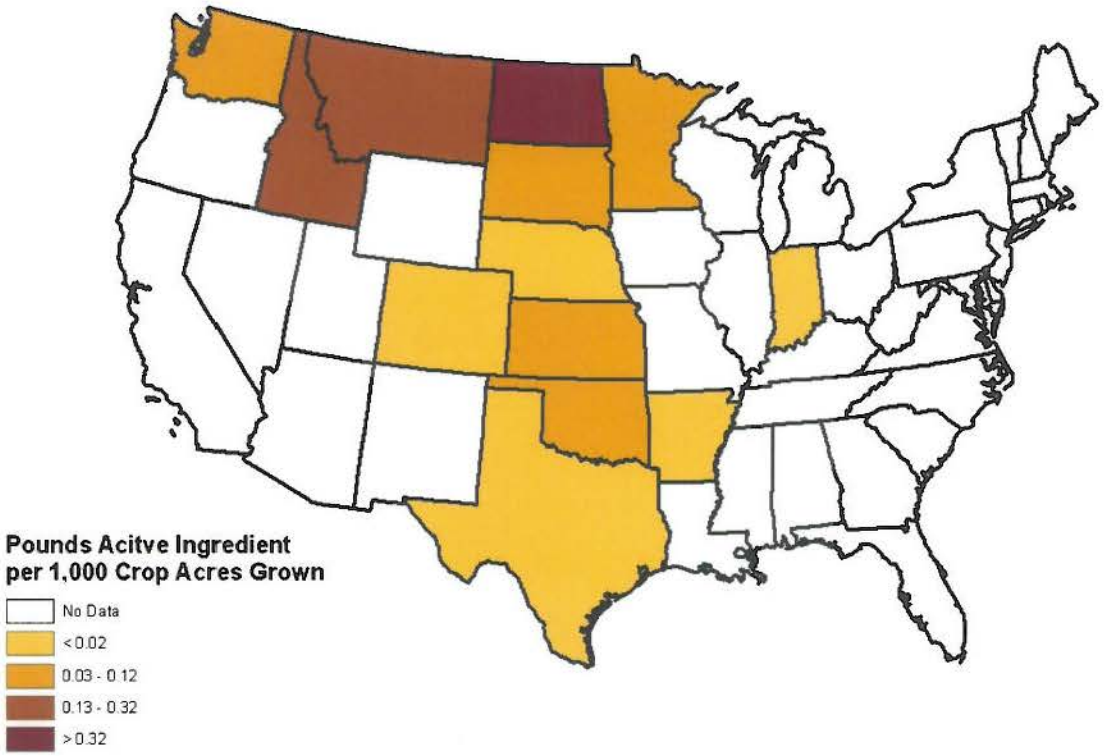


Note: A minimum percentage of barley and fallow was treated with flucarbazone-sodium.
(Source: Proprietary data, 2001-2012)

Geographic Distribution of Flucarbazone-sodium Use

Figure 3 depicts the regions of the United States where use of flucarbazone-sodium is reported. The map indicates the relative intensity of use where the use intensity is expressed as the pounds A.I. applied per 1,000 acres of cultivated crop land. This differs from the application rate, which is expressed as the pounds A.I. applied per treated acre. The average application rate for the period 2008-2012 is 0.015 pounds A.I. per acre, or 15 pounds A.I. per 1,000 treated acres. As shown in Figure 3, however, use intensity range is well under one pound per 1,000 acres of crop land. The area of highest intensity is in North Dakota reflecting a relatively high percent of spring wheat treated with flucarbazone-sodium and a high proportion of spring wheat in farmland. Relatively low intensity of use is shown in Kansas, Oklahoma, and Texas. These three states account for almost 50 percent of winter wheat acreage in the U.S. (NASS, 2012), but, as noted above, less than one percent of U.S. winter wheat is treated with flucarbazone-sodium (NASS, 2010).

Figure 3. Flucarbazone-sodium Usage by State (2008–2012)



See Appendix A for explanation of the methodology and data used to generate Figure 3, as well as a discussion of data limitations and uncertainties.

CHEMICAL AND USE CHARACTERISTICS

Flucarbazone-sodium belongs to the sulfonylaminocarbonyltriazolinone group of herbicides (Weedscience.org, 2013). Herbicides belong to this group inhibit the acetolactate synthase (ALS) enzyme which is also called the acetohydroxyacid synthase (AHAS). Inhibition of this enzyme interferes with the bio-synthesis of branched chain amino acids (valine, leucine, and isoleucine) in susceptible weeds (WSSA, 2013). Other major classes of herbicides which inhibit this enzyme are imidazolinones, pyrimidinylthiobenzoates, sulfonylureas, and triazolopyrimidines. Variations on residual activity, crop selectivity, and spectrum of weeds controlled may be observed with the application of herbicides included in these classes (Univ. of Tennessee, 2013). The majority of these herbicides are systemic herbicides and they are active on annual and perennial weed species. The major weed species controlled by flucarbazone-sodium are green foxtail (*Setaria viridis*), wild oats (*Avena sativa*), barnyard grass (*Echinochloa-crusgalli*), brome species (*Bromus* spp.), redroot pigweeds (*Amaranthus retroflexus*), wild mustard species (*Brassica* spp.), curly dock (*Rumex crispus*), and Pennsylvania smart weed (*Polygonum pensylvanicum*).

Generally, injury symptoms occurring due to the applications of ALS inhibitors appear within a week after the herbicide treatments. Significant symptoms are chlorosis, purple leaf veins, and bottlebrush appearance of roots in some weed species. Complete death of susceptible weed species may occur within two to three weeks after the herbicide applications. It has been reported that currently, 131 different weed species have developed resistance to ALS inhibiting herbicides in more than 400 locations in the world (Weedscience.org, 2013). Clodinafop, fenoxaprop, pinoxaden, and propoxycarbazone-sodium are some of the herbicides that can be used as alternatives to control wild oats, Italian ryegrass, and other grass weed species in spring wheat production (Morishita and Lyon, 2012).

Flucarbazone-sodium is applied as a post-emergence treatment (herbicide applied after the emergence of the crop) in wheat. Generally, post-emergence treatments are highly effective when applied at the seedling stage of weeds. The use of post-emergence herbicides, including flucarbazone, is important when pre-plant or pre-emergence treatments do not provide adequate weed control. The alternatives noted above can also be use post-emergence. Furthermore, flucarbazone-sodium is used for the selective control of grass and broadleaf weed species in tolerant cool and warm season turf grass species. In addition, this herbicide is used for the growth management and seedhead suppression of certain turf grass species (Align Product Label, 2010).

ROLE OF FLUCARBAZONE-SODIUM IN PEST CONTROL

Given the low percentage of the crop treated, flucarbazone-sodium does not appear to play an important pest control role in winter wheat production. However, the relatively higher percentage of spring wheat treated suggests that flucarbazone-sodium may be important for weed control in spring wheat production. While many weed species have developed resistance to ALS-inhibiting herbicides such as flucarbazone-sodium, the fairly steady usage of this herbicide in wheat production for the past several years does not suggest that growers are facing resistance

problems at this time. Flucarbazone-sodium may play a role in resistance management, for example, in a tank mix in combination with herbicides with different mechanisms of action.

As a post-emergence herbicide, it can provide growers with useful options if pre-plant or pre-emergence herbicides do not provide adequate weed control. Flucarbazone-sodium is likely to be an effective product for the control of wild oats, foxtails, Italian ryegrass, and other grass weed species found in wheat. However, it is not unique in either the weeds it controls or in its use as a post-emergence herbicide.

BEAD does not have sufficient information on the use of flucarbazone-sodium to assess its value in grass grown for seed, in conifer production, or in turf.

INFORMATION THAT MAY BE USEFUL FOR BEAD'S FUTURE WORK ON FLUCARBAZONE-SODIUM

The Agency currently does not have important information on some uses of flucarbazone-sodium. To understand the role of flucarbazone-sodium in the production of grass seed, conifers, and turf, and any benefits it provides users, useful information would include

- acres treated and application rates,
- timing and frequency of applications, and
- target pests

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Appendix A. Flucarbazone Use Intensity by State (2008 – 2012)

The map included herein is primarily for the use of the risk assessors in the Environmental Fate and Effects Division. The map provides a very broad geographical view of the average annual amount (in pounds) of the active ingredient applied per 1,000 acres of crop acres grown. These data are included in the maps because risk assessors are interested in the amount of a pesticide used across agricultural land. The calculated values presented in the map are not equivalent to an application rate (lb ai/A).

The data used to make these maps have several limitations. Any interpretation of the maps should consider the underlying data and the associated limitations carefully.

The numerator (annual average pounds applied) is based on private market surveys of pesticide use in agriculture averaged over the last five years (Proprietary Data, 2008-2012). These surveys cover about 60 crops and are targeted in states that produce the majority of the crop. Although the surveys capture most of the use of a particular active ingredient in agriculture, there are several limitations to these surveys.

- States with minor production of a surveyed crop are not sampled
- Not all types of pesticides are surveyed in every crop in every year
- Many specialty crops with very small acreages are not included in the survey

The result of these limitations is that states that show no usage may actually have a small amount of the active ingredient being used. In some cases the displayed use intensity may be distorted because the surveyed crops and the reported pesticide usage may not accurately represent the actual pesticide usage on the crops produced in the state.

The denominator (1,000 crop acres grown) was also obtained from the same private market survey database. The "Crop Acres Grown" variable represents the total acres grown in a given state of all of the surveyed crops. This value is independent of pesticide usage and pesticide registration. It is important to note that the surveyed crops (about 60) are sampled from states that are major producers of each crop. Therefore, there are cases where the actual crop acreage in a state is higher than that reported by crop acres grown in the survey because either that state and/or crop was not included in the survey.

The reader should pay particular attention to the figure legends and realize that a map prepared for a particular chemical is not directly comparable to a map prepared for a different chemical as the legend bins will likely be different.