

# **WEED MANAGEMENT IN ALFALFA: WHERE WE'VE BEEN AND WHERE WE'RE GOING**

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## **ABSTRACT**

Weed management is a critical component of profitable alfalfa production in California and herbicides have played a key role. In this paper we review the herbicide registration timeline to provide a historical perspective on weed management in alfalfa and to offer some insight as to where we may be headed in alfalfa weed control in the future. Herbicide use patterns in 2002 were contrasted with 2012 for several alfalfa production regions in California. Weed management systems and herbicide use patterns vary considerably across the state, a reflection of the extreme diversity in alfalfa production environments that exist in California. There is nearly as much diversity in environments in California as there is across the entire U.S. Since the 1960's there has been a more or less continual flow of herbicide development and registration in alfalfa. However, it has been over 10 years since the last new herbicide registration in alfalfa. Possible reasons for this are discussed in this paper.

**Key Words: Weed control, herbicide use, herbicide registration, broadleaf weeds, grass weeds, Roundup Ready alfalfa**

## **INTRODUCTION**

Weed management is a continual challenge for alfalfa producers statewide, but important weed control issues are regional and depend on the production area. Regardless of the area, more money is typically spent on weed control than on insect or disease management in most years. Weeds can reduce the vigor and stand density in seedling alfalfa. In established alfalfa, weeds reduce the forage quality and marketability of alfalfa. Many markets have near zero tolerance for weeds without discounting the price of the hay significantly. Therefore, herbicides are a key component of most weed management systems in California. No one has a crystal ball to predict where we are headed when it comes to weed control and herbicide development in alfalfa, but it is often useful to look at where we have been to get a better sense of trends and where we may be headed.

## **BEFORE 1960**

The non-chemical weed control practices used before 1960 were the same as those used today. These included the use of weed-free seed, planting between peak periods for annual weed germination, properly leveled fields, keeping borders, ditches and ditch banks clean, timing cuttings to enhance crop vigor, summer fallow, cover crops, sheep grazing and other practices.

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Some non-selective chemicals were also used at this time to control weeds around fields and within fields where particularly undesirable weeds such as dodder were present. This included salts such as sodium chlorate and ammonium salts, oils and acids like boric, sulfuric and carbolic acids. Arsenicals including sodium arsenic trichloride and arsenic acids were also used.

### **1960-1970**

The period between the end of World War 2 and about 2008 was a period of remarkable discovery and development of selective herbicides in alfalfa. Herbicides in the developmental stages in the 50's began to be registered and used in the 60's. Eptam (EPTC), Balan (benefin) and Chem Hoe (chlorpropham) were the first preemergent herbicides and 2,4-DB and dinoseb were the first postemergent herbicides used at this time. Eptam was the first herbicide applied by chemigation and it was used both preplant and on established alfalfa. It was the standard for the 20-year period between 1960 and 1980. It is still used but on a very limited scale today. Balan was introduced shortly after Eptam and could only be used preplant incorporated. It was the first dinitroaniline herbicide registered on alfalfa and is still on a limited scale today. Dinoseb (DNBP) and 2,4-DB were the first postemergent herbicides used in alfalfa. Dinoseb was a contact herbicide while 2,4-DB was a systemic growth regulator. Dinoseb was used widely from 1962 to 1987 when registrations were cancelled due to long term health effects. 2,4-DB was used in 1960 and is still widely used today.

### **1970-1980**

New registrations continued this decade, although many of them had limited use in the Low Desert due to the lack of a dormant period there and the marginal crop safety of these herbicides to an actively growing crop. Gramoxone, Tolban and Sencor were registered during this time period, but all had problems with crop safety for them to be used safely in the Low Desert. Eptam, 2,4-D and dinoseb continued to be standards. Treflan EC was briefly registered for a Special Local Need, 24c for water-run applications in alfalfa for irrigation runs of 660 feet or less. This was prior to the development of TR-10 which worked much better; this registration was dropped in 1980.

### **1980- 1990**

This was a very active period of product testing and registration in alfalfa. Some of the registrations from this period continue to have a major impact on alfalfa weed control. Velpar (hexazinone), the soil residual herbicide used on dormant alfalfa, was registered during this decade and remains a dominant herbicide in central and northern California and other western states where the alfalfa has a winter dormant period. Significant advances in selective grass control also occurred during this period. Treflan (trifluralin) granules were registered for pre-emergence control and the "over the top" products such as Poast (sethoxydim), Fusilade (fluazifop) and Select (clethodim) were developed and registered. Poast was first followed by Select about 10 years later. Fusilade was never registered in alfalfa. Treflan had been registered as an EC in local areas and Treflan granules on a different granule formulation were tried earlier but neither worked as well as this new formulation. Buctril (bromoxynil) and Kerb (pronamide) were also registered during this period but their use was limited in some areas. The problem

with Buctril was a lack of crop safety in some areas (especially when applied under high temperature and sunlight intensity conditions) and was primarily only effective on small weeds. Reasons for the limited use of Kerb were leaching of the product below the germinating weed seed with flood irrigation, the cost of the product and its limited effectiveness on larger weeds (especially mustards).

### **1990-2000**

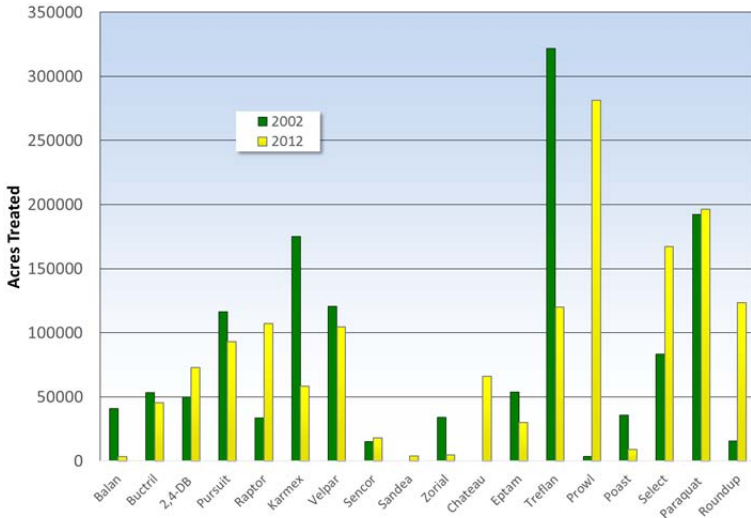
The imidazolinone herbicides [Pursuit (imazethapyr), Scepter (imazaquin), Arsenal (imazapyr)] were registered during this decade. Pursuit and later Raptor (imazamox) are still the standards for weed control in seedling alfalfa to this day. A broad spectrum of broadleaf weeds are controlled both pre-emergence and postemergence with these herbicides. Select (or Prism) was registered in this period and offered improved control of certain grasses such as annual bluegrass and sprangletop. Zorial (norflurazon) was also registered during this period, briefly as a granule called Evital and later only as Solicam.

### **2000-PRESENT**

The first part of this decade saw the registration of two new herbicides for alfalfa, Raptor and Chateau (flumioxazin), the expanded registration of two products used on other crops, Prowl H2O and Sandea (halosulfuron), the expanded registration of Velpar to the Low Deserts, and the deregulation and commercialization of Roundup Ready (RR) alfalfa. Raptor controls a broader spectrum of weeds than Pursuit with less soil residual and has become the most popular herbicide used on conventional seedling alfalfa. Chateau offered pre-emergent control of winter annual weeds. Prowl H2O offered a “water run” option for grass control and could also be easily tank mixed with winter dormant applied herbicides in central and northern California for year-round weed control in a single application. Sandea is effective during the “summer slump” period for nutsedge control in areas that contend with that challenging weed. The old restriction on Velpar excluding its use in the low deserts was also dropped around 2010.

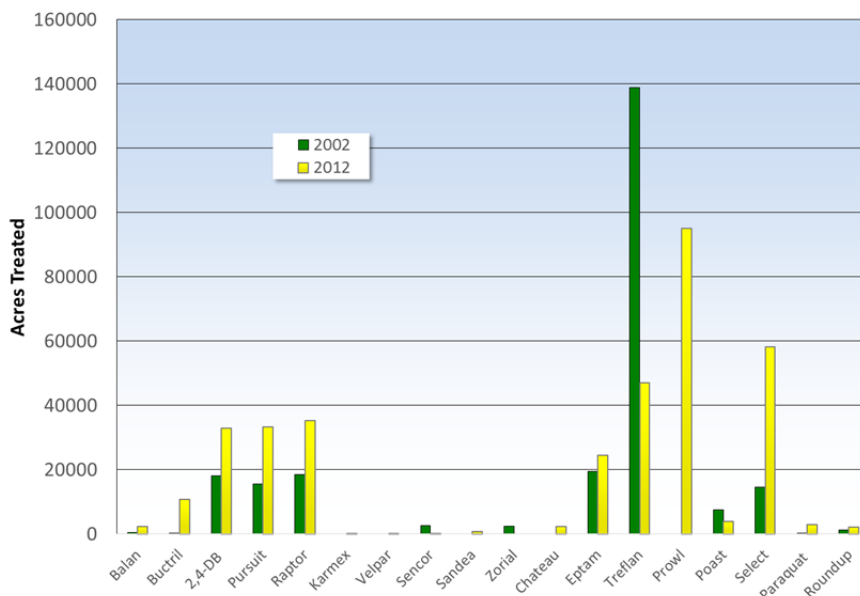
### **HERBICIDE USE PATTERNS**

It is interesting to observe how herbicide use patterns differ for the different regions of California, and secondarily how they have changed over just the last decade from 2002 to 2012 (most recently available data from the California Department of Pesticide Regulation data base). Figures 1 – 5 show herbicide usage on alfalfa for California as a whole and for individual counties representing the Low Desert (Imperial County), the Central Valley (Tulare and San Joaquin Counties), and the Intermountain Region (Siskiyou County).



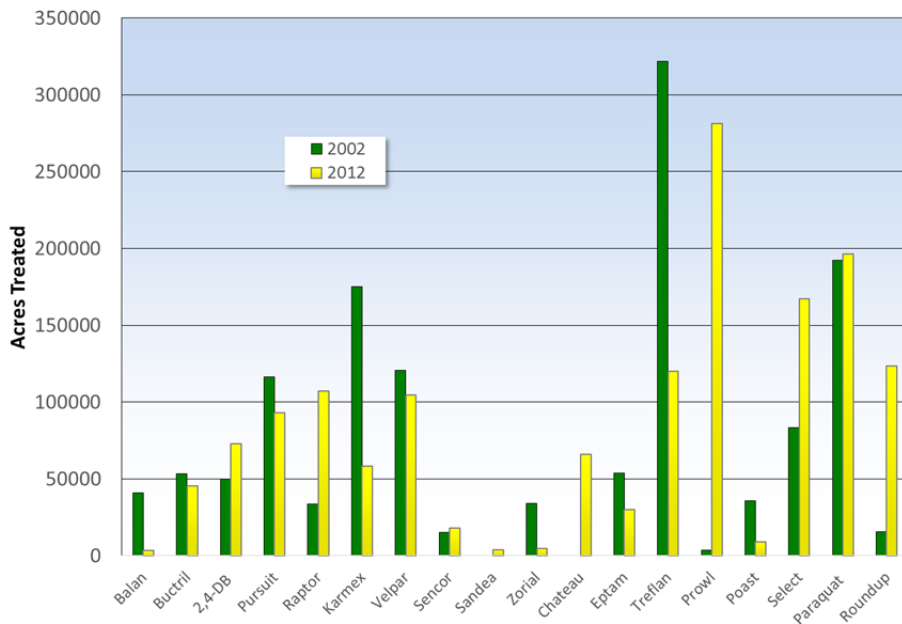
**Figure 1.** Herbicide Use in Alfalfa in California in 2002 Versus 2012

Low Desert. The primary herbicides used are Prowl, Treflan, Select, 2,4-DB, Pursuit and Raptor. The winter dormant herbicides widely used in other areas of California (soil residual herbicides and the contact herbicide Gramoxone) have very little use in the Low Desert. There is no dormant season and alfalfa is cut 7 to 10 times per year for an average yield of 9 tons per acre. For this reason weeds are a problem year round but winter dormant herbicides cannot usually be applied without excessive crop injury. Fortunately weeds are rarely a serious problem where a good stand of alfalfa is properly managed. Frequent cutting and rapid regrowth of non-dormant varieties help the crop compete with most annual weeds. Herbicides are often needed where the stand is weakened, thin or perennial weeds are present. The most significant trend in the Low Desert is a decrease in Treflan usage over the past ten years coupled with an increase in the use of Prowl H2O and Select. Unlike the other areas of California, Roundup usage has not increased in the Low Desert because of the absence of RR alfalfa in that part of the state.

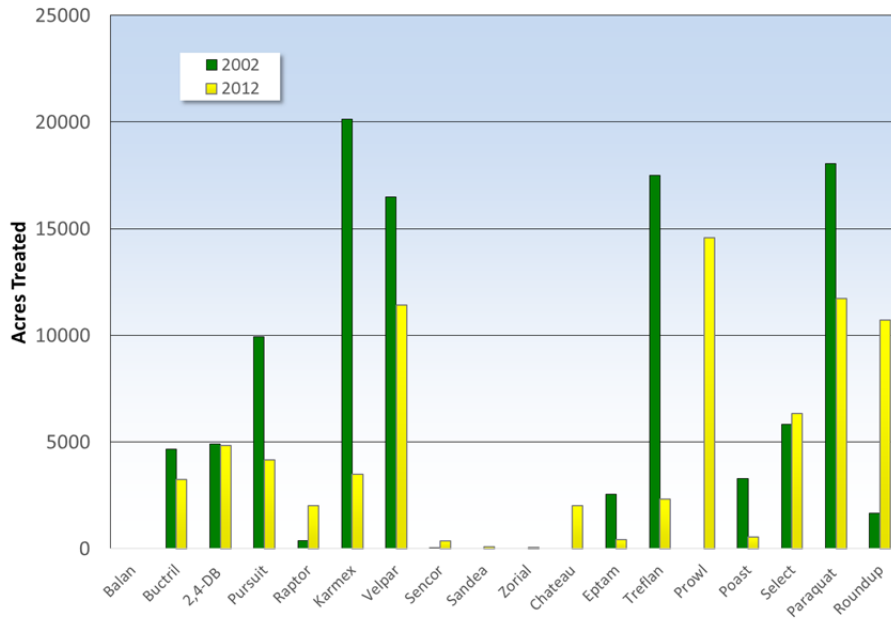


**Figure 2.** Herbicide Use in Imperial County Alfalfa in 2002 Versus 2012

Central Valley. For seedling alfalfa, the use of the pre-emergent herbicide Balan has significantly declined. Pursuit and Raptor are key herbicides in seedling alfalfa, with Raptor becoming more widely used (the two are currently often tank mixed at reduced rates of each). Raptor has a broader weed control spectrum but Pursuit has longer soil residual and is typically less injurious to the alfalfa. Buctril use has declined slightly but is still often tank mixed with Pursuit and/or Raptor to control difficult to control toxic weeds like common groundsel and fiddleneck. Similarly, 2-4-DB is often tank mixed with Raptor or Pursuit. Winter dormant herbicides for winter annual weed control are widely used but the relative importance of each has changed over the last decade. Karmex was the dominant soil active herbicide but its usage has declined rather significantly. Velpar use has declined slightly, while Chateau use has increased. The primary factor that triggered this switch is California Ground Water Protection regulations, which established ground water protection areas (GWPA) that significantly restricted the use of this herbicide. Furthermore, common groundsel continues to be a problem and Karmex does not control this weed. Some growers are using less soil residual herbicides to allow the option of rotating to more lucrative nut crops such as almonds and walnuts, but this could change with California’s water shortage. Gramoxone is widely used in the Central Valley, most often as a tank mix with soil residual herbicides as a dormant application. Treflan has been a dominant herbicide in the Central Valley, but over the last ten years has largely been replaced by Prowl H2O. For postemergent grass control, Select has become increasingly popular while Poast usage has declined. The impact of RR alfalfa is evident—a dramatic increase in Roundup usage in both Tulare and San Joaquin Counties from 2002 to 2012. In 2002 Roundup was used for stand takeout, but much of its current usage is with RR alfalfa.

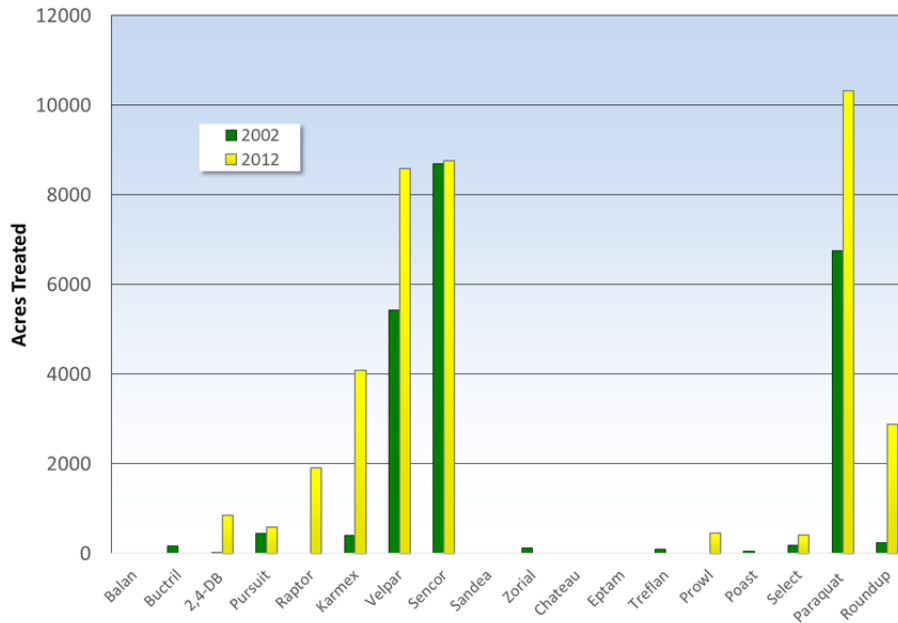


**Figure 3.**  
Herbicide Use in  
Tulare County  
Alfalfa in 2002  
Versus 2012



**Figure 4.**  
Herbicide Use in  
San Joaquin  
County Alfalfa in  
2002 Versus 2012

Intermountain Region. Raptor, Pursuit and 2,4-DB are used in the intermountain area for weed control in seedling alfalfa, with Raptor being the dominant herbicide. The most widely used herbicides in established alfalfa are Velpar and Sencor, which are typically tank mixed with Gramoxone. Sencor is a dominant herbicide in the intermountain area while it is rarely if ever used in other areas of the state. It is often used in the last year of the stand where plant-back restrictions limit the use of Velpar. Due to the cooler climate and short growing season, summer annual grasses are far less of a problem than they are in the rest of the state. Thus, the usage of pre-emergence herbicides Treflan and Prowl and postemergence herbicides Poast and Select is very low. A small amount of Treflan was used in 2002 but that has been completely replaced by Prowl H2O in 2012. Like the Central Valley, Roundup usage has increased sharply with the adoption of RR alfalfa. Even so in 2012 more acres were still treated with Karmex, Velpar, Sencor and Gramoxone than were treated with Roundup.



**Figure 5.**  
Herbicide Use in  
Siskiyou County  
Alfalfa in 2002  
Versus 2012

### THE PAST AND FUTURE OF HERBICIDE USE

What the future holds for herbicides available for use in alfalfa is unknown. It is clear though that herbicide development for alfalfa has decreased dramatically. In the past (between 1960 and 2000), between four and eight new herbicides were developed and registered every 10 years for use in alfalfa. However, new herbicide development and registration has dropped off significantly. In fact, there hasn't been a new herbicide registration in this crop for over 10 years (the longest drought in new registrations since alfalfa herbicides were developed)—and that registration (Prowl H2O) was just a new formulation and not a new active ingredient.

There are several plausible reasons for this lack of new herbicide active ingredients in alfalfa. One may be the advent of RR alfalfa and concerns about developing a product when the market share may be dramatically reduced. The eventual long-term adoption rate of RR alfalfa is not known, but the acreage is increasing in most areas where it is permitted. Concerns over the export market, primarily Chinese acceptance, and the public's perceptions about "GMO crops" has somewhat tempered the adoption rate of RR alfalfa. The cost of bringing new products to market is probably a greater deterrent to the development of new herbicides for alfalfa than concerns over the market share and the prominence of RR alfalfa. New herbicide development often takes 8 to 10 years and typically costs from \$120 to \$250 million dollars. One of the reasons for the cost is that a product intended for use on food crops must undergo approximately 120 health, safety and environmental fate tests to ensure their safety and effectiveness before being registered by the U.S. Environmental Protection Agency. The success rate for products developed in the lab actually making it to the commercial market and being applied to a farmer's field is low—it has been estimated that only one in 139,000 products ever make it successfully through the process!

There probably aren't too many new herbicide products on the horizon for alfalfa. Likely the next herbicide we will see is a burndown type herbicide BASF is developing. It causes a more

dramatic contact burn than Gramoxone and in the Low Desert its effect has been likened to “chemical sheeping”. The herbicide is called Sharpen (salfufenacil) and is used in other crops under the name Kixor, Treevix and other names. Another new herbicide is Odyssey, a premix formulation of Raptor and Pursuit. Both of these herbicides will be discussed in another presentation at this Symposium by Mick Canevari.

## **SUMMARY**

Alfalfa weed control has advanced significantly over the past fifty years, largely due to the development of new and improved selective herbicides. Through industry and university collaborations, effective weed management programs have been developed that have enabled us to adequately control most of the weed problems encountered in alfalfa production systems today. However, despite this effort, weed control challenges continue to arise and new approaches to effectively manage new weed issues (such as weed shifts and herbicide resistance in a safe and economical manner) are needed. The herbicide development pipeline has slowed substantially due to the continually escalating costs of herbicide development and commercialization. Moving forward will likely need to continue finding techniques to fine-tune the use of time-honored standard alfalfa herbicides. Also finding potential new uses for old herbicides will be required, as it appears we have entered into an era of slower paced herbicide development.



**Table 1.** Alfalfa herbicide registration timeline in California.

<b>Trade Name</b>	<b>Common Name</b>	<b>Date First Alfalfa Registration Date</b>
Treflan	Trifluralin	6/17/1966
Eptam	EPTC	Pre 1970
Butyrac	2,4-DB, dimethylamine salt	Pre 1970
Gramoxone	Paraquat dichloride	Pre 1970
Sencor	Metribuzen	Pre 1970
Karmex	Diuron	Pre 1970
Kerb	Pronamide	Pre 1970
Roundup	Glyphosate, Isopropylamine salt	Pre 1970
Balan	Benefin	4/11/1977
Buctril	Bromoxynil octanoate	12/28/1978
Butyrac	2,4-DB, butoxyethanol ester	3/4/1980
Velpar	Hexazinone	8/11/1982
Poast	Sethoxydim	5/20/1983
Treflan TR-10	Trifluralin	5/30/1984
Butyrac	4(2,4-DB), isooctyl ester	3/18/1987
Prowl	Pendimethalin	1/30/1992
Pursuit	Imazethapyr	8/17/1993
Pursuit	Imazethapyr, ammonium salt	8/17/1993
Select Max	Clethodim	10/31/1994
Solicam	Norflurazon	10/29/1996
Butyrac	2,4-DB	5/20/1997
Sandea	Halosulfuron methyl	9/26/2000
Raptor	Imazamox	7/10/2002
Chateau	Flumioxazin	10/16/2003
Prowl H20	Pendimethalin	8/17/2004

Data provided by  
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