Medusahead control with Milestone® herbicide

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Medusahead Overview
Medusahead (Taeniatherum caput-medusae) is an aggressive exotic annual grass that has become widely established throughout much of California and the Great Basin. Native to the Mediterranean region of Europe, medusahead is well adapted to the semi-arid climate predominant in California and throughout the western United States. Medusahead was first introduced into the U.S. in 1887 (George 1992, Young 1992) and rapidly spread throughout much of the Pacific Northwest and Great Basin. By the 1950’s medusahead had become established in California. Today it is estimated that medusahead infests over 1 million acres in California and over 5 million acres throughout the Great Basin.

Medusahead is a winter annual grass that dominates annual grasslands, oak woodlands, and chaparral communities. It consists of very high silica content (Bovey et al. 1961) making it a non-desirable forage for most livestock and wildlife animals. The high silica also slows the annual decomposition process resulting in an accumulation of thatch that can reach levels of 3-6 inches. The thatch acts as a weed barrier for desirable grasses and forbs, inhibiting their germination and establishment; however medusahead has no problem growing through the thick thatch layer. Overtime, medusahead creates a monotypic stand out competing and suppressing all other vegetation.

When it comes to controlling medusahead, much of the work over the past three decades has been on using well-timed grazing, burning, mechanical removal of thatch, and the use of herbicides (DiTomaso et al. 2005). One of the challenges with using herbicides has been selectivity. Because of the taxonomic similarity to other more desirable grasses, achieving selective control of an undesired introduced annual grass like medusahead in a predominantly desirable introduced annual grassland has proven challenging.

Over the past few years, a number of researchers have examined the efficacy of Milestone® herbicide for medusahead control (Kyser et al. 2012). Milestone is a relatively new pyridine carboxylic acid herbicide from Dow AgroSciences designed and developed specifically for use on rangeland and pastures to control noxious and invasive broadleaf species and other problem weeds. Although it is considered a broadleaf herbicide, recent efforts have shown it to be efficacious as a pre-emergent and early post-emergent herbicide for medusahead control.

Development History of Milestone for Medusahead Control/Suppression
In developing Milestone herbicide through years of research, Dow AgroSciences (DAS) tested over 20 species of commercially important grasses to determine their susceptibility to aminopyralid during stand establishment. Research throughout the US, including California, showed that these grass species would not be significantly affected if planted a minimum of 60 days before or after a Milestone treatment. Researchers and customers noted that newly germinating weedy winter annual grasses were adversely affected by Milestone. These observations led to a research program to establish more information on the effect of Milestone on winter annual grasses. The key seemed to be that applications made prior to germination of the weedy winter annual grasses were suppressing or controlling these weeds.

In small plot research trials conducted by Dr. Joe DiTomaso and Guy Kyser at the University of California at Davis (UC Davis) in 2007, it was observed that early fall applications (September - October) had fewer weedy winter annual grasses germinating in the Milestone treated plots even though medusahead was present in the nontreated control plots. DAS cooperated with UC Davis to conduct greenhouse studies to determine rate sensitivity for medusahead and downy brome (Bromus tectorum, cheatgrass). These studies confirmed that Milestone applications made prior to seed germination were achieving significant levels of control for medusahead and cheatgrass at rates ranging from 7 to 14 fl oz of product/acre.

University of California Field Research 2009-2010
In the fall of 2009, DiTomaso, Kyser and other UC scientists established replicated field research trials prior to medusahead germination at three northern CA locations (1) Bobcat Ranch in Winters, application on October 9th, (2) Sierra Foothill Research & Extension Center in Browns Valley, applied October 8th and (3) Gallatin Ranch in Red Bluff applied September 28. Results from these 3 trials are shown in Figure 1.

Even though the medusahead reduction was greater at 14 fl oz Milestone/acre (spot treatment rate), there was a significant release of desirable grasses (Italian ryegrass, soft chess and meadow barley) when they were present in the understory at the 7 fl oz Milestone® herbicide rate (Figure 2-3). Results of the annual grass cover taken 7-8 months after the fall applications from the Sierra Foothill Research station and Red Bluff sites is shown below in Figure 4. All of the Milestone treatments were significantly different from the Matrix (rimsulfuron) and Plateau (imazapic) treatments. Milestone at 14 fl oz/acre showed the greatest increase in desirable annual grass cover. This increase in desirable annual grasses has been consistent.
across trials and demonstrations to date where there is grass seed present in the understory.

**Cosgrave Ranch Demonstration (Calaveras County) 2009-2010**

In 2009, a demonstration plot was established in Calaveras County to test Milestone for medusahead control. The site (Figure 5) was dominated by medusahead (cover >80%) with considerable thatch buildup from previous years. Two rates were tested, 7 and 14 fl oz/acre. Although a preemergent application was planned, the El Nino weather pattern and increased rain events set the application timing back. As a result, medusahead had already germinated and was approximately 1 inch tall on the day of application. Both the 7 and 14 fl oz/acre treatments showed significant reductions in medusahead compared to the nontreated check. While we could find medusahead fairly easily in the nontreated areas, the abundant rainfall seemed to shift the competitive balance away from medusahead and more to desirable grasses and forbs (Figures 6-7). Italian ryegrass and soft brome was extremely abundant in both treated plots and to a lesser extent the nontreated check. The Italian ryegrass in the treated plots had considerably more biomass than the nontreated check. In drier years, medusahead seems to have a competitive advantage for limited resources and takes advantage of its earlier germination and rapid root development. While there are no data to support these claims, more research is needed to examine the impact of rainfall, temperature and germination timing on weed prevalence.

**Milestone Label Updated in 2011 to Include Preemergent Applications for Winter Annual Grasses**

Based on the performance of Milestone® herbicide on these winter annual grasses, especially medusahead, DAS issued a supplemental label in 2011 for use of Milestone to control or suppress medusahead and other winter annual grasses in rangeland and pastures in western states. The next version of the Milestone label will have this use on the specimen and package label.

**Use Rates and Timing for control or suppression of winter annual grasses**

This use statement has recently been incorporated into the Milestone herbicide label:

*Milestone applied broadcast at 7 to 14 fl oz/A can suppress or control many winter annual grasses including medusahead rye (Taeniatherum caput-medusae) and downy brome (Bromus tectorum). The key to optimum results is the timing of application. Applications should be made in late summer prior to rains and seed germination in order to provide the best possibility of suppression or control.*

**Grass control results will be poor if any of the winter annual grass seeds have germinated prior to application.** Tank mixes with Accord XRT II at 12 fl oz/A, where a non-selective herbicide can be used or desired grasses are dormant and will not be harmed, will aid in controlling those winter annual grasses that have already germinated. Spot treatment restrictions (see below) apply for rates above 7 fl oz/A for broadcast applications.

**Maximum Application Rate: Do not broadcast apply more than 7 fl oz per acre of Milestone per year.** The total amount of Milestone applied broadcast, as a re-treatment, and/or spot treatment cannot exceed 7 fl oz per acre per year. Spot treatments may be applied at an equivalent broadcast rate of up to 0.22 lb acid equivalent (14 fl oz of Milestone) per acre per annual growing season; however, not more than 50% of an acre may be treated at that rate. Do not apply more than a total of 0.11 lb acid equivalent (7 fl oz per acre of Milestone per annual growing season as a result of broadcast, spot or repeat applications.

**UC Cooperative Extension Field Trial, Gianandrea Ranch (Amador County) 2012-2013**

Scott Oneto, Farm Advisor, UC Cooperative Extension implemented a replicated trial which tested the efficacy of Milestone herbicide for control of medusahead using a number of different rates and application timings. Preemergent or early postemergent applications in the Central Valley of California are usually made in October before the first fall rains. Medusahead tends to germinate with the first rains but can continue through the winter (Figure 8). The question was whether Milestone would provide adequate control throughout the winter and spring. One of the elements of this trial was to examine whether a split treatment, Milestone applied in the fall (November 1, 2012) and an additional treatment applied as a “booster” in the winter (January 10, 2013) would be more or less effective than a single treatment applied in the fall. The treatments were: 14 fl oz/acre, 7 fl oz/acre and 4 fl oz/acre applied as a single treatment, versus splits treatment of two, 7 fl oz treatments as described above, 9 fl oz/acre (split into a 7 fl oz fall and 2 fl oz winter treatment) and an 8 oz/acre (split into two, 4 oz treatments). Due to some logistical site problems the fall treatment was made early post emergent rather than pre emergent as planned. On the day of the November application, medusahead had germinated and was about 1 inch tall (Figure 8). Results (Table 1) show there was no increase in control with the split treatments. The 7 fl oz/acre and 14 fl oz/acre treatments applied in the fall provided the best control with the least amount of medusahead cover 30% and 35%, respectively. As with previous years, weather conditions continue to raise new
questions. The 2012-13 year was one of the driest winters on record; as a result even the 7 fl oz/acre and 14 fl oz/acre gave less control than observed at other sites in other years. In addition, there appeared to be three separate germination events during the 2012/13 wet season. One with the first fall rains (October), another in early January, and another very late flush in late spring. Although there have been considerable increases in desirable forage after a Milestone application at other sites in other years, there wasn't a similar response in this trial. This could be a result of the extremely dry winter, and/or the lack of desirable forage seed in the seed bank.

### Table 1

<table>
<thead>
<tr>
<th>Treatment</th>
<th>% Cover</th>
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<tbody>
<tr>
<td>14 fl oz Milestone/acre</td>
<td>30%</td>
</tr>
<tr>
<td>7 fl oz Milestone/acre</td>
<td>35%</td>
</tr>
<tr>
<td>14 fl oz Milestone/acre split into two 7 fl oz treatments</td>
<td>35%</td>
</tr>
<tr>
<td>9 fl oz Milestone/acre split into two treatments; 7 fl oz fall, 2 fl oz winter</td>
<td>45%</td>
</tr>
<tr>
<td>8 fl oz Milestone/acre split into two 4 fl oz treatments</td>
<td>40%</td>
</tr>
<tr>
<td>4 fl oz Milestone/acre</td>
<td>40%</td>
</tr>
<tr>
<td>Untreated control</td>
<td>80%</td>
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**Sachau Ranch Application (Alameda County) 2011-2013**

The Sachau Ranch is a family owned cow/calf operation on approximately 1,000 acres near Livermore, CA. Dan Sachau treated 100 acres of heavy medusahead-infested ground in mid-September 2011 with 7 fl oz/acre of Milestone via helicopter (Figures 9-10). Medusahead observations were made at this ranch in March through May 2012 and again in May 2013 (Figures 11-16). Treated areas are showing significant release of desirable grasses in both 2012 and 2013. On May 25, 2012, medusahead was in flower, so it was easy to identify the new medusahead growth and also to see reductions in areas treated with Milestone® herbicide. However, cattle had grazed much of the treatment area, since grasses had matured and the treated area was very attractive for grazing. As experience indicates, cattle avoid the medusahead when other grasses are available, making it easy to determine performance in treated versus untreated areas. We were able to inspect small nongrazed patches within the treatment area and estimated 80% or higher reduction in medusahead compared with the nontreated areas. Based on the release of desirable forage in 2012, Dan doubled the number of cow/calf pairs on the ranch. He has been able to continue this higher grazing capacity in 2013 since the treatment benefits are still evident.

In May 2013, Dan again showed us the dramatically improved forage production in his treated areas. There is little to no medusahead in the treated acreage this year — except for small patches (roughly 1 foot diameter patches dubbed “cow pie checks”), that may be where cattle manure excluded the Milestone from reaching the soil after treatment in September 2011 (Figure 17). Dan is very pleased with the investment he has made in renovating his most severely affected acreage and has long term plans to remove medusahead from his remaining acres using Milestone every year in September. Overall, Dan feels that treating his rangeland with Milestone at 7 fl oz/acre was a solid decision and he is willing to relate his Milestone experience to anyone with questions.

**Vineyard Mountain Ranch Application (Monterey County) 2012-2013**

The Vineyard Mountain Ranch is a 2,700 acre privately owned property consisting of working horse and cattle operations in addition to tourist and hunting accommodations northeast of San Miguel, CA. Nathan Sanders manages livestock in addition to other responsibilities on this ranch. In October 2012, he treated about 80 acres of medusahead-infested areas with a boom sprayer (no GPS-assistance). He commented that some early rains had already caused some grasses to germinate which may have been medusahead. In spring of 2013, Nathan contacted us to visit the ranch and document his results. Even though rainfall was a little less than 8 inches for the year, Nathan saw significant release of desirable grasses, primarily ryegrass in Milestone herbicide-treated areas. The most impressive area was an enclosed pasture that had not been grazed when we visited in April and May 2013. In the photos (Figures 18-23) notice that areas inadvertently not sprayed with Milestone serve as nontreated “checks”. Comparison between the treated areas and the nontreated skips is dramatic with much more desirable forage in treated areas. The October applications with Milestone also controlled fiddleneck, an undesirable broadleaf weed present in this pasture (Figure 20). Nathan is very pleased with the results and will treat more acreage this fall.

**Large Corporate Ranch Based in Monterey County Application 2012-2013**

This large corporate-owned ranch will not participate in testimonials as a matter of policy. However this ranch manager treated about 200 acres by ground in September 2012 and he was very impressed with his results in
There were also small spray skips and larger nontreated areas in these applications that highlighted the performance of Milestone herbicide on medusahead. Included photos show very heavily grazed ground, but once again, the medusahead present in the nontreated skips was largely untouched. The September application also controlled annual mustards, as shown in Figures 24 and 25. This ranch manager was very pleased overall and indicated he will treat larger acreage for medusahead this fall.

Conclusion
In conclusion, Milestone herbicide applied broadcast at 7 to 14 fl oz/acre can suppress or control many winter annual grasses including medusahead rye (Taeniatherum caput-medusae) and downy brome (Bromus lectorum). The key to optimizing results is the timing of application. Applications should be made in late summer prior to rains and seed germination in order to provide the best possibility of suppression or control. Grass control results will be poor if any of the winter annual grass seeds have germinated prior to application. See the supplemental label for more information.

Literature Cited
Figure 3: Red Bluff research trial: Release of annual ryegrass in plot treated with Milestone® herbicide at 7 fl oz/acre (left of line) versus the nontreated plot on the right. Application was made in September 2009, photo taken in May 2010. Josh Davy (left), UC Extension Farm Advisor and Guy Kyser (right), UC Davis Specialist.

Figure 4: Annual grass cover taken 8 months after the fall 2009 medusahead applications from the Sierra Foothills Research Station and Red Bluff sites. From Kyser et al. (2012).

Figure 5: Medusahead cover on day of treatment at the Cosgrafe Ranch Demonstration on October 19, 2009.

Figure 6: Scott Oneto (left), UC Extension Farm Advisor pictured with Rick Miller (right), Dow AgroSciences in the 7 fl oz/acre Milestone herbicide treatment photo taken at teh Cosgrave Ranch Demonstration on April 27, 2010.
**Figure 7:** Photo: Release of soft brome (*Bromus hordeaceus*), Italian ryegrass (*Lolium multiflorum*) and other desirable grasses at the Cosgrave Ranch after treatment with 7 fl oz/acre of Milestone® herbicide on October 19, 2009. Photo taken April 27, 2010.

**Figure 9:** Photo: Sachau Ranch in Livermore, CA one month prior to treatment with Milestone herbicide.

**Figure 8:** Medusahead on day of Milestone treatment. November 1, 2012 at the UCCE research trial at the Gianandrea Ranch.

**Figure 10:** Photo: Day of treatment with helicopter with 7 fl oz/acre of Milestone herbicide.
Figure 11: Photo: Close up of new desirable grass in Milestone treated section of Sachau Ranch. Photo taken on March 9, 2012.

Figure 12: Grasses emerging after 9 inches of rain to date on April 18, 2012 at the Sachau Ranch.

Figure 13: Flowering grasses collected from the Sachau Ranch on April 18, 2012. *Bromus diandrus* (ripgut brome, upper specimen) and *Hordeum murinum* (wild meadow barley, lower specimens).

Figure 14: Medusahead in nontreated section of the Sachau Ranch on May 25, 2012.
**Figure 15:** Largely nongrazed section of Milestone herbicide-treated area of the Sachau Ranch on May 25, 2012. Italian ryegrass, wild oats and hare barley were three of the dominant grasses identified.

**Figure 16:** Cattle feeding on Milestone® herbicide-treated range at the Sachau Ranch on April 18, 2012.

**Figure 17:** Small patch of medusahead approximately the same size as a cow pie — possibly area where cow manure prevented Milestone from reaching soil in time to control germinating medusahead. Cattle avoid even these small patches of medusahead. Photo taken May 2013 at the Sachau Ranch.

**Figure 18:** Nongrazed pasture at the Vineyard Mountain Ranch. Nontreated dry retention pond is in foreground. Milestone herbicide-treated area noted by dark green grass is in the background. Photo taken April 2013.
Figure 19: Retention pond (nontreated in center) surrounded by Milestone herbicide treatment at the Vineyard Mountain Ranch. Photo taken May 2013.

Figure 20: Spray skip in nongrazed pasture at the Vineyard Mountain Ranch. Inside the spray skip, note brown medusahead and some taller fiddleneck in the back of the skip. Photo taken April 2013.

Figure 21: Nathan Sanders (left) Vineyard Mountain Ranch Manager and Mike Hollarman (right) Crop Production Services Pest Control Advisor standing in the nongrazed pasture treated with 7 fl oz/acre Milestone in April 2013.

Figure 22: Macro view of a spray skip in nongrazed pasture at the Vineyard Mountain Ranch. Medusahead is the short brown grass inside the spray skip. Rye and other forage species are growing in the Milestone herbicide-treated areas outside the skip. Photo taken May 2013.
**Figure 23:** Medusahead inside a spray skip (foreground) compared to the heavy forage released in the Milestone herbicide treatment (background) at the Vineyard Mountain Ranch. Photo taken May 2013.

**Figure 24:** Spray skip (center) compared to adjacent Milestone herbicide-treated areas in this heavily grazed pasture. Milestone was applied in September 2012 by tractor-mounted boom on this large corporate ranch in Monterey County. Photo taken May 2013.

**Figure 25:** Triangular shaped darker region is heavily grazed Milestone herbicide-treated on the right in this photo taken May 2013 at a large corporate ranch in Monterey County. Cattle grazed the Milestone-treated area heavily where desired grasses were released while relatively avoiding the nontreated area (left), which contains medusahead and annual mustards.

**Figure 26:** Milestone herbicide-treated areas (foreground and left center) with nontreated swaths (background right and left) at a large corporate ranch in Monterey County. Application made September 2012. Photo taken May 2013.