TURFGRASS TRENDS

POA ANNUA CONTROL

Tenacity: A New Weapon in the *Poa Annua* Battle

By Bruce Branham, Ph.D.

Controlling annual bluegrass (*Poa annua*) has been a challenge for turfgrass managers since we began managing it. Finding herbicides that control annual bluegrass selectively has been difficult, and only in the past decade have we been able to use products that can provide postemergent control of annual bluegrass reliably. Velocity (bispyribac-sodium, manufactured by Valent) is one of the first herbicides to control annual bluegrass with postemergent applications safely and effectively. Other herbicides have been used, but the results were inconsistent or caused excessive injury or death to the desirable turf.

It's difficult to find selective herbicides to control annual bluegrass in Kentucky bluegrass. Both species are from the same botanical genus and are presumed to be similar in growth and physiology. Currently, there are no herbicides labeled for the postemergent control of annual bluegrass in Kentucky bluegrass.

Tenacity (mesotrione) is a relatively new herbicide introduced in the market in 2008 by Syngenta. Mesotrione has been used on corn for several years under the trade name Calisto. This reduced-risk herbicide is an analog of a natural product, leptospermone, which is produced by the bottlebrush plant (*Callistemon citrinus*). Mesotrione, which represents a new class of herbicides known as HPPD inhibitors, works by inhibiting the enzyme 4-hydroxyphenylpyruvate dioxygenase (HPPD), which blocks the pathway that produces plastoquinone and tocopherols — antioxidants that reduce damaging oxygen radicals. Without plastoquinone, carotenoids, which are critical for harvesting light and quenching the high-energy states of chlorophyll, can't be synthesized. Without carotenoids, radicals and reactive oxygen species damage the photosynthetic enzymes and membranes so that eventually all leaf pigments can't be produced (Beaudegnies et al. 2009). This causes the characteristic bleached-tissue look in plants treated with HPPD herbicides, and it's common to all HPPD inhibitors.

Mesotrione selectivity derives from differential rates of metabolism in plants. Tolerant plants degrade mesotrione rapidly; susceptible plants have a slower rate of mesotrione metabolism. We noticed that in the cooler temperatures of spring and fall, mesotrione would cause bleaching of annual bluegrass. During the sum-

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TABLE 1: CONTROL OF ANNUAL BLUEGRASS FROM VARIOUS RATES & APPLICATION TIMINGS OF MESOTRIONE

Rate (lbs. a.i./A) or [oz. prod/A]	Application schedule	Total applications	Treatment duration in days	Percent annual bluegrass control					
				05/09	07/09	05/10	06/10	07/10	10/10
0.05 [1.6]	M W F	10	21	85a*z	93a	40b	96a	88a	68a
0.05 [1.6]	M Th	10	31	84ab	77b	75a	68ab	86a	100a
0.17 [5.3]	M (every 2 weeks)	3	28	**y	**y	3c	0d	27b	100a
0.17 [5.3]	M	3	14	**y	**y	3c	58abc	79a	82a
0.17 [5.3]	M Th	3	7	**y	**y	3c	20cd	70a	23b
0.17 [5.3]	M W F	3	5	0c	51c	3c	0d	31b	0b
0.1 [3.2]	M W F	5	9	38bc	95a	3c	38bc	87a	33b
0.1 [3.2]	M Th	5	14	80ab	97a	5c	76ab	90a	37b
0.1 [3.2]	M	5	28	57b	41c	15c	43bc	92a	53a
0.2 followed by 0.1 [6.4 fb 3.2]	M Th	4	10	**y	**y	3c	85a	65a	5b
0.075 [2.4]	M Th	7	21	**y	95a	**y	**y	62a	86a
Average temperature in the 21 days after treatments begin				61.9	69.7	62.0	76.0	78.1	***

*z *Means within a column followed by the same letter are not significantly different according to the LSD at α=0.05*

y *Indicates that all treatments were not used in all trials* * *The author intended for this box to be blank*

When presenting treatment mean data in a table such as this, scientists often present the mean for each treatment followed by a lowercase letter or letters. In this table, each treatment mean followed by the letter a is statistically equivalent to all other treatment means followed by the letter a. A treatment mean followed by the letters a,b is statistically equivalent to all other treatments followed by either the letter a or b or a,b. A treatment mean followed by the letter a is statistically different from a treatment mean followed by the letter b. And a treatment mean followed by the letter b is statistically different from a treatment mean followed by the letter c.

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mer, one application of mesotrione on annual bluegrass would, at most, cause a minor loss of green color but no bleaching. Thus, we didn't see enough activity to think mesotrione could control annual bluegrass. In fact, the label for Tenacity states annual bluegrass is suppressed by a preemergent application but doesn't control or suppress annual bluegrass by a postemergent application.

There are numerous preemergence herbicides that will control annual bluegrass, but the real test is finding a postemergence herbicide that can control established annual bluegrass safely.

The observation that mesotrione bleaches annual bluegrass during the cooler months but hardly at all during the warmer months led us to think the metabolism of mesotrione in annual bluegrass was rapid enough during the summer to reduce the herbicidal activity to essentially nothing. In other words, temperature controls the rate of metabolic activity in plants. Under high temperatures, plants have a higher metabolic rate; under cooler temperatures, the metabolic rate is slowed.

The question became: How do you keep enough mesotrione in annual bluegrass long enough for it to cause toxicity? We tried frequent applications at low rates.

Experiments and results

Beginning in 2009, we conducted six trials examining different rates and timings of mesotrione in a mixed stand of annual and Kentucky bluegrasses maintained at a height of 7/8" (See Table 1). The results showed that several factors affected the level of annual bluegrass control from mesotrione. The good news was several treatment regimes provided consistently high levels of annual bluegrass control. The bad news was these treatment regimes required a significant number of frequent, low-rate applications.

Upon closer examination of the data, we saw temperature during the treatments had a large effect on the results. For most treatment regimes, the higher the temperature, the better the results. Note that the trial with the highest average daily air temperature was the trial conducted in July 2010. In this trial, five treatment regimes gave more than 80 percent annual bluegrass control. Some regimes that provided poor control in other trials provided respectable annual bluegrass control in this trial. For example, applying 0.1 lbs. active ingredient per acre weekly for a total of five applications resulted in control ranging from 15 to 57 percent in the other five trials; but in the July trial, annual bluegrass control was 92 percent. Similarly, 0.17 lbs. a.i./acre applied three times on a Monday-Thursday-Monday schedule showed control levels of 3, 20 and 23 percent in the other trials conducted in 2010 but 70 percent in the July trial. The higher temperatures increase the activity of Tenacity dramatically, probably because higher temperatures result in greater production of oxygen radicals, and without the carotenoids to quench them, the oxygen radicals wreak havoc on the plants.

So when temperatures are hot, control is excellent, and good control can be achieved with less frequent applications. Excellent control was achieved from 0.1 lbs. a.i./acre applied once a week for five applications or twice a week for five applications. Conversely, when temperatures are cool but not cold, activity is reduced. In the May 2010 trial, only two treatments provided control above 40 percent. The May 2009 trial saw several treatments provide greater than 80 percent control even though the average temperature of the trial was comparable to the 2010 trial.

Looking more closely at the temperature data, we saw that, in 2010, temperatures dropped right after the first application, reaching a low, average daily air temperature of 46 F at four days after the initial treatment. Day 5 experienced a low of 34 F and an average of 48 F. Beginning at 17 days after the initial treatment, the air temperatures in 2010 exceeded the ones in 2009 and helped push the averages close together. But my guess is that drop in temperature after the initial application

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Mesotrione selectivity derives from differential rates of metabolism in plants.

PHOTO COURTESY: BRUCE BRANHAM, PH.D.

The bleached annual bluegrass on the left half of the photo has been treated with Tenacity.

Overall plot view from the May 2010 trial of mesotrione treatments 16 days after the beginning of treatments.

PHOTO COURTESY: BRUCE BRANHAM, PH.D.

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halted the mesotrione activity.

The last trial we conducted in October 2010 gave completely different results. Treatments that had a long interval between successive applications provided the best control. For example, applying 0.17 lbs. a.i./acre every two weeks for three applications resulted in an average of 10 percent annual bluegrass control in the three trials conducted in the spring and summer of 2010 but 100 percent control in the October trial.

How can this be explained? My hypothesis is, as temperatures cool off in the late fall, the metabolism of mesotrione by annual bluegrass slows substantially, keeping a higher level of mesotrione in the plant for a longer period of time (i.e., the half-life of mesotrione in annual bluegrass increases from one to two days in the summer to seven to 10 days in the late fall). The increase in mesotrione half-life resulted in sound control from an application regime that would be completely ineffective during the spring or summer.

Treatment duration

Another observation from these trials is that annual bluegrass must be bleached for a substantial number of days before control is achieved. As can be seen in the photo above, almost every plot in the picture, from the May 2010 trial, is showing substantial bleaching at 16 days after the first application. Yet, all treatments in this trial provided poor control, with only two treatments providing significantly better control than the untreated plots (See Table 1). The two treatments that resulted in marginal control used light, frequent applications that, from the first treatment to the last, took 21 or 31 days.

Only when the temperatures were hot — the July trials — did treatment durations of less than 14 days provide reasonable annual bluegrass control (See Table 1). For example, applying 0.1 lbs. a.i./acre five times on a Monday-Wednesday-Friday application schedule provided an average of 91 percent annual bluegrass control in the two trials conducted in July of 2009 and 2010. Average control from this treatment regime was only 28 percent in the other four trials conducted in cooler temperatures. This treatment regime took nine days from the first application to the last.

Summary and future work

We've shown Tenacity can be used to control annual bluegrass at almost any time of year when using the proper application strategy. During the warmer months (June through September), frequent, low-rate applications provide the best results. Applying 0.05 lbs. a.i./acre (1.6 fl. oz. product/acre) three times per week totaling 10 applications provided consistently sound results. However, few turf managers would want to chain themselves to their sprayers for this kind of application schedule. Similar results can be obtained by applying 0.1 lbs. a.i. /acre (3.2 fl. oz. product/acre) twice a week totaling five applications. If we exclude the October trial because of the cooler temperatures and different results, the five-application treatment regime resulted in 70 percent control when averaged over the other five trials while the 10-application treatment yielded an average of 80 percent control. So, for half of the labor, you'll give up an extra 10 percent, on average, of annual bluegrass control.

Treatments initiated in the cooler weather of late fall also look promising but would require a different strategy. Under these conditions, applications of 0.17 lbs. a.i. /acre (5.3 fl. oz. product/acre) applied three times on a 14-day interval appear to be most effective. These results support work done by Reicher and his colleagues (Reicher et al. 2010), who reported effective control from fall applications with similar rates and timings.

We continue to attempt to improve the efficacy of Tenacity for annual bluegrass control by examining the effects of different spray adjuvants, spray volume and nitrogen fertilizer applications. We're also looking at tank mixes of mesotrione and amicarbazone (Xonerate, Arysta). Research of other crops has shown that tank mixes of mesotrione and herbicides that inhibit photosynthesis, the mode of action for amicarbazone, are synergistic.

Results showed that several factors affected the level of annual bluegrass control from mesotrione.

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