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Hay Swather Applied Flutriafol to Alfalfa Stubble: Residue Levels in Immediately Harvested Hay and Subsequent Flood Irrigation Water

Abstract

The fungicide TopGuard Terra® (active ingredient = flutriafol) was applied at top labeled rate of 12 oz./acre to alfalfa (*Medicago sativa* L.) stubble/bare soil via swather at cutting to determine if such applications would result in flutriafol residues of harvested alfalfa placed upon immediately treated stubble would exceed the established alfalfa hay tolerance level of 70 parts/million (ppm). Residue levels in flood irrigation water moving across treated areas were obtained as such data were also unavailable, and concerns existed for product movement with this irrigation method and potential accumulation at field end for product usage in California. Flutriafol residues from windrowed hay that had been in contact with treated stubble and collected two days post application averaged 8.97 ppm, ranging from 5-16, far below the 70 ppm tolerance level. Sampling of flood irrigation waters in first subsequent irrigation after application and post baling noted very low flutriafol levels (0.12-0.30 ppm) contained in irrigation waters in treated areas. Such residues were thought to be due to fine soil particles adhering to and contained within flood irrigation water movement across field, rather than disassociation from soil. Residue levels remained low as flood irrigation waters proceeded across field, without evidence of accumulation at end of field. Data indicate that swather application of TopGuard Terra® and other fungicides containing flutriafol is a viable technique and could be added to product labeling and result in reduced application costs.

Keywords: alfalfa, Flutriafol, irrigation water, *Medicago sativa*, residue, swather, TopGuard Terra®

Introduction

*Phymatotrichopsis omnivora (*Duggar*)* Hennebert is a disease known by several names: cotton root rot, Texas root rot, *Phymatotrichum* root rot, and *Phymatotrichopsis* root rot. This wide-ranging disease has a host range of more than 1,800 dicot plants, and is known to damage crops from far eastern California (Davis et al., 2017) to Texas and southern Oklahoma, and several northern states of Mexico (Isakeit, 2016).

Alfalfa (*Medicago sativa* L.) grown in the desert southwest, especially in the first year of production, can be severely affected by infection of *Phymatotrichopsis omnivora*. This disease can result in plant death, leaving circular areas in fields that lack crop production for multiple cuttings and are susceptible to weed infestations.

Prior to 2020 no effective fungicide was registered to control this alfalfa disease in the United States. TopGuard Terra® (active ingredient flutriafol) had been given a 24C (special local need) by the Texas Department of Agriculture in 2012 for control of *P. omnivora* in cotton, and one for grapes in 2015. In 2020 FMC received supplemental registration for TopGuard Terra® to be used in eight states on alfalfa (Ledbetter, 2020). Other fungicide products containing flutriafol registered for alfalfa in the United States include Flutriafol 500 SC (alternate name = TopGuard Terra®), Flutriafol 250 SC (alternate name = Rhyme), and most recently Xyway® LFR (as a special local need registration in Arizona as a replacement for TopGuard Terra®).

The TopGuard Terra® label for alfalfa usage notes that the product contains 42% flutriafol by weight (4.16 lbs. flutriafol/gal.) and works by forming a protective layer around the alfalfa root at the point of disease infection. To accomplish this, label directions note to apply prior to three inches of new growth in the early spring or between two to three inches of regrowth, and use a minimum spray solution volume of 10 gallons/acre for broadcast applications, and five gallons/acre by air. This product can also be applied via chemigation. Product labeling also notes that precipitation in the form of rainfall or irrigation is required to move the product into the infection zone.

Labeled use rate of TopGuard Terra® is a maximum of 12 oz./acre in a single application, with a maximum of 19 oz./acre per year.

Previous local research in commercial alfalfa fields with TopGuard Terra® in the Palo Verde Valley of far eastern Riverside County, California, involved applications made shortly after bale removal (stubble plus beginning regrowth). Applications made at this crop development stage created several foot-plus wide streaks of alfalfa leaves on the soil surface, lost during field operations such as raking and/or baling and associated with location of alfalfa windrows. Lines of lost leaves were usually thick enough to intercept sprayed solution and prevent a consistent and uniform application to the soil surface (Figure 1), thus potentially reducing fungicide effectiveness. In desert alfalfa production, these leaves would be moved by subsequent flood irrigation and accumulate at field bottom/tail end (opposite end of field from where irrigation is initiated from canal/field head). This often will not occur until five to seven days after baling.

Figure 1. Alfalfa stubble/early regrowth showing alternating soil areas that have field length strips of lost leaves (dark brown) alternating with clean soil (lighter colored soil) that does not have lost leaves due to field operations.

Many alfalfa producers in the Palo Verde Valley have swathers equipped with spray tanks and nozzles for pesticide/liquid fertilizer/biostimulant application to stubble as alfalfa is being cut. While this application method is not noted on the TopGuard Terra® label, one would expect a more uniform application without dried, dropped leaves intercepting part of the fungicide spray solution prior to it reaching the soil surface.

Application via swather also eliminates the need for a separate application after bales are removed, reducing inputs (time, labor, fuel), and preventing additional damage from wheel traffic on alfalfa crowns/regrowth, thus improving production economics.

Labeling for TopGuard Terra® notes to not make applications within 14 days of harvest. Using a swather for application to stubble/soil surface while cutting alfalfa (Figure 2) would technically not be within 14 days of harvest as only stubble is treated, but cut alfalfa is deposited directly and immediately on top of the treated surfaces and contacts applied fungicide.

Figure 2. Alfalfa harvested with a swather equipped with spray tanks and nozzles. Outside nozzles are each located behind a front wheel and two inside nozzles (not shown) are located at the back of the cutting bar and spray soil/stubble just after alfalfa is cut and before alfalfa is deposited on surface. Spray pattern (flat fan) for outside nozzle behind right front tire is faintly visible.

This study was initiated to address two critical residue-related issues. The first was to document flutriafol residue level on alfalfa hay after coming into immediate contact with treated soil surface/alfalfa stubble via swather application, and to determine if residues on hay were below the 70 parts/million U.S. federal limit (USEPA 2020).

The second concern regarded the level(s)/movement of flutriafol in flood irrigation water following an flutriafol application to soil/alfalfa stubble. This was necessary as the TopGuard Terra® label for usage on California alfalfa at time of experimentation only allowed product to be applied to fields that are not irrigated or are irrigated using pressurized irrigation systems. This limitation does not exist on labeling in other states.

The vast majority of alfalfa fields in southeastern California are flood/furrow irrigated rather than being irrigated via pressurized irrigation systems due to the available flood irrigation systems needed to overcome summer heat (easily exceeding 115ºF multiple days during the year) and associated high evapotranspiration rates. The stated label conditions for California are due to concerns over leaching and groundwater contamination with areas with shallow water tables, but also with flutriafol levels in flood irrigated field “standing tail waters” that could potentially be removed from a field post irrigation and moved to an irrigation canal and/or be applied to another field.

Conversations with FMC representatives indicated that no data were available to answer the question of “does this product move with the water via flood irrigation after application to soil/stubble under southeastern California alfalfa production conditions and thus have higher rates at the end of the field?” These data were thought essential for potential future label changes to allow flutriafol application to flood/furrow irrigated alfalfa fields in the Palo Verde Valley and other locations in southeast California

Methods and Materials

A first year field of flood-irrigated alfalfa that had six areas (plots) of land (divided by five borders) was utilized for this experiment. This resulted in individual plots which were approximately 212 feet wide and ranged from 1,200-1,650 feet in length.

The maximum labeled rate of 12 oz./acre of TopGuard Terra® for a single application was applied to three plots via a Hesston swather equipped with four (4) spray nozzles on May 29, 2021, as alfalfa was being cut, with treated plots alternating with untreated plots. Harvested alfalfa was deposited immediately upon the treated stems and soil (Figure 3), devoid of rows of dropped leaves on soil surface from the immediately preceding harvest intercepting spray solution.

Spray deposition from each nozzle averaged 3.5 feet wide, with each swather pass treating a 14 foot width. Application rate was four (4.0) gallons of solution/acre. This finished solution rate was below the labeled minimum solution rate of 10 gallons/acre (gpa) for ground applications but thought to be equivalent of and/or potentially superior to the five (5) gpa for aerial applications due to directed application to soil surface and stubble achieved via swather application.

Figure 3. Soil surface following alfalfa harvest by swather is usually devoid of copious amounts of older leaves that could intercept pesticide application from swather at cutting. Leaves from previous cutting are not expected to be present, having either decomposed and/or been moved by flood irrigations.

Alfalfa hay samples

Alfalfa hay samples were collected on May 31 from windrows after two ‘swaths’ had been raked together and prior to baling. Sampling consisted of collecting all alfalfa from an approximate 3 foot length of windrow from two locations in each plot, and placing collected alfalfa into large brown paper bags. Bags were then marked, stapled shut, and returned to the laboratory where they were placed into freezers prior to being sent for laboratory analyses. This technique was used rather than sampling from alfalfa hay post baling due to the amount of material needed for analyses and was also expected to have higher residue levels as some leaves would to be lost during the baling process.

Irrigation water samples

Irrigation water samples were collected from the irrigation canal prior to their entering the field during the first flood irrigation (June 7) after swather application. Samples were also obtained from the leading irrigation edge at two distances (25% and 80% of run) from the irrigation canal (head end) in each plot on this date. Sampling consisted of using a 200 cc Scienceware® Polypropylene plastic scoop and collecting water at multiple locations across the leading edge to fill two 8.5 inch tall x 2.25 inch diameter Cooking Concepts® clear plastic condiment bottles for each plot and each distance. The multiple locations of the leading edge also ensured a composite sample to accurately represent the plot mean rather than just a single sample from a plot.

A water collection from the tail end of the field was made for one treated and one untreated plot. Tail waters in other plots were not sampled as waters started mixing together across the plots, thus resulting in potential contamination and misleading data.

Containers were marked and returned to the laboratory shortly after each collection where samples were immediately placed in a refrigerator to keep samples cool.

Laboratory analyses

Hay and water samples were packaged together in Styrofoam containers with ice packs added to keep samples as cool as possible during overnight shipping to OMIC USA, Inc., 3344 NW Industrial St., Portland, OR, 97210, which conducted the flutriafol residue

analyses. Statistical analyses of data and treatment mean separations were conducted using a Student's T test (JMP Pro 16.0.0).

Results and Discussion

Flutriafol residues from alfalfa hay from TopGuard Terra® treated plots averaged 8.97 parts/million (Table 1), well below the US Environmental tolerance level of 70 ppm, indicating that swather applications can be used for this fungicide and not exceed current established tolerance levels, even at top of label rate of flutriafol.

Alfalfa from untreated alfalfa plots was surprisingly noted to have traces of flutriafol, averaging 0.11 ppm. Every sample from untreated alfalfa did contain very small amounts of flutriafol, ranging from 0.07-0.16 ppm (Table 1). It is thought that the small levels of flutriafol noted from untreated alfalfa samples resulted from residues transferred from the single pair of gloves used when handling and collecting all alfalfa hay samples. A TopGuard Terra® treated alfalfa plot was the first plot handled with the gloves.

Table 1. Mean flutriafol residue levels (ppm) following swather application of 12 oz./acre of TopGuard Terra® on May 29, 2021, to alfalfa stubble as alfalfa being cut, Blythe, CA.

Treatment	**Alfalfa hay** (Sampled May 31)		**25% of irrigation run** *(June 7)*		**80% of irrigation run** *(June 7)*		**Tail water** ***(1 rep only) ppm***
	Mean	Range	Mean PPM	Range	Mean PPM	Range	
TopGuard Terra® 12 oz./acre	8.97 a	5.0 - 16.0	0.22 a	0.13 - 0.30	0.167a	0.12 - 0.24	*0.13*
Untreated	0.11 a	0.07 - 0.16	0.00 b	0.00 - 0.00	0.00 b	0.00 - 0.00	*0.05*
P Value	*0.066*		*0.011*		*0.0109*		

Means in columns followed by the same letter are not statistically different at the p<0.05 level (T-test, JMP Pro 16.0.0)

Irrigation water data

Application of flutriafol via swather allowed irrigation water residue data to be obtained almost exclusively from potential disassociation from soil/stubble, avoiding post-baling flutriafol interception occurring from aerial/ground applications by dried, dropped leaves remaining on soil surfaces immediately after baling/swathing operations. Any residues noted would thus be associated with soil rather than from post-harvest treated leaves on soil surfaces.

The field consisted of three soil types with the following approximations of area: Imperial silty clay, 50%; Meloland silty clay loam, 25%, and Glenbar silty clay loam 25%. The upper 40% of the field consisted of the Meloland and Glenbar soils. The remainder of this field contained all the Imperial silty clay soil with a substantial area of Glenbar silty clay loam across most of the field at about the 90% point of the irrigation run.

Meloland silty clay loam 60-70% soil is noted to have 60-70% of particles that would pass through a No. 200 (0.074 mm) sieve, while 90-100% of the soil particles of both Imperial silty clay and Glenbar silty clay loam are small enough to do so (USDA Soil Conservation Service, 1974).

Flood irrigation waters traveling across TopGuard Terra® treated soil types contained very small amounts of flutriafol, with the highest level never exceeding 0.3 ppm (Table 1). No flutriafol was detected in water collected from within untreated plots, nor in canal water prior to entering field (Table 1).

Data indicated that flutriafol was not releasing from the soil particles and moving with irrigation water as levels decreased rather than increased as leading edge of waters reached the tail end of the field. Flutriafol levels were less at the 80% of the irrigation run than at 25% (Table 1). The single tail water sample (0.13 ppm) was very similar to the lowest level documented for each of the two points across the field.

These data suggest that flutriafol levels in the irrigation waters are due more to the dust/soil particles that were moving in the water rather than the product itself releasing from the soil and moving with the water. Speed of water moving across fields is often a bit slower at the tail end of fields. The slower speed is thought to allow fewer soil

surface particles to adhere to the moving irrigation water as it moves across the field as well as allow other particles to settle out.

One plausible explanation for the very low (0.05 ppm) level noted from the single untreated tail water area (Table 1) may be due to some undetected water movement between plot areas in the tail ends of plots where field borders are not as tall, allowing some spillage between the two plot areas. As equipment and tire traffic also cross these areas and result in depressions due to machinery weight, it is possible that some water moved undetected below the visible water surface areas between these tail water areas in an unrecognized equipment tire track or through soil cracks.

Conclusions

Flutriafol application via swather at harvest, even at full label rate, results in residue levels that are far below current tolerance levels (70 ppm) for this active ingredient in alfalfa hay. These data validate that application made by this method will not violate established tolerance levels and could be added to product labeling as an application method.

Residue levels in flood irrigation waters did not increase as irrigation water moved across the field, nor were they higher in field tail water, indicating that product is not accumulating in irrigation water but noted presence is thought due to suspended soil particles. These data are important to potentially result in a change in current California usage limitation on flutriafol applications to alfalfa.

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Literature Cited

Davis, R.M., C.A. Frate, and D.H. Putnam. 2017. *Phymatotrichopsis* root rot (Texas root rot). University of California IPM Pest Management Guidelines: Alfalfa. *UC ANR Publication 3430*. https://ipm.ucanr.edu/agriculture/alfalfa/phymatotrichopsis-root-rot-texas-root-rot/#:~:text=The%20first%20symptom%20of%20phymatotrichopsis,found%20on%20the%20root%20surface.

Isakeit, T. 2016. Cotton root rot (*Phymatotrichopsis omnivora*) and its management. *Texas A&M AgriLife Extension*. PLPA-FC010-2016.

Ledbetter, K. 2020. Texas A&M AgriLife research culminates in new label for cotton root rot control in alfalfa. *Texas A&M AgriLife Today*. July 1, 2020. https://agrilifetoday.tamu.edu/2020/07/01/texas-am-agrilife-research-culminates-in-new-label-for-cotton-root-rot-control-in-alfalfa.

USEPA (United States Environmental Protection Agency). 2020. Flutriafol; pesticide tolerances. 40 CFR Part 180 [EPA–HQ–OPP–2018–0297; FRL–10004–03]. *Federal Register* 85 (31): 8461-8468. https://www.federalregister.gov/documents/2020/02/14/2020-02035/flutriafol-pesticide-tolerances

USDA Soil Conservation Service. 1974. *Soil Survey of Palo Verde Area, California*. 38 pp. + maps.