Spray carrier pH effect on absorption and translocation of trifloxysulfuron in Palmer amaranth (*Amaranthus palmeri*) and Texasweed (*Caperonia palustris*)

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INTRODUCTION

Trifloxysulfuron is a sulfonylurea herbicide used to control weeds in row crops, vegetables, and turf (Vencill, 2002). Sulfonylureas are widely used, have low use rates, have very high activity, and have low environmental impact (Russell et al. 2002).

Generally, the uptake of weak acids by plant tissues is greater at lower carrier pH due to a higher proportion of the molecules being present in an undissociated form. Yet, Liu et al. (2002) reported greater uptake of bentazon by white mustard (*Sinapsis alba* L.) and wheat (*Triticum aestivum* L.) leaves at pH 7 and 9 compared to pH 5. These studies indicate that increasing the pH of the carrier solution may enhance absorption and translocation of trifloxysulfuron in some species.

Palmer amaranth and Texasweed are annual broadleaf weeds that are troublesome in cotton production. Morgan et al. (2001) reported that cotton yields decreased linearly from 13 to 54% as a result of 1 to 10 Palmer amaranth plants per 9.1 m of row. Moreover, Palmer amaranth in cotton can reduce mechanical harvest time at densities greater than 650 plants ha^{-1} (Smith et al. 2000). In recent years, Texasweed has become a problem weed in soybean and rice production in the midsouth USA (Koger 2004).

The water used for spray applications can vary significantly depending upon the source. Adjusting the pH of the spray carrier may enhance absorption and translocation of trifloxysulfuron by these species.

OBJECTIVES

- To evaluate the absorption and translocation of foliar-applied trifloxysulfuron in Palmer amaranth and Texasweed as influenced by pH of the spray carrier.

MATERIAL AND METHODS

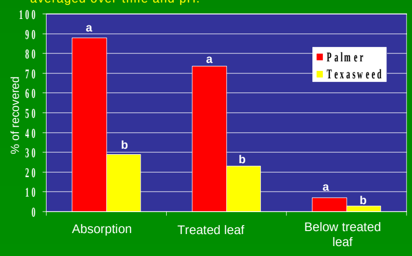
Palmer amaranth and Texasweed plants were propagated from seed in a greenhouse. Each treatment unit consisted of 1 plant per pot. Plants were grown at 32/25 C (± 3 C) day/night temperature and were subirrigated as needed. Palmer amaranth plants were at the six- to eight-leaf stage and Texasweed plants were at the three- to four-leaf stage when ^{14}C-trifloxysuluron was applied. Plants were not presprayed with formulated trifloxysulfuron before application of ^{14}C-trifloxysulfuron to minimize stress during the exposure period. Pretreated (Camacho and Moshier 1991) and nontreated (Gillespie 1994) plants have produced similar absorption and translocation trends when sulfonylurea herbicides were spotted on the leaves.

Technical grade [pyridinyl-2-^{14}C] trifloxysulfuron with 815.7 kBq μmol^{-1} specific activity and 95.9% radiochemical purity was used in these experiments. ^{14}C-trifloxysulfuron was dissolved in HPLC-grade methanol and deionized water. Radioactive solutions were a mixture of KH_2PO_4:NaOH buffered deionized water at pH 5, 7, and 9 and 0.25% v/v nonionic surfactant. ol. A 5-µl volume of each treatment solution containing 2.8 kBq radioactivity was placed on the adaxial surface of the fourth true leaf of a Palmer amaranth or the second true leaf of a Texasweed plant as 15 droplets.

Plants were harvested at 4, 24, 48, and 72 h after treatment (HAT) and separated into treated leaf, aerial sections above and below treated leaf, and roots. The treated leaf including the petiole was rinsed by gently shaking for 15 s with 15 ml methanol:water (1:1, v/v) to remove nonabsorbed herbicide. Plant sections were wrapped in tissue paper[5], placed in glass scintillation vials and oven dried for 48 h at 45 C. Oven-dried plant samples were combusted with a biological sample oxidizer. Sample radioactivity was quantified by liquid scintillation spectrometry LSS.

The amount of ^{14}C present in the leaf washes and plant sections was considered as total ^{14}C recovered, which averaged 91% of applied ^{14}C-trifloxysulfuron. Sum of the radioactivity present in all plant parts was considered as absorption and expressed as percentage of the ^{14}C recovered. Radioactivity in all plant parts except the treated leaf was considered as translocated and expressed as a percentage of the ^{14}C recovered. Treatments were replicated three times and the experiment was repeated. Where appropriate, significant main effects were averaged over harvest interval, species, and/or pH and separated by Fisher's protected least significant difference at $P < 0.05$.

Figure 1. Effect of species on absorption and partitioning to plant sections in Palmer amaranth and Texasweed averaged over time and pH.



RESULTS AND DISCUSSION

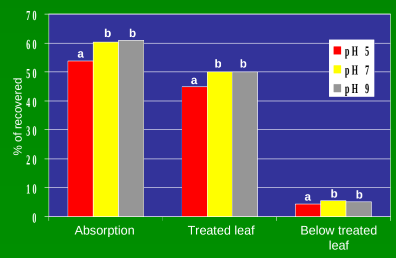
Trial effects were not significant at any harvest interval, plant species, or pH. Main effects for the absorption of ^{14}C-trifloxysulfuron were significant. Main effect of harvest interval was pooled over species and pH, while species main effect was pooled over harvest interval and pH. Main effect of pH was pooled over harvest interval and species.

Absorption of ^{14}C-trifloxysulfuron followed a logarithmic trend with the majority of the herbicide absorbed by 24 HAT. Absorption of ^{14}C-trifloxysulfuron by Palmer amaranth was greater than that of Texasweed (Figure 1). Differential absorption among species has been reported previously. Askew and Wilcut (2002) reported that absorption of ^{14}C-trifloxysulfuron decreased in the order of jimsonweed > sicklepod > peanut > cotton. Low absorption of ^{14}C-trifloxysulfuron by Texasweed may contribute to poor weed control observed along Texas Upper Gulf Coast.

Absorption of trifloxysulfuron decreased in the order of pH 7 = pH 9 > pH 5 (Figure 2). Greater absorption of trifloxysulfuron at high pH is in contrast to most weak acid herbicides. Liu (2002) noted that the absorption of most weak acid herbicides into plant tissues is greater at a low carrier pH due to a greater proportion of the molecules being present in an undissociated form. To our knowledge, no study has reported on the effect of carrier pH on the absorption of sulfonylurea herbicides into plant foliage *in vivo*.

The main effects and interaction of pH, species, and harvest intervals were significant ($P<0.05$) for the translocation of trifloxysulfuron. After 4 HAT, translocation was greater in Palmer amaranth compared to Texasweed at all pH levels and harvest intervals (Figure 3). Altering pH did not affect the translocation of trifloxysulfuron in Palmer amaranth.

Figure 2. Effect of pH on absorption and partitioning to plant sections averaged over time and species.



In contrast, translocation of ^{14}C-trifloxysulfuron in Texasweed at 72 HAT increased in the order of pH 5 (5%) < pH 7 (10%) = pH 9 (10%) (Table 4). At all harvest intervals Palmer amaranth translocated more ^{14}C-trifloxysulfuron into above treated leaf sections than Texasweed (Figure 3). Less than 11 and 20% of recovered ^{14}C-trifloxysulfuron moved out of the treated leaves of Texasweed and Palmer amaranth, respectively.

^{14}C-trifloxysulfuron partitioning into roots accounted for less than 2% of recovered ^{14}C for all pH and species combinations (data not shown).

CONCLUSIONS

Acidic spray carrier pH led to decreased absorption of trifloxysulfuron when averaged over harvest interval and species. Additionally, translocation of trifloxysulfuron was reduced by acidic spray carrier pH in Texasweed. These data suggest that increasing the pH of the spray carrier by approximately two pH units above the pKa can enhance absorption and translocation of trifloxysulfuron in some weed species as evident in Palmer amaranth and Texasweed.

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Figure 3. Translocation of ^{14}C-trifloxysyulfuron over time in Palmer amaranth and Texasweed at 3 pH levels.

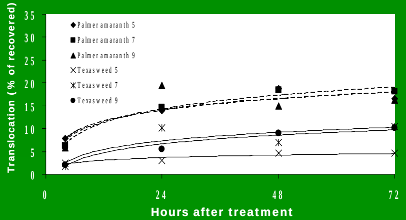

Figure 4. Partitioning of ^{14}C-trifloxysulfuron in the above treated leaf sections of Palmer amaranth and Texasweed averaged over pH.