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Atrazine Impacts on Arthropods in St. Augustinegrass[1]

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Numerous interactions occur between weeds, arthropod pests, and their natural enemies in managed ecosystems. These include phytophagous pest arthropods using weeds as alternate food sources, poly- and tritrophic interactions between weeds and beneficial arthropods, effects on arthropods of habitat modification by weeds, etc. (Norris and Kogan 2000, Weed Sci. 48: 94-158). The effect of herbicides on arthropods also has been investigated with the original impetus for this research coming from early observations that the herbicide 2,4-D affected sugarcane borer, *Diatraea saccharalis* (F.), populations (Ingram et al. 1947. J. Econ. Entomol. 40: 745-746).

There are numerous recorded examples of the effects of herbicides on arthropods. However, there are few, if any, published accounts of the effect of herbicides on arthropods in turfgrass. For example, there is virtually no mention of arthropod-herbicide interactions in two recently published turfgrass insect books being that of Potter (1998. Destructive turfgrass insects – biology, diagnosis, and control. Ann Arbor Press, Chelsea, MI) and Vittum et al. (1999. Turfgrass insects of the United States and Canada. Second edition. Cornell U. Press, Ithaca, NY).

St. Augustinegrass, *Stenotaphrum secundatum* (Walt.) Kuntze, lawns are used throughout the southern United States for their climatic and environmental (soil types) adaptation and ability to tolerate full sun to moderate shade. Although weed infestations in turf are often a result of weakened stands due to insects, diseases, nematodes, and poor cultural management (Unruh and Brecke 2006. University of Florida/IFAS-EDIS), most homeowners attempt to manage them with herbicides. Atrazine, sold as the herbicide alone or in combination with fertilizer, is widely available to homeowners and is used frequently because it controls many dicot and monocot weeds. Our objective was to determine if atrazine is affecting various arthropod populations in St. Augustinegrass, the most widely used turfgrass in Florida lawns.

Four pairs of plots were delineated in St. Augustinegrass at the Everglades Research and Education Center, Belle Glade, FL. Each plot was 32 × 32 m approximating 0.1 ha which is the size of the average lawn in the United States (Potter. 1993.

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Intern. Turfgrass Soc. J. 7: 69-79). The two plots in each pair were immediately adjacent with one plot being the control (untreated) and the other plot treated with atrazine. Each pair of plots was ≥ 100 m from other pairs. Atrazine was applied to treated plots using a tractor-mounted sprayer calibrated to deliver 190L per ha. The initial atrazine application of 1.12 kg per ha was applied on 29 March 2006, followed by a second application of 1.12 kg per ha on 21 June 2006. Atrazine rates were selected because they are the maximum amount of atrazine that can be applied to residential turf in 1 yr (Anonymous 2005. Aatrex 4L label, Syngenta Crop Protection Inc.).

Weed populations were sampled prior to the first atrazine application and approx. 3 wks after each atrazine application. Sampling consisted of counting weeds by genus and species in 5 randomly located 0.5 × 0.5 m areas in each plot. Samples from the 4 plots were pooled, and *t*-tests (SAS 2006) were used to determine differences in weed populations between control and atrazine-treated plots.

Arthropods in plots were sampled 3 times in 2006. Pretreatment samples were taken in February. Samples were taken again in late April 1 month after the first atrazine treatment to measure short-term effects of atrazine on arthropod populations. Lastly, samples were taken in August 2 months after a second atrazine treatment to measure long-term effects on arthropod populations.

Five samples for arthropods were taken randomly throughout each plot on each of the 3 sample times. Each sample was a 1 × 1 m area of turf vacuumed for 5 min using a modified commercial gas-powered blower/vacuum (Poulan/Weedeater, Shreveport, LA). Samples were bagged at collection and then frozen for later sorting. Thereafter, samples were examined microscopically, and arthropods were removed from plant debris and stored in alcohol. Arthropods were later identified microscopically and counted. Samples from the 4 plots were pooled and *t*-tests (SAS 2006, SAS Institute, Cary, NC) used to determine differences in arthropod populations between control and atrazine-treated plots.

Spiny pigweed (*Amaranthus spinosus* L.), southern crabgrass (*Digitaria ciliaris* (Retz.)Koel), common beggarticks (*Bidens alba* (L.)DC.) and Florida pusley (*Richardia scabra* L.) were most common in plots. Preapplication populations averaged 6.9 ± 1.6 (SD) per m^2 in the untreated controls and 6.2 ± 1.7 (SD) per m^2 in the atrazine plots and were not significantly different (*t*-test, alpha = 0.05). Weed populations after the first atrazine application averaged 5.6 ± 2.2 (SD) per m^2 in the control plots and 3.6 ± 1.7 (SD) per m^2 in the atrazine plots and were significantly different (*t*-test, alpha = 0.05). Weed populations after the second atrazine application averaged 5.1 ± 2.1 (SD) per m^2 in the control plots and 3.1 ± 1.5 (SD) per m^2 in the atrazine plots and were significantly different (*t*-test, alpha = 0.05). Based on the species present, the reduction in weed populations in plots treated with atrazine was within the anticipated range (Unruh and Brecke 2006).

Data are presented (Table 1) for those arthropods collected in sufficient number for statistical analysis although other arthropods in smaller numbers were also found in samples. Ants, followed by spiders, were the most abundant predators collected overall on the 3 sampling dates. Consistent with this study, Cherry (2006. J. Entomol. Sci. 41: 165-169), using 3 sampling methods (vacuum, irritant, visual) determined that ants were the most abundant predators followed by spiders in a large survey of arthropod predators in Florida St. Augustinegrass. The sequence of ants being the most abundant predators, followed by spiders, also has been observed in other turf ecosystems. Cockfield and Potter (1984, Great Lakes Entomol. 17: 179-184) reported that ants were the most abundant predators followed by spiders caught in

Table 1. Mean ± SD* numbers of arthropods in St. Augustinegrass after atrazine treatments

Treatments	Ants	Chinch bugs	Leafhoppers	Planthoppers	Spiders
		Pre-treatment			
Atrazine	5.5 ± 7.8	3.6 ± 9.7	3.3 ± 4.7	1.3 ± 1.9	6.8 ± 9.7
Control	7.9 ± 6.9	0.7 ± 0.9	5.3 ± 6.2	3.0 ± 3.5	11.3 ± 11.5
		Short-term exposure**			
Atrazine	6.4 ± 6.0	0.4 ± 0.9	0.6 ± 5.7	1.4 ± 2.0	4.2 ± 4.3
Control	9.1 ± 8.0	0.5 ± 1.4	1.4 ± 4.7	2.6 ± 4.8	4.6 ± 4.8
		Long-term exposure+			
Atrazine	11.2 ± 11.1	4.6 ± 9.3	1.5 ± 1.6	0.6 ± 1.4	5.5 ± 8.8
Control	17.0 ± 20.1	3.6 ± 3.7	1.9 ± 1.8	0.3 ± 0.6	5.4 ± 5.5

* *t*-test analyses showed no significant difference ($P > 0.05$) between any arthropod populations in control versus atrazine treatments at any of the 3 sample times.
** Populations 1 month after the first atrazine application.
+ Populations 2 months after the second atrazine application.

pitfall traps in Kentucky bluegrass (*Poa pratensis* L.) and tall fescue (*Festuca arundinacea* Screb) in Kentucky. And, ants followed by spiders were the most abundant predators in pitfall traps in centipedegrass (*Eremochloa ophiuroides* (Munro) Hack) in Georgia (Braman and Pendley. 1993. J. Econ. Entomol. 86: 494-504). These preceding data emphasize the importance of ants and spiders in turf ecosystems.

Southern chinch bugs, *Blissus insularis* Barber (Lygaeidae), leafhoppers (Cicadellidae), and planthoppers (Delphacidae) were the most abundant herbivores in samples. The southern chinch bug is the most damaging insect pest of St. Augustinegrass, so its presence was to be expected. Leafhoppers and planthoppers are commonly found in St. Augustinegrass although they seem to have little economic impact. Leafhoppers as occasional turf pests are discussed by Vittum et al. (1999. Turfgrass insects of the United States and Canada. Cornell Univ. Press. London). Until 2006, no publications had reported delphacid planthoppers to be turf pests in the United States. However, recently Cherry et al. (2006. Florida Entomol. 89: 459-461) reported large numbers of the delphacid, *Liburnia pseudoseminigra* (Muir and Gifford), infesting some varieties of St. Augustinegrass in Florida.

There were no significant differences in population densities in any of the 5 arthropods between atrazine and control plots in the February pretreatment samples. Samples taken in late April 1 month after the first atrazine treatment (short-term exposure) showed that there were again no significant differences in population densities in any of the 5 arthropods between atrazine and control plots. Samples taken in August 2 months after the second atrazine treatment (long-term exposure) showed that there were again no significant differences in population densities in any of the 5 arthropods between atrazine and control plots.

Atrazine has shown several effects on different arthropods. These effects include population reduction, repellency, chemosterilant, and synergistic increase in toxicity in insecticides. However, there are also numerous examples where herbicides including atrazine showed no effect on arthropods (Norris and Kogan 2000). Our data show that atrazine applications had no significant short- or long-term effects on population densities of ants, chinch bugs, leafhoppers, planthoppers, or spiders in St. Augustinegrass. It is especially important to note that ants and spiders which are the most abundant biological control agents in St. Augustinegrass (Cherry 2006) were not disrupted by atrazine applications. Reasons for the lack of population reduction may be due to atrazine having no effect on the arthropods and/or rapid immigration back into plots. However, as noted earlier, plots approximated a normal yard size and, hence, our data are thought to reflect a real-world situation.

AUTHOR GUIDELINES

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