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Biology and Control of Sedges Associated with Sugarcane and Rice in Florida[1]

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Sugarcane (*Saccharum* spp. interspecific hybrids) is an important crop cultivated on organic soils in the Everglades Agricultural Area (EAA) and surrounding mineral soils in southern Florida. Florida is a leading producer of sugarcane in the United States with an average of 400,000 acres of production over the last two decades (VanWeelden et al. 2020). The sugarcane crop in Florida is cultivated in rotation with several crops, including rice (*Oryza sativa* L.), during the sugarcane fallow renovation period. Rice cultivated on approximately 25,000 acres, mainly on organic soils in the EAA, provides income to growers and also provides important ecosystem services, including soil health improvement and reduction of soil subsidence or soil loss due to oxidation (Bhadha et al. 2020). Flooded rice fields also negatively influence populations of corn wireworm (*Melanotus communis*), an important insect pest of sugarcane in the region (Cherry 2017). In Florida, sugarcane is vegetatively propagated by planting stalk sections while rice is drill-seeded. Several weed species such as broadleaves, grasses, and sedges infest Florida sugarcane and rice fields. Sedges are among the most common and troublesome weeds associated with sugarcane and rice production in Florida (Rott et al. 2018; Webster 2012). After planting, sedges can emerge prior to crop emergence or at any time during the sugarcane growing season.

Sedges are grass-like plants with parallel leaf venation and aerial flower-bearing stems in the family Cyperaceae composed of approximately 3,000 species, with roughly 220 species considered as weeds (Bendixen and Nandihalli 1987). A majority of these sedge species in crops such as sugarcane and rice are in the genus *Cyperus* (Etheredge et al. 2010). The most common and problematic sedges found in Florida sugarcane and rice are purple nutsedge and yellow nutsedge, with the latter being the most prevalent. These two species may be found growing together in fields and are difficult to distinguish if flowers are absent. They are common in sugarcane and rice in Florida due to their ability to tolerate a wide range of soil types, wet soils, and poorly drained soils, and their ability to grow under flooded rice conditions. Less problematic sedges found in these cropping systems include annual sedge, flatsedge, and rice flatsedge. This article describes the biology and control options for sedges associated with sugarcane and rice in Florida to assist growers in making correct identification and appropriate management decisions to help control these species.

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Purple Nutsedge

Purple nutsedge (*Cyperus rotundus* L.) is a herbaceous perennial weed native to Eurasia (Bryson and DeFelice 2009). In the continental United States, it is found in Texas to Virginia, Maryland, Delaware, Pennsylvania, and New Jersey, and in Arizona, California, and Oregon (Murphy et al. 2013; USDA 2020b). Purple nutsedge is found throughout Florida from the Panhandle to the Keys (USDA 2020b). The distribution of purple nutsedge is limited by low temperature and moisture (Bendixen and Nandihalli 1987), which are not limiting environmental factors in southern Florida where sugarcane and rice are cultivated.

Biology and Life Cycle

Purple nutsedge is a rapidly spreading sedge with tubers and underground runners or rhizomes. Seedlings of purple nutsedge are inconspicuous and rare to find because the plant spreads almost exclusively via rhizomes and tubers (Stoller and Sweet 1987). The leaves are shiny, dark green, linear, flat or slightly corrugated, approximately 1/16 inch to ¼ inch wide and 6 to 12 inches long with a prominent midvein, and formed in groups of three (i.e., three-ranked). The leaves abruptly taper to a sharp point at the tip and are often described as "boat-shaped" (Figure 1). The stem is triangular, smooth, solitary, and 4 inches to 6 inches tall. Purple nutsedge has reddish-purple to reddish-brown flowers formed at the end of stems and 2 to 4 leaflike bracts below the flowers (Figure 2). Although flowers sometimes develop into mature viable seeds, propagation is primarily by rough, irregularly shaped tubers connected by wiry rhizomes which are underground stems (Figure 3). Purple nutsedge flowering occurs at 12-hour photoperiod indicating that it has an intermediate flowering response to daylength (Williams 1978). However, daylength does not affect tuber formation dramatically compared to high temperatures, which stimulate tuber formation (Stroller and Sweet 1987). The survival of these tubers increases with soil depth (Stroller and Sweet 1987).

Yellow Nutsedge

Yellow nutsedge (*Cyperus esculentus* L.) is a herbaceous perennial weed native to North America found throughout the United States with the exception of Montana and Wyoming (Bryson and DeFelice 2009; Murphy et al. 2013; USDA 2020a). In Florida, yellow nutsedge is found from the Panhandle to the Keys (USDA 2020b). Yellow nutsedge is found within a wider geographic area compared to purple nutsedge because it is more tolerant of cold and drought (Bendixen and Nandihalli 1987).

Figure 1. Purple nutsedge leaf tip.
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Figure 2. Purple nutsedge flower.
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Biology and Life Cycle

Yellow nutsedge is a rapidly spreading sedge that forms tubers at the end of the rhizomes. Similar to purple nutsedge, the seedling is small, inconspicuous, and rarely found because it also spreads almost exclusively by rhizomes and tubers. The basal leaves formed in groups of three are flat or slightly corrugated, and usually longer than the flowering stem. Leaf blades are bright green, narrow or linear, and 1/16 inch to 7/16 inch wide. The leaf tips are long and attenuated, gradually tapering to a thin, sharp point (Figure 4). The stem is triangular in cross section and 6 inches to 2 1/2 feet tall. The flower is yellowish-brown or straw colored and formed at the end of the stem with 3 to 7 conspicuous leaves below (Figure 5). The seed is brown and less than 1/16 inch long. Tubers are round, smooth, and formed at the ends of whitish rhizomes (Figure 6). Unlike purple nutsedge, yellow nutsedge does not form groups of tubers connected by wiry chains (Figure 3). Propagation is primarily by tubers, and rarely by seeds (Stroller and Sweet 1987; Bendixen and Nandihalli 1987). Tuber survival increases with soil depth; they can emerge from deep in the

soil (Figure 7) and remain viable for more than 10 years (Stroller and Sweet 1987).

Figure 3. Purple nutsedge tubers connected by wiry rhizomes.
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Figure 4. Yellow nutsedge leaf tip.
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Figure 5. Yellow nutsedge flower.
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Figure 6. Yellow nutsedge tuber at the end of a rhizome.
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Figure 7. Yellow nutsedge emergence (on the left) from deep in the soil.
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Other Sedges

Unlike the perennial growth habits that describe purple and yellow nutsedge, the annual sedge *(Cyperus compressus* L.), flatsedge (*Cyperus odoratus* L.), and rice flatsedge (*Cyperus iria* L.) are annual sedges. These sedge species are also commonly found in the EAA, mainly in rice fields. They do not produce tubers and propagation is by seed. Their leaves are linear and formed in groups of three, and roots are fibrous and branched. Roots of annual sedge are red, rice flatsedge roots are yellowish-red, and flatsedge roots are brown. Roots of annual sedge are also aromatic. A key characteristic to differentiate these three species is the flower or seed head. Flowers of annual sedge are clusters or flat and are greenish-white in color with toothed margins (Figure 8). Flatsedge has tan or brown flowers with 3 to 10 small and conspicuous leaves or bracts (Figure 9). Flowers of rice flatsedge are composed of elongated spikes with 3 to 7 leaflike bracts.The lowest bract is longer than the inflorescence, and spikelets of individual spikes are crowded and golden brown (Figure 10).

Figure 8. Annual sedge flower.
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Figure 9. Flatsedge flower.
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Figure 10. Rice flatsedge flower.
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Control of Sedges in Sugarcane and Rice

There are a few herbicides available for control of sedges in sugarcane and rice (Table 1). These herbicides must be used in conjunction with other weed management tools such as crop rotation and cultivation to obtain maximum benefit. In addition, healthy competitive crop stands with the ability to close canopy and shade nutsedges enhance their control. The herbicides can be applied preemergence or postemergence. However, there are no preemergence herbicides for sedge control in Florida rice. Proper timing of herbicide application with respect to the growth stage of the weeds is very important. Efficacy of these herbicides on sedges will be achieved when the weeds are under 4 inches to 8 inches in height. Always read the label for the proper time of application of each herbicide.

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Table 1. Sedge control in sugarcane and rice. Contact: Extension weed specialist (dcodero@ufl.edu).This table lists registered pesticides that should be integrated with other pest management methods. Contact your local UF/IFAS Extension office for additional information (https://sfyl.ifas.ufl.edu/find-your-local-office).

Herbicide Active Ingredients (Commonly used products)	HRAC MOA	Application (rate and total/year)	Reentry (hours)	Weeds Controlled, Application Methods, and Effectiveness (see product label for details)
PREEMERGENCE FOR SUGARCANE				
S-metolachlor + atrazine + mesotrione (Lumax 3.674 EZ)	15 + 5 + 27	2.75–3.75 qt/acre, max. 3.75 qt/acre for PRE only application	24 hours	Apply after new plantings, or after harvest, but prior to re-emergence of ratooncane for control of yellow and purple nutsedge. Higher rates should be applied to organic soils. If the sedges have emerged at the time of application, add a crop oil concentrate (COC) at 1% v/v or a nonionic surfactant (NIS) at 0.25% v/v to the spray solution. In addition to COC or NIS, a spray-grade UAN (e.g., 28-0-0) at 2.5% v/v (2.5 gal/100 gal spray solution) or ammonium sulfate at 8.5 lb/100 gal of spray solution can be added to the spray solution. **Restricted Use**.
POSTEMERGENCE FOR SUGARCANE				
S-metolachlor + atrazine + mesotrione (Lumax 3.674 EZ)	15 + 5 + 27	1.5–3.0 qt/acre. If a PRE application was made earlier in the season (not to exceed 3.75 qt/acre), only 1.5 qt/acre may be applied POST. Max. (PRE + POST) 5.25 qt/acre	24 hours	Can be applied POST for yellow and purple nutsedge before sugarcane reaches 60 inches in height. It should be applied to actively growing weeds. If sedges have emerged at the time of application, add adjuvants at rates similar to PRE application. **Restricted Use**.
Trifloxysulfuron (Envoke 75 DG)	2	0.3–0.6 oz/acre, max. 1.5 oz/acre	12 hours	Provides good control of yellow and purple nutsedge. Apply POST (0.3 oz/acre) on pre-spiking to spiking plant cane when sedges are less than 4 to 6 inches in height. Apply POST over-the-top on ratoon cane or POST-directed on both plant and ratoon cane. POST over-the-top (0.3 oz/acre) can be applied until sugarcane reaches 24 inches in height in ratoon cane. POST-directed applications (0.3–0.6 oz/acre) can be made on plant and ratoon cane that is 24 inches tall through layby. Applications cannot be more than 3 per season. Apply with NIS at 0.25% v/v and COC at 0.5–1.0% v/v. COC may be used ONLY when applying POST-directed. Refer to the label for tank-mix options.
Halosulfuron-methyl (Sandea 75% DF)	2	0.75–1.33 oz/acre, max. 2.67 oz/acre	12 hours	Can be applied at any stage of sugarcane growth for control of yellow and purple nutsedge. No more than 3 applications (including PRE applications) may be made. Apply to emerged nutsedge after nutsedge has reached 3- to 8-leaf stage. Add COC at 1% v/v or NIS 0.25–0.50% v/v. Applications should be made to actively growing weeds.
Halosulfuron-methyl + dicamba (Yukon 67.5 WSG)	2 + 4	4–8 oz/acre, max. 8 oz/acre	24 hours	May be applied to any stage of sugarcane growth for control of yellow and purple nutsedge. Apply to emerged nutsedge after sedge has reached 3- to 8-leaf stage. Do not make more than 2 applications per growing season. Take care to prevent spray drift to sensitive crops and consult the Florida Organo-Auxin Herbicide Rule prior to application. Add COC at 1% v/v or NIS at 0.25–0.50% v/v. Applications should be made to actively growing weeds.

Herbicide Active Ingredients (Commonly used products)	HRAC MOA	Application (rate and total/year)	Reentry (hours)	Weeds Controlled, Application Methods, and Effectiveness (see product label for details)
POSTEMERGENCE FOR RICE				
Bentazon (Basagran 4 L)	6	1.5–2.0 pt/acre, max. 4 pt/acre	48 hours	Best control of sedges is achieved with early application. Yellow nutsedge (4- to 6-leaf) may be controlled with the lower rate. Higher rates are needed for larger yellow nutsedge. Refer to the label for tank-mix options.
Bensulfuron-methyl (Londax 60% DF)	2	0.5–1.0 oz/acre, max. 1.67 oz/acre	24 hours	Best control is achieved when applied early POST to small, actively growing sedges. Can be applied to flooded rice; see label for specific requirements. Refer to the label for tank-mix options.
Halosulfuron-methyl (Sandea 75% DF)	2	0.67–1.33 oz/acre, max. 1.67 oz/acre	12 hours	Provides control of annual sedges, purple and yellow nutsedges. Can be applied after rice emergence to 48 days before harvest. Use 0.67 oz/acre for nutsedges less than 6 inches tall and 1–1.33 oz/acre for nutsedges 6 to 12 inches tall. Add NIS at 0.25–0.50% v/v or COC at 1.0% v/v. Refer to the label for tank-mix options.
Penoxsulam (Grasp 2 EC)	2	2.0–2.8 fl oz/acre, max. 5.6 fl oz/acre	12 hours	Provides control of annual sedges. Apply at 2- to 3-leaf stage rice or after 1/2-inch internode elongation stage of rice. Do not make more than 2 applications per season. Add a COC or methylated seed oil (MSO) at 1% v/v. Flooding should be delayed for 3 days following application.
Penoxsulam + triclopyr (Grasp Xtra 2.31 EC)	2 + 4	16–22 fl oz/acre, max. 22 fl oz/acre	24 hours	Provides control of annual sedges. Apply at 2- to 3-leaf stage rice or after 1/2-inch internode elongation stage of rice. Add a COC or MSO at 1% v/v. Flooding should be delayed for 3 days following application.