Nutsedge (Cyperus spp.) Eradiation: Impossible Dream?

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*Webster T.M. 2003. Nutsedge (*Cyperus *spp.) eradiation: impossible dream? In: Riley L.E., Dumroese R.K., Landis T.D., technical coordinators. National Proceedings: Forest and Conservation Nursery Associations—2002. Ogden, UT: USDA Forest Service, Rocky Mountain Research Station. Proceedings RMRS-P-28: 21–25. Available at: http://www.fcnanet.org/proceedings/2002/webster.pdf*

Abstract

The elimination of methyl bromide use will affect a broad range of crops, from vegetables to cut flowers to pine seedlings. In many plant production scenarios, once methyl bromide applications have ceased, nutsedges have become significant problems due to their tolerance of many herbicides and their prolific production of energy-rich tubers. Instead of independently researching nutsedge management in each of these diverse crops, sharing knowledge concerning nutsedge biology, ecology and management may allow us to efficiently find viable solutions to this problem. This paper is a brief review of some of the knowledge of purple and yellow nutsedge biology, ecology, and management in agronomic and vegetable crops.

Key Words

Cyperus rotundus, *Cyperus esculentus*, noxious weeds

Nutsedge Importance and Distribution

The Cyperaceae or Sedge family consists of 17 different genera in the Southeast US (Radford and others 1968). While several of these genera are weedy (examples: *Kyllinga* spp. and *Carex* spp.), those commonly described as most troublesome across a broad range of crops are found in the genus *Cyperus*. There are 45 *Cyperus* spp. found in the southeastern US, of which 29 are perennial. Two of these perennial species, purple nutsedge (*Cyperus rotundus* L.) and yellow nutsedge (*Cyperus esculentus* L.), can be separated from the rest due to their economic impact on agriculture.

Nutsedges were food crops before they were considered weeds. Purple nutsedge tubers have been identified as a staple of the diet of Egyptians in the late Paleolithic era (circa 1600 BC) (Negbi 1992). Recipes for ground-up yellow nutsedge tubers mixed with honey have been discovered in Egyptian tombs dating from the 15th century BC (Negbi 1992). The first reference to purple nutsedge as a weed occurred in the first century AD (Negbi 1992). Nutsedges have since become important weeds throughout the world. Based on the worldwide distribution (considered weeds in at least 92 countries) and importance in many diverse crops (infesting at least 52 different crops), purple nutsedge was ranked as the world's worst weed, while yellow nutsedge was listed among the top 15 worst weeds (Holm and others 1978). A survey competed by county extension agents in Georgia ranked the nutsedges among the top 5 most troublesome weeds in corn, cotton, peanut, and soybean, and the most troublesome weeds of tobacco and vegetables (Webster and MacDonald 2001).

The 2 nutsedge species have different distributions in the US. Yellow nutsedge is found throughout the continental US, while purple nutsedge is primarily restricted to the coastal states of the southern US and along the Pacific coast in California and Oregon. Researchers determined that 95% of yellow nutsedge tubers survived 36 °F (2 °C) for 12 weeks when buried in the soil to a depth of 4 inches (10 cm); however less than 10% of purple nutsedge tubers survived this treatment (Stoller 1973). The general conclusion is that purple nutsedge will typically thrive only in areas where the soil freezes infrequently.

How to Distinguish the Nutsedge Species

Both nutsedges have triangular stems (easily felt if you roll the stems between your finger and thumb), distinguishing them from grasses that have flat or round stems. Purple and yellow nutsedge can be difficult to separate; however there are distinguishing characteristics for each. Purple nutsedge tubers are cylindrical, with a brownish-black coat, susceptible to desiccation, and have a pungent taste. Yellow nutsedge tubers are also cylindrical. However, they are a yellow-beige color, can be dried to a wrinkly consistency with minimal affect on viability, and have a pleasant nutty taste. In fact, chufa is a subspecies of yellow nutsedge that is grown as a crop for wild turkey and swine feed. Purple nutsedge tubers form chains, capable of expanding beyond the shadow of the mother plant. In contrast, yellow nutsedge tubers will be relatively close to the mother plant, as all rhizomes that end in a tuber will be attached to the mother plant.

The tips of the leaf blades are important for distinguishing between species. Yellow nutsedge often has long blades with a gradually tapering leaf tip. Yellow nutsedge leaves also tend to be "pinched", forming folded boat-shaped blades near the tips. In contrast, purple nutsedge often has a shorter leaf blade that always comes to an abrupt tip that remains flat near the tip of the blade. Yellow nutsedge plants tend have a lighter yellowish-green color, while purple nutsedge plants are often darker green in color. Soil fertility, however, will often influence this and should not be used a definitive identification tool. Inflorescence color is a good means of easily distinguishing these species. Purple nutsedge has a reddish-purple inflorescence, while yellow nutsedge has a yellow inflorescence.

Why Are Nutsedges Such Persistent Weeds?

Purple and yellow nutsedge are perennial weeds that are prolific producers of tubers. Studies have demonstrated that purple nutsedge will produce seed, but viability of the seed is very low. As a result, there is minimal genetic variation in purple nutsedge populations (Okoli and others 1997). In contrast, yellow nutsedge has greater genetic variation and higher seed production (17% of flowers produced seed) (Thullen and Keeley 1979; Okoli and others 1997). Yellow nutsedge seeds were viable two weeks after full bloom and had a high rate of germination (78%) (Lapham and Drennan 1990). However, under agronomic conditions, less than 1% of the germinated seeds survived and became a mature plant. Yellow nutsedge seeds are important in dispersing this species into new areas; once established in a field, yellow nutsedge predominantly relies on vegetative reproduction to sustain itself.

Tubers of purple nutsedge have been estimated to have a half-life of 16 months and a predicted longevity of 42 months (Neeser and others 1997). This is not long when compared to other weed species, which have survived in the soil profile under natural conditions for greater than 70 years (Regnier 1995). While tubers may not be as long-lived as seeds, tubers possess large carbohydrate reserves, which allow for rapid emergence and growth, an advantage over seeded crops.

Purple nutsedge tuber production begins approximately 6 to 8 weeks after foliar emergence, corresponding to flower initiation (Hauser 1962). Roots and tubers have more biomass than aboveground foliage by 6 weeks after foliar emergence and tuber chains are initiated a month later (Hauser 1962). When purple nutsedge was planted at 43,560 tubers/acre (107,340 tubers/ha), after 1 season of growth there were 3,090,000 shoots/acre (7,635,400 plants/ha) and 4,442,000 tubers/acre (10,980,000 tubers/ha) (Hauser 1962). A single yellow nutsedge plant growing without competition in a bareground area produced 700 tubers after 6 months of growth (Webster unpublished data). It is critical to remember that nutsedge populations can increase rapidly when fields are not managed between crops.

Yellow nutsedge appears to be more tolerant to shading than purple nutsedge, but neither thrives under low light conditions. Yellow nutsedge biomasses were not different when grown in either full sunlight or 30% shade, while purple nutsedge biomass was reduced linearly as light levels decreased (Jordanmolero and Stoller 1978). Supporting this finding is the lower light compensation point (amount of light needed for photosynthesis to equal respiration) for yellow nutsedge than for purple nutsedge (Santos and others 1997).

Expansion of Nutsedge Patches

Once nutsedge plants become established in the field, little is known about how fast nutsedge patches expand. A single tuber of each nutsedge was established and allowed to grow and expand in a non-competitive environment. After 3 months of growth, the number of shoots was similar for both yellow nutsedge (22 shoots) and purple nutsedge (29 shoots) (Webster unpublished data). However, the average number of purple nutsedge shoots (323 shoots/patch) after 6 months of growth more than doubled the number of yellow nutsedge shoots (136 shoots/patch). There were not only striking differences in shoot population among the nutsedge species, but the sizes of nutsedge patches were also different. Yellow nutsedge growth formed compact, densely populated patches. In one particular patch after 6 months of growth, a single tuber expanded to form a patch with an area of 1.9 ft^2 (0.18 m^2) (Webster unpublished data). At the center of this patch, the density was 650 shoots/ft^2 (7000 shoots/m^2). [However there were only 177 shoots over the 0.6 ft^2 (0.18 m^2)area, for an average patch density of 91 shoots/ft^2 (980 shoots/m^2)]. In contrast, purple nutsedge tubers formed a much larger patch that was sparsely populated (relative to yellow nutsedge). After 6 months of growth, the purple nutsedge patch expanded to an area of 84 ft^2 (7.85 m^2), over 43-fold larger than the yellow nutsedge patch. In this particular purple nutsedge patch, there were 518 shoots in the patch, with the maximum density of 26 shoots/ft^2 (280 shoots/m^2), with the average patch density of 6 shoots/ft^2 (66 shoots/m^2). The primary conclusion that can be drawn from this preliminary data is that purple nutsedge populations are capable of distributing themselves throughout the environment, while it appears that yellow nutsedge tubers require human action to distribute them throughout the environment. This supports the conclusions of Schippers and others (1993) that farming operations are the main causes of yellow nutsedge dispersal in the field.

How Do I Get Rid of My Nutsedges?

The majority of purple nutsedge tubers are relatively shallow; 45% of the tubers are within the top1.5 inches (4 cm) of the soil profile and 95% are found within the top 4.7 inches (12 cm) of the soil profile (Siriwardana and Nishimoto 1987). With relatively shallow distribution in the soil, frequent tillage was the primary means of controlling nutsedges prior to the development of herbicides. Tillage every 3 weeks over a 2-year period eradicated purple nutsedge from fields on more than 10 different soil types (Smith 1942; Smith and Mayton 1938). While frequent tillage over time can be effective in controlling tuber populations, it is possible that infrequent tillage may serve to fragment tuber chains, releasing apical dominance and possibly increasing nutsedge populations.

Successful nutsedge management requires the integration of knowledge of the biology and ecology of these species with management strategies (which include herbicides and cultural crop production practices). One of the keys to managing nutsedge species is to target postemergence herbicide applications to coincide with the maximum number of emerged nutsedge shoots. Emergence of nutsedge shoots is largely dependent upon soil temperature. While moisture extremes will affect emergence, due to the large carbohydrate reserves in the tuber, soil temperature will largely be the driving force behind emergence. We followed nutsedge emergence throughout the growing season and found a relation between temperature and nutsedge emergence. Using a base temperature of 41 °F (5 °C), the accumulated number of growing degree days that corresponded with 80% emergence of yellow nutsedge was 782 growing degree-days (GDD), which occurred on 6 May 1999 and 30 April 2000 (Webster unpublished data). Purple nutsedge required more growing degree-days, 1264 GDD, to achieve 80% emergence, corresponding to 1 June 1999 and 21 May 2000. These dates were 3 to 4 weeks later in the growing season than yellow nutsedge (Webster unpublished data). Why is this important? Several herbicides require foliar contact (for example, glyphosate and paraquat) or have better activity against nutsedge when applied to the foliage (for example, halosulfuron). Proper timing of postemergence applications will improve the efficiency of these applications.

The following section contains estimated purple and yellow nutsedge control levels for several compounds. These estimates are based on research in agronomic (in other words, corn, cotton, and peanut) or vegetable crops (in other words, cucurbits, eggplant, and tomato) and are collective ratings from several research and extension weed scientists with the University of Georgia and USDA-ARS in Tifton, Georgia (table 1). While weed control effectiveness may be similar in pine seedling nurseries (depending upon herbicide rate, time of herbicide application, and desired length of control), crop tolerance has not been evaluated for pine seedlings. In many of these crops, a competitive crop canopy is established within the first several weeks in the season, which may improve overall control. Also, discussion of these products does not imply that these herbicides are registered for use outside of agronomic and vegetable crop situations. Please refer to the herbicide label before making any herbicide application.

There are 3 types of herbicides that are used to manage nutsedge populations. The first type of herbicide is applied to the soil prior to nutsedge emergence, called preemergence (PRE) herbicides. The most common examples of these types of herbicides are metolachlor (trade name: Dual®) and fomesafen (trade name: Reflex®). Yellow nutsedge control (55% to 85%) is more effective than purple nutsedge control (< 35%) with these compounds. While anecdotal evidence suggests fomesafen has PRE activity on yellow nutsedge, control of this species is not listed on the registration. Fomesafen has a 24C registration in Mississippi for use in pine seedling nurseries.

Table 1. Estimates of yellow and purple nutsedge control with herbicides commonly used in agronomic and vegetable crops. The tolerance of pine seedlings has not been tested.

Herbicide activity	Herbicide	Rate	Yellow nutsedge	Purple nutsedge
		Kg ai/ha	- - - - - - - - - Percent control	- - - - - - - -
Soil activity only	Metolachlor PRE[a]	1.40	55 to 85	< 20
	Fomesafen PRE[b]	0.56	85	< 35
	Fomesafen POST	0.42	50 to 60	?
Foliar activity only	Bentazon POST[c]	1.12	75	< 20
	Glyphosate POST[d]	2.24	55	70
	MSMA POST[e]	1.12	45	30
	MSMA POST	2.24	90	65
Soil and Foliar Activity	Imazapic POST[f]	0.07	90	95
	Imazethapyr POST[g]	0.07	60	70
	Halosulfuron[h]	0.07	85 to 95	85 to 95
	Trifloxysulfuron[i]	N/A	75 to 95	?

[a] Trade name: Dual® Magnum (7.62 lbs ai/gal of product); 1.3 pt product/ac.
[b] Trade name: Reflex® (2 lbs ai/gal of product); 2 pt product/ac. There is a 24C label for application of Fomesafen PRE in pine seedling nurseries in Mississippi. This label does not exist in any other state.
[c] Trade name: Basagran® (4 lbs ai/gal of product); 2 pt product/ac.
[d] Trade name: Roundup™ and many generics; rate of product depends upon formulation.
[e] Trade name: Various generics; rate of product depends upon formulation.
[f] Trade name: Cadre® (0.70 lbs ai/1.0 lb of product); 1.44 oz product/ac.
[g] Trade name: Pursuit® (0.70 lbs ai/1.0 lb of product); 1.44 oz product/ac.
[h] Trade name: Sandea™ and Permit® (0.75 lbs ai/1.0 lb of product); 1.3 oz product/ac.
[i] Trade name: Evoke, CGA-362622; experimental, not yet registered.

The second class of herbicides is applied following nutsedge emergence (commonly referred to as postemergence or POST treatments) and these rely on foliar contact because they do not possess any soil activity. The most common examples of these herbicides include bentazon (trade name: Basagran®), glyphosate (trade name: Roundup™ and similar generic brands), MSMA, and paraquat. Differential effectiveness for these herbicides between the nutsedge species has been noted. Yellow nutsedge is more susceptible to MSMA (90% control) than is purple nutsedge (65% control). Bentazon is more effective on yellow nutsedge (75% control), while purple nutsedge control is poor (less than 20% control). There appears to be a similar efficacy among the nutsedge species for paraquat (50% control), while glyphosate has better activity on purple nutsedge (70%) than on yellow nutsedge (55%). Glyphosate will translocate through the plant within 3 days and subsequently kill the foliage and the tuber directly attached to the foliage (Rao and Reddy 1999). The key to controlling or suppressing nutsedge growth with these compounds is ensuring the herbicide contacts the nutsedge foliage, which can be predicted using growing degree-days.

The final class of herbicides used to manage nutsedges has both soil activity and foliar activity. These herbicides include some of the more recently registered compounds, including halosulfuron, imazapic, and imazethapyr (Richburg and others 1993, 1994; Vencill and others 1995; Molin and others 1999). Imazethapyr and imazapic tend to have greater activity against purple nutsedge (70% and 95%, respectively) than yellow nutsedge (60% and 90%, respectively), while halosulfuron is equally effective (85% to 95% control) against both nutsedge species. Vencill and others (1995) determined that 53 g ai/ha (1 oz of product/ac) of halosulfuron reduced purple and yellow nutsedge regrowth at least 96% when applied to the foliage, the soil, or both the foliage and the soil. The number of purple nutsedge tubers was reduced 50% after consecutive years of halosulfuron applied at 72 g/ha (1.3 oz of product/ac) (Webster and Coble 1997).

The effectiveness of several of these herbicides, including glyphosate and halosulfuron, in controlling nutsedges is largely dependent upon the growing conditions. Conditions favoring nutsedge growth (in other words, warm temperatures, adequate moisture and fertility) will tend to improve nutsedge efficacy of these herbicides. Dry conditions will often reduce the effectiveness of these herbicides (including metolachlor).

Nutsedge control is a multi-season effort. Herbicides will often be the basis of nutsedge management programs. While control of foliage is important, successful long-term control will require management options that reduce or eliminate tuber production and viability.

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