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Cogongrass Biology and Management in the Southeastern U.S.

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Cogongrass [*Imperata cylindrica* (L.) Beauv.] is one of the world's most invasive plants. Native to the tropical and subtropical regions of southeastern Asia, this invasive grass is an aggressive pest in over 73 countries. Cogongrass is present on every continent except Antarctica and is problematic in a wide range of managed forests, cropland, rangeland, and natural ecosystems[19]. Cogongrass was unintentionally introduced to Mobile, Alabama in 1912 when it was used as packing material for oranges arriving from Japan[7]. Planting material from the Philippines was later introduced to Mississippi in 1921 for forage trials, and subsequently to Florida, Alabama, and Texas in the early 1930s[14]. However, field evaluations determined cogongrass was a poor forage species due to low crude protein content and poor digestibility, partially because the leaves accumulate silica. Since its introduction, cogongrass has spread throughout the southeastern U.S. It is currently listed as a Federal Noxious Weed in Alabama, Georgia (as per USDA APHIS), Florida, Hawaii, Minnesota, Mississippi, North Carolina, South Carolina, and Vermont, and is listed as a quarantine species for California and Oregon. Cogongrass continues to increase in abundance in the U.S. and, if left unchecked, is predicted to undergo a considerable northward range expansion in the next 50 years[2].

Identification

Cogongrass is one of the few warm-season grasses that bloom immediately after winter dormancy. However, when identifying cogongrass it is best to focus on vegetative characteristics, because it flowers only for a brief time. Note that the presence of just one of these characteristics does not confirm identity as cogongrass – it is best to look at multiple traits to confirm. Cogongrass can be identified by bright green leaves, which commonly grow up to 4' in height, but can reach over 6 feet in height and approximately 1 inch wide (Figs. 1, 2). Cogongrass leaves have serrated margins and a distinctly off-center white midrib (Fig. 3) (note that there are a number of other grasses that also have an off-center midrib, so this alone is not a reliable identification method). Cogongrass lacks above-ground stems, as leaves arise directly from underground horizontal stems called rhizomes (Fig. 4). These rhizomes are white, segmented, and covered with reddish-brown scales (Fig. 5). Cogongrass rhizomes possess several features to ensure survival and spread, including specialized internal anatomy to reduce water loss and sharply pointed tips.

Figure 1. Large cogongrass infestation in Central Florida. Note the bright green color of the grass.

Figure 2. Cogongrass leaves emerging from undeground rhizomes – note the lack of true stems.

Figure 3. Closeup of a cogongrass leaf showing the off-center midvein and the serrated leaf margins.

Figure 4. Cogongrass rhizomes.

Figure 5. Segments of cogongrass rhizomes with scale leaves attached (lower) and scale leaves removed (upper). Note the reddish color is usually not observed under field conditions.

The only stem above the ground is the flowering stalk, which typically lacks subtending leaves. Flowers of cogongrass are whitish-silver, plume-like (fluffy) and range from 4 to 8 inches in length (Fig. 6). Each seed head can contain over 100 individual flowers, but most flowers abort and lack seed development. When seeds are produced, they are extremely small, brownish-tan colored with long white hairs attached to aid in wind dispersal (Fig. 7).

Figure 6. Cogongrass flowers just prior to anthesis (left) and after pollination (right).

Biology and Ecology

Cogongrass thrives on forest edges and open fields, and responds quickly to disturbance, particularly from human activities. While cogongrass is adapted to acidic, nutrient-poor soils, it can tolerate a wide range of environmental conditions, including drought, salinity, and shade[12,19,27]. Cogongrass grows fastest in full sun compared to shaded sites[9,10,24], but reports of cogongrass growing under southern pine forest canopies for several years is not uncommon.

Cogongrass spreads through rhizomes and seed, although expansion of individual patches is exclusively through rhizome growth[10,19]. Circular cogongrass patches expand at a rate of 6 to 8 feet per year, although disturbances such as fire or tillage have been shown to increase expansion rates up to 12 feet per year[19]. Rhizomes have also been the primary mechanism of long-range spread, as fragments in contaminated soil or on equipment have resulted in new infestations throughout the southeastern U.S. Cogongrass rhizomes are persistent, and have an astounding regenerative capacity. Even very small rhizome fragments are capable of forming new populations; although

establishment success increases with rhizome length, even single-node fragments can have a nearly 50% establishment rate[9]. In fine-textured soils, cogongrass rhizomes usually grow to about 8" deep in the soil, but can extend down to 20" in sandy soils[22].

Flowering occurs in the late winter through early spring in the southeastern U.S., although disturbances such as burning or mowing can stimulate flowering throughout the year. Cogongrass from peninsular Florida appears to flower at various times throughout the year, rather than in the typical timeframe (winter through early spring). Seeds are dispersed by wind and capable of traveling long distances. Cogongrass can be a prolific seed producer; it has been reported to produce in excess of 3,000 seeds per plant[19,26]. However, cogongrass is an obligate outcrosser, meaning that only flowers fertilized with pollen from separate, genetically different populations will develop viable seeds[19,21]. Seeds are short-lived, with viability lost after one year[28]. Cogongrass seedlings colonize open habitats following disturbance, and are unable to withstand plant competition[30]. In contrast, cogongrass rhizomes are capable of persisting in established populations of other plant species. Increased cogongrass germination rates have been correlated with acidic soils (pH < 5). Spring burning may increase success by exposing soil and creating open areas for seed establishment[15,26]. Water level also plays a critical role, with no seed germination and reduced seedling growth reported to occur under flooded conditions[16]. Thus, for cogongrass seeds, invasion success is largely determined by site characteristics at the time of seed dispersal and seedling establishment.

Figure 7. Closeup of cogongrass flower and seed – note hairs attached at the base.

Impacts

Cogongrass can be found in pastures, turf, orchards, mine reclamation sites, CRP land, pine plantations, sandhill communities, roadside and utility rights-of-way, and along shorelines and river margins. It reportedly infests over 1.2 million acres in the southeastern U.S.[19]. Cogongrass is a significant pest plant in pine plantations, reducing survival and height of loblolly pine (Pinus taeda) seedlings[6] (Figs. 8, 9). Typically, cogongrass becomes established along roads and trails before expanding into natural areas[13,17]. It can quickly take advantage of openings caused by disturbance (particularly burning), and once established it forms dense monocultures that outcompete understory vegetation.

Cogongrass also has a major impact on fire regimes (Fig. 10). When present, it increases the fuel load in a system because of its high rate of biomass accumulation. This results in fires with greater maximum temperatures, causing mortality in species that are usually fire-tolerant, such as longleaf pine, *Pinus palustris*[18]. Cogongrass invasions along roadways, near residential

Figure 8. Cogongrass infestation in an upland forest community in Florida.

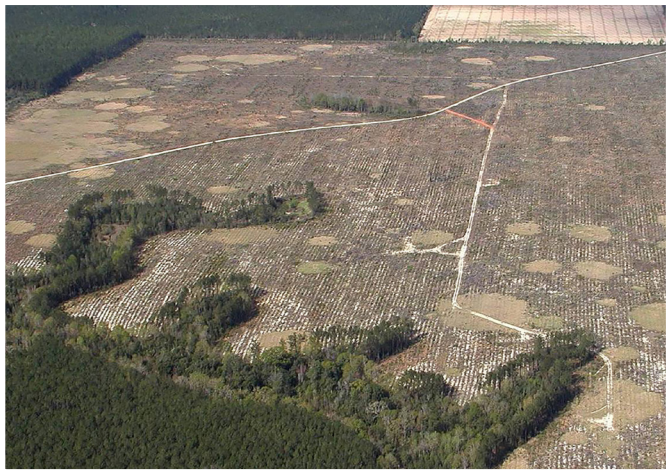

Figure 9. Cogongrass infestations, as denoted by circular patches, in a recently planted southern pine plantation.

areas, or adjacent any wooden object, such as an outbuilding, utility pole, fence posts, etc. also present a major fire hazard[19].

Cogongrass is highly competitive for water and nutrients; in particular, cogongrass is able to outcompete native legume species for phosphorus[3]. Cogongrass also has allelopathic activity (meaning it exudes compounds that deter growth of neighboring plants) against certain native species, including the native grass *Aristida stricta*, and slash pine, *Pinus elliottii*. Other species (*Lyonia ferruginea* and *Andropogon arctatus*) have shown some level of tolerance to these effects[11]. Cogongrass can also cause physical injury to other plants by penetrating the roots with its sharp rhizome tips[32].

Management and Control

PREVENTION

Prevention is the first step in cogongrass management[19]. Good sanitation to keep equipment free of seeds and rhizome fragments is critical towards preventing further spread. Avoid movement through and in cogongrass when it is in flower. Mulch or fill dirt from cogongrass infested areas should be avoided. Disturbed areas along roadsides and trails should be monitored, as these are likely sites for initial cogongrass establishment. Fire lines and logging operations are also primary ways in which cogongrass can be spread in forests. Prioritize monitoring and eradication of small patches along the northern borders of its range, as these populations are predicted to expand further northward[2]. If possible, determine if the population is producing viable seed, as those infestations should be given priority for control and eradication. Ornamental varieties of cogongrass ('Japanese blood grass' or 'Red Baron grass') have been banned for sale in many southern states. Avoid planting these varieties in states where it is legal, particularly in the northern range of cogongrass. There are concerns that it may outcross with the invasive variety in natural areas or revert to the more aggressive biotype in suitable environments (e.g., 'Red Baron' from an Oregon nursery lost the red foliage color immediately as it began to grow in a Georgia nursery [D. Moorhead, personal communication]).

Figure 10. Cogongrass burning near a roadside in Central Florida.

MECHANICAL

Mechanical control of cogongrass can be effective, but is often difficult to implement in an effective manner. Thick, well established cogongrass stands require large, heavy equipment to completely cut up the rhizomes and till the soil. Because it is a perennial grass, cogongrass must be tilled repeatedly each season for several seasons for complete control. The most effective tillage implement is a PTO powered rotary tiller. A disk harrow may be the most readily available implement for most land owners, but its effectiveness for control is poor. A roller chopper or other heavy equipment that is used in rangeland renovation may also provide some suppression, but multiple passes to complete disrupt the rhizome mat will be necessary[14]. The exact frequency and duration of disking or roller chopping depends on the density of the cogongrass and the availability of moisture (drier conditions lead to a faster drying of the rhizomes). If tillage is part of the management program, be certain to remove and dispose of rhizome fragments before leaving the site. Mowing will not eradicate cogongrass populations, but may reduce its rate of spread[32]. Mowing can also be used to remove above ground thatch, but is not as effective as burning due to the amount of leaf biomass behind the clipper. Mowing to suppress seed formation is also employed, but must be performed prior to seed formation and the 'fluffy-stage'. Two cautions with mechanical control: 1) single tillage operations often result in thicker infestations due to the increased sprouting of rhizome fragments (*the key for success is repeated operations to completely deplete rhizome reserves and starve cogongrass*) and 2) clean seed and rhizome fragments from equipment to prevent additional spread.

BIOLOGICAL CONTROL

Research regarding biocontrol agents for cogongrass management has had limited success[4]. Surveys have been conducted to seek out possible control agents, and several insects (e.g. stemborers, *Acrapex* spp., from East Africa and Japan, and a gall midge, *Orsioliella javanica*, from Indonesia) have been identified that appear to be herbivores specific to cogongrass. However, none of these insects have successfully colonized cogongrass in a controlled environment[23] and research is ongoing. There are also two fungal pathogens that infect cogongrass in the United States (*Bipolaris sacchari* and *Dreschlera gigantean*), although their effect is primarily on the foliage and impacts on rhizomes are minimal[20].

CULTURAL

Cover crops have shown potential in reducing cogongrass populations in agricultural settings, where the cover crop is planted to suppress and deter growth and expansion in cultivated land. This practice is implemented primarily in Africa and southeastern Asia where access to traditional mechanical tillage is limited[5]. However, seeding with native plant species as the sole management strategy in natural areas has been ineffective[8]. Moreover, cogongrass will reinvade native plantings if the pre-existing cogongrass was not completely eradicated. Altering soil conditions may provide some cogongrass control, as the addition of phosphorus reduced rates of cogongrass invasion in a pine savannah without detrimental effects on native species[3]. Another study demonstrated an increase in soil pH increased the competitive ability of bahiagrass (*Paspalum notatum*) with cogongrass[31]. Flooding during early spring may also limit germination and growth of cogongrass seedlings[16]. Cogongrass seedlings are weak and considered poor competitors, so maintaining good native plant cover will help prevent cogongrass establishment from seed. Maintaining a ground cover, whether pine straw, mulch, leaves, thatch, etc. to prevent seed contact with soil may be useful in certain areas. In southern forests where food plots are used for hunting, a common strategy is to establish and continuously maintain food plots in cogongrass patches, where traditional farming practices will eventually eliminate the cogongrass infestations.

CHEMICAL

Chemical control is the most common form of cogongrass management. Currently, only glyphosate and imazapyr, both broad-spectrum systemic and non-selective herbicides, provide effective control of cogongrass[19]. The soil activity from imazapyr provides control over a longer period of time compared to glyphosate, but can also result in off-target effects. **Always read and follow the herbicide label for specific information concerning applications near water and in sensitive areas, non-target injury, specific rates, and application guidance. Keep in mind that it is illegal to use herbicides in a manner that is inconsistent with the label. It is highly recommended to contact a professional when working with herbicides.** Imazapyr is lethal to many hardwood and some pine tree species, and applications made to cogongrass under or near susceptible trees within the rooting zone often result in severe injury or mortality (Fig. 11). Glyphosate and imazapyr are generally used at maximum labeled rates when applied alone. These herbicides can also be applied together as a tank-mix – refer to local or state recommendations for cogongrass control. Repeated applications over several years are usually required to achieve adequate control; one study reported that a tank-mix of imazapyr and glyphosate applied three years in a row resulted in complete eradication of cogongrass populations in southern Alabama[1]. Time of application is an important consideration when managing cogongrass. Applications in the fall are typically most effective (>90% control for 12 months) for both glyphosate and imazapyr, because during this time plants are translocating carbohydrates (and thus herbicide) to the rhizomes in preparation for winter. In most situations, one additional follow-up treatment the following year can achieve complete control. For example, in one study applications of imazapyr in the fall, or glyphosate in either the fall or spring, over a consecutive three year period achieved eradication[1]. As with any herbicide treatment regime, application technique, herbicide rate, age, and density of the cogongrass stand, and environmental conditions before, during, and after herbicide application, can influence control. In most cases, control from glyphosate and imazapyr is visually evident 2-3 and 3-4 weeks after treatment for each herbicide, respectively.

INTEGRATED MANAGEMENT STRATEGIES

Integrating different control methods can significantly improve the success of cogongrass management. Removing thatch and standing dead leaves through burning or mowing can improve herbicide efficacy by ensuring applications are made to actively growing leaves. Tillage can also provide a similar reduction, but in most cases tillage is more effective following herbicide treatment. Regardless of operation, cogongrass will show regrowth almost immediately and chemical treatment should be applied when the grass reaches a minimum of 12 to 18 inches in height. This ensures that new rhizomes are being formed and most existing rhizomes have resprouted. Tillage after herbicide application

Figure 11. Tree mortality from an application of imazapyr to cogongrass under the tree canopy. Note that imazapyr herbicide product labels provide application information concerning off-target injury.

can also contribute to the success of seeding with native species. In one study, authors found that burning prior to glyphosate application improved short-term control, although there was no significant long-term improvement[8]. They also determined that integrating glyphosate treatment with revegetation of native species (via seeding) resulted in greater species richness and diversity than plots that were only treated with herbicide. In natural systems, integrating herbicide applications with shading by fast-growing tree species may also improve control of cogongrass[25]. An integrated system that combines burning followed by tillage followed by Roundup Ready soybean and glyphosate applications can be a highly successful management tool for cultivated areas or food plots[33].

Summary

Cogongrass is an aggressive invader in the southeastern U.S., where it can be found infesting a wide range of habitats. It reproduces both sexually via seed and asexually via rhizome fragments, with the latter being much more common throughout parts of its invaded range. Seeds are dispersed through the wind, while rhizomes are commonly transported by human activities. Once established, cogongrass forms dense monocultures that outcompete native vegetation for resources. Management of cogongrass is difficult due to regrowth from its extensive rhizome system, but repeated applications of glyphosate and/or imazapyr herbicides are effective. Integrated chemical control with other management techniques, such as mowing, burning, or tillage, can improve the success of a management system.

DEVELOPING A COGONGRASS MANAGEMENT PLAN

Cogongrass is a difficult and formidable invasive species that infests many different types of systems throughout the southeastern U.S. Developing a long-range plan is critical to the success of cogongrass management. Listed below are some questions/concerns that should be addressed when putting together a plan for cogongrass management.

- What is the end goal in terms of vegetation/ecosystem after the cogongrass has been removed?
- To achieve this goal, what needs to be done to the site after removal of cogongrass – soil fertility management, hydrology manipulation, burn regimen?
- Is there existing desirable vegetation that prevents the use of certain control methods (usually trees which may preclude tillage and/or burning)?
- What is your timeframe?
- Resources available for control practices: it is better to completely control a smaller area with limited resources than to treat a large area and not have the ability to follow-up with successive treatments to ensure eradication.
- Is active revegetation part of the plan? If so, can you provide the ideal environment to ensure restoration success – proper soil conditions, adequate water, etc.? Remember, imazapyr herbicide has residual activity and this may impact certain native species. Be sure that all cogongrass has been removed – it is nearly impossible to selectively control cogongrass (however minimal the infestation level) within existing native species.
- Above all else, follow-up control and monitoring is critical to achieving and maintaining a cogongrass free site.

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Resources

For the location and phone numbers of state agencies in the southeastern U.S. providing forestry assistance and information, see the following websites:

Alabama Forestry Commission: http://www.forestry.alabama.gov/

Arkansas Forestry Commission:
http://forestry.arkansas.gov/Pages/default.aspx

Florida Forest Service: http://www.floridaforestservice.com/

Georgia Forestry Commission: http://www.gatrees.org/

Kentucky Division of Forestry:
http://forestry.ky.gov/Pages/default.aspx

Louisiana Department of Agriculture and Forestry:
http://www.ldaf.state.la.us/

Mississippi Forestry Commission: http://www.mfc.ms.gov/

North Carolina Forest Service: http://www.ncforestservice.gov/

Oklahoma Forestry Services: http://www.forestry.ok.gov/

South Carolina Forestry Commission:
http://www.state.sc.us/forest/

Tennessee Division of Forestry:
https://www.tn.gov/agriculture/section/forests
Texas A&M Forest Service: http://texasforestservice.tamu.edu/

Virginia Department of Forestry: http://www.dof.virginia.gov/

To locate a consulting forester:

Association of Consulting Foresters:
http://www.acf-foresters.org/acfweb.

Click on "Find a Forester", then select your state in the "People Search – Public" search page.

For more information on how to select a consulting forester, go to:

http://msucares.com/pubs/publications/p2718.pdf

http://texashelp.tamu.edu/011-disaster-by-stage/pdfs/recovery/ER-038-Selecting-a-Consulting-Forester.pdf

http://www.uaex.edu/environment-nature/forestry/FSA-5019.pdf

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