Ecology and Control of Reed Canary Grass

(*Phalaris arundinacea* L.)

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ABSTRACT: Reed canary grass (*Phalaris arundinacea* L.) is a problem grass in many natural wetlands. This paper reviews the literature regarding the ecology and management of reed canary grass and presents preliminary data that suggests reduced soil-seed banks occur in wetland substrates containing a dense cover of this species. Chemical methods usually provide poor long-term control of canary grass, and most effective canary grass control techniques are not acceptable in natural areas. Because of the lack of canary grass management information, we have established a field program of control tests. Appended is a bibliography of the literature.

INTRODUCTION

Reed canary grass (*Phalaris arundinacea* L.) has been cultivated for forage (Piper 1924, Wilkins and Hugh 1932) and used as silage or grass fodder for ruminant livestock (Aase et al. 1977, Myhr et al. 1978, Hovin et al. 1980). The plant also has invaded natural wetlands, necessitating costly control measures. The following literature review outlines recent field research on the ecology and management of reed canary grass. Much of this information has come from agricultural studies. While the findings may not always directly relate to natural area stewardship, we feel they may provide insight for persons attempting to control the spread of this exotic species within protected areas.

TAXONOMY AND ECOLOGY

Reed canary grass is one of fifteen species of the genus *Phalaris* that is distributed throughout the world, except in Antarctica and Greenland (Anderson 1961). The center of diversity for the genus is the Mediterranean region. Species in this genus occur from wet to dry habitats, from sea level to high mountain elevations. Some species dominate the native vegetation of an area; at least three species have become undesirable weeds. *Phalaris arundinacea* L. is considered native to North America but is now more widely represented through introductions in agricultural areas (Anderson 1961).

Reed canary grass is a highly variable species. Field observations by Baltensperger and Kalton (1958) indicate considerable variability in height during anthesis, in the size and shape of inflorescence, and in overall coloration. These authors showed that plant height, panicle size, and shape could not be correlated with geographic distribution or with each other, suggesting a high degree of inherent plasticity. Reed canary grass grows as a perennial from scaly creeping rhizomes, with culms usually from 0.5 m to 2.0 m in height and panicles varying from 7 cm to 40 cm in length (Baltensperger and Kalton 1958).

Reed canary grass forms dense, highly productive monocultures that spread radially. In a four-year experiment, the species produced 30 percent more hay than all other grasses tested (Wilkins and Hughs 1932). Where the species invades into short perennial grasses, such as red top (*Agrostis alba*) or creeping red fescue (*Festuca rubra*) (species typically planted along irrigation ditches), it apparently inhibits their growth within three to five months, eventually eliminating them. New canary grass plants reestablish quickly from seeds in the soil when chemical and mechanical control treatments are used (Comes et al. 1981).

Because of its tenacity and rapid growth, this species poses a major threat to many wetland ecosystems. Preliminary data suggest drastic declines of wetland and wet prairie species after several years of canary grass growth (Apfelbaum 1986). Canary grass grows and spreads quickly, forming dense monocultures not unlike cattails (Apfelbaum 1984, Wilcox et al. 1985) and purple loosestrife (*Lythrum salicaria* L.). The plant is capable of producing dense rhizome growth in suitable habitat within one growing season.

Proliferation is enhanced greatly because seeds germinate immediately after ripening; there are no known dormancy requirements. The spread of this species is intensified along ditches and waterways, which serve as dispersal corridors (Piper 1924).

Unlike many grasses (i.e., creeping red fescue and red top), canary grass grows vertically for five to seven weeks after germination, after which tillering occurs (Comes et al. 1981). Ninety-seven percent of canary grass seed (greenhouse-grown) germinated immediately after harvest (Comes et al. 1981). Seeds stored in damp sand germinated after a year of alternating temperatures. Rhizome development in greenhouses occurred twenty-six days after germination. Sixteen weeks after germination, plants bloomed and had an average of forty-eight rhizomes (6.5 cm average length) per plant. In the field, at least 88 percent of emergent shoots on established plants originated from rhizome or tiller buds located in the upper 5 cm of soil. Laboratory studies using mature roots indicate that 74 percent of new shoots originate from rhizomes and the remainder from axillary buds on basal nodes (Casler and Hovin 1980). Few shoots arose from buds deeper than 20 cm; no tiller development occurred below this depth (Comes et al. 1981). Vegetative vigor is related to maximum root and shoot production (Casler and Hovin 1980). Significantly increased growth (indicated by increased stem density) was found to be associated with nutrient enrichment; elevated tissue levels of nitrogen and phosphorus also resulted when nutrient levels were increased (Ho 1980).

Canary grass (along with *Phragmites communis* and *Typha latifolia*) survives prolonged flooding by possessing anoxia tolerant rhizomes (Brandle 1983). Canary grass was one of the most tolerant species tested; it tolerated the highest levels of alcohol in rhizomes. Barclay and Crawford (1983) found carbohydrate levels in canary grass rhizomes to be very stable and suggested this related to the survivability of plants during prolonged anoxic periods.

In Minnesota, Moyle (1945) reported that canary grass was associated with slightly basic lake water (pH range 7.3-8.8), relatively low sulfate concentrations, and low alkalinites (ranging from 22.5 to 134.0 ppm).

Primary production of canary grass at Theresa Marsh (as measured by above ground standing crop) increased from 85.5 g/m² in mid-June to 1352.7 g/m² in mid-September (Klopatek and Stearns 1978). Productivity peaked in mid-June and declined in mid-August. Fertilization and liming of canary grass, directly or by runoff from agricultural land, has produced extremely productive stands (Linden et al. 1981). Seed ripening and dispersal for canary grass occurred in late June at Theresa Marsh, Wisconsin, where canary grass had two major periods of production, before and after seed maturation. Flowering, as indicated by anthesis, was observed by Klopatek and Stearns (1978) from late May to mid-June in northern Illinois and southern Wisconsin.

CONTROL

Chemical Control

Various methods of chemical control of canary grass have been tested. Canary grass is reportedly sensitive to boron and was tested to determine if boron could be used as a herbicide (Marquis et al. 1984). Complete tissue necrosis occurred three weeks after canary grass leaves and roots were exposed to 300 ppm of boron. The plant showed increasing tissue damage with each elevated test concentration.

Susceptibility of canary grass to Dalapon, Amitrol, and Glyphosate has also been tested (Comes et al. 1981). Amitrol (4.5 kg/ha plus ammonium thiocyanate at 4.1 kg/ha) reduced three-week-old seedlings of canary grass by 94 percent but had little effect on older seedlings. Glyphosate (1.1 kg/ha) controlled nearly 100 percent of five- to ten-week-old canary grass seedlings. Glyphosate (used at 1.1 kg/ha) also controlled five- to ten-week-old seedling emergence (June 20 to July 25). Amitrol offered similar control when applied three weeks after emergence (July 4). When applied at five weeks, Glyphosate had inconsequential effects on co-occurring species such as creeping red fescue and red top grass. Similar results have been measured by Hodgson (1968), Bruns (1973), Fisher and Faulkner (1975), Bingham et al. (1980), and Marquis et al. (1984).

Dalapon and Amitrol-T controlled canary grass for five years on canal banks in Montana. Dalapon and Trichloroacetic (TCA) were more effective as late fall or early winter treatments to control canary grass the following growing season. These are soil sterilizing herbicides sprayed on dried foliage. Rates of 22.4 to 44.8 kg/ha (20 to 40 lbs./acre) controlled the grass for one growing season (Hodgson 1968). In Indiana, reed canary grass control was most effective when applied at flowering time at 13.5 kg/ha (12 lbs./acre) Dalapon or 1.7 kg/ha (1.5 lbs./acre) Glyphosate.

In aquatic systems, short-term effects from herbicide use often include reduced dissolved oxygen, increased carbon dioxide, reduced pH, increased bacterial populations, changes in nutrient status, and changes in vegetation and faunal communities. Long-term effects depend on the persistence and toxicity of the herbicide (or surfactant or carriers) and the degree of habitat disturbance (Newbold 1975). Newbold found only three of twelve tested herbicide treatments provided a canary grass "kill for one year"; these were Dalapon and Paraquat, separate and mixed. Diquat, Paraquat, Dichlobenil, chlorthiamid terbutryne, and 2,4-D were not recommended for use. Dalapon alone or in mixture with Paraquat or 2,4-D amine was efficient at canary grass control for up to two years. The weakly cationic Dalapon was not absorbed by substrates like many other herbicides, and it tended to persist for two to three days before being rapidly broken down by bacteria (Magee and Colmer 1959).

Mechanical Control

Heavy construction equipment has been another method used to remove canary grass. Canary grass responds quickly by growing back from rhizomes and seeds remaining in the soil following mechanical removal. Hovin et al. (1973) found that all stands of canary grass from four different clones were killed when the culms were chopped just before or at anthesis. No data on mowing as a single treatment or combined with other treatments are available.

Seed heads of canary grass were clipped in an Illinois nature preserve and monitored for vegetative growth (Apfelbaum and Rouffa 1983). This was not effective. Apfelbaum and Rouffa also clipped 1 m^2 to 5 m^2 plots at ground level and covered these areas with opaque black plastic tarps for up to two growing seasons. This successfully reduced canary grass populations, but the species persisted.

Burning

Canary grass is native in some British wetlands that are managed for production of reed thatch (*Phragmites communis*) for building roofs. This is typically done by spring burning, which increases budding density of reed thatch. It also produces faster growth and early shading of competitors. In a study by Haslam (1973), spring burning and summer flooding were used to suppress competitors. This constitutes the only published example of the use of fire where reed canary grass is present. The effects of burning on canary grass (and whether this species is a management problem) were not addressed in the study (Haslam 1973).

A two- to three-year burn rotation on an Illinois prairie preserve (Apfelbaum and Rouffa 1983) apparently restricted canary grass to disturbed margins of the preserve (i.e., along a parking lot and fence row; fire was stopped several meters short of the property fence lines during controlled burns). So far the species has not invaded the relatively undisturbed wetland and prairie communities. At the preserve, the grass has a limited and relatively stable distribution; the fire management strategy may be linked to the behavior of this species since canary grass usually spreads quickly where introduced.

DISCUSSION

The high cost of on-ground surveys has restricted control of exotic aquatic plants to only a few species. However, innovative, inexpensive, and accurate remote sensing methods are available for finding and monitoring aquatic plants (Lovvorn and Kirkpatrick 1982). Species identification is best at photograph scales of 1:4800 or larger, and identification of most plant species is easiest in early September. These techniques must be successfully developed for reed canary grass.

In contrast to the concern and eradication programs for purple loosestrife, reed canary grass has largely escaped the scrutiny of most natural area and public land managers, perhaps because it was planted for forage and erosion control and is not recognized as an eminent threat. A wetland study in Iowa suggested canary grass was absent in 1915 (Volker and Smith 1965). In a 1961 resurvey, canary grass had invaded the emergent vascular plant communities. During this period, eleven species disappeared and narrow-leaved cattail, hybrid cattail, reed (*Phragmites communis*), and reed species (*Scirpus acutus* and *S. heterochoetus*) appeared. During this period, agricultural activities intensified in the watershed; other changes in the lake included increased nutrient and sewage effluent loading and increased siltation (Volker and Smith 1965).

Buttery and Lambert (1965) evaluated morphologic characteristics in *Phragmites* and *Glyceria maxima* to explain competitive relationships between species. They found *Phragmites* had a deep long-lived rhizome that formed a thick mat. Growth occurred from buds on the ends of rhizomes that annually upturned to produce an above-ground stem. After stem production, bud development and rhizome growth continued. *Glyceria* produced shallow shorter-lived rhizomes with buds rising from a continuous horizontal rhizome. Growth of *Phragmites* was synchronized; most shoots emerged in early spring. In *Glyceria*, early shoots were fertile and emerged from beneath a thick mat of dead material from dormant apices, or small green shoots emerged at the end of annual rhizome extensions. The authors suggested the earlier spring growth of *Glyceria* and larger number of growth apices gave it a competitive edge over *Phragmites* at many sites. We speculate that a similar mechanism may favor canary grass.

Prairie glacial marshes typically have dormant soil seedbanks. Seeds of forty species of plants germinated during tests of soil seed banks from an Iowa marsh (Van der Valk and Davis 1978). Estimated seed bank sizes ranged from 21,000 to 43,000 seeds per m^2 of sediment within a 5 cm depth. The seed bank included emergent species (*Typha*, *Scirpus*, *Sparganium*, *Sagittaria*, etc.), submerged and free-floating species (*Lemna*, *Spirodela*, *Ceratophyllum*, *Najas*, *Potamogeton*, etc.), and mud flat species (*Bidens*, *Cyperus*, *Polygonum*, and *Rumex*).

Investigations of soils from a wetland near Woodstock, Illinois, which was planted in the 1940's to produce canary grass hay, suggest the seed bank today is completely dominated by reed canary grass. Random composite sediment samples from this wetland were planted in greenhouses in October 1986; within eight days, thousands of canary grass seedlings per square meter emerged. No other species grew. These soil seed bank studies were conducted to help determine the amount of native seed and seedlings necessary to achieve a desired restoration planting.

SUMMARY

The literature reviewed shows that effective methods for canary grass control in natural areas are unknown. Many control efforts have used techniques such as broadcasting herbicides, which may not be desirable in preserves. Consequently, we have implemented canary grass control field tests and wetland restoration techniques in a randomized complete block design (Little and Hills 1978). Results will be reported in a forthcoming paper.

Several large-scale wetland plant eradication and research efforts are now underway in North America. These include efforts to control *Hydrilla*, purple loosestrife (*Lythrum salicaria*), and European millefoil (*Myriophyllum spicatum*). We predict that interest in aquatic plant eradication will grow and more effective control techniques will be developed for other species such as reed canary grass.

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