Final Report

On

Arundo Donax

(Giant Reed Grass)

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Arundo Donax Committee Report

Contents

Preface

On June 8, 2004 the Associate Deans of Research and Extension (Drs. Cherry and Garber) formed the Arundo Donax committee. They formed the committee in response to an increase of interest that had developed about this plant species. A formal meeting was held in Atlanta where various public and private organizations meet to discuss the feasibility of developing a production and processing industry in South Georgia based on Arundo Donax. The committee was tasked with scientifically evaluating the potential for this crop in Georgia.

The committee met several times to discuss this issue. Each member of the committee was asked to research and compile specific information on Arundo Donax. Reports covered management, genetics, ecology and economics. Within each of these technical areas, faculty were asked to consider what is presently known about Arundo donax, what do we need to know before this plant could be grown on significant acreage and what should be done next. A webpage was created to compile and disseminate information, list committee members and compile the final report: http://www.cropsoil.uga.edu/Special/

Economic and Market Assessment

Giant Reed Grass is a crop that has been receiving much attention over the last couple of years as a potential replacement to numerous cash crops in several southern states. There are at least two groups in the U.S. doing feasibility work on this crop, however, at the same time they are also involved in producing and marketing the seedstock and production systems for the crop. Currently, there is no independently generated cost and return information for Giant Reed Grass. There is a need for work to be done on this crop to obtain estimates on costs of production, yields over time, and determining the value of the crop in the marketplace for its many different uses. It is also important that the cost of appropriate harvest cost be assessed. Since, it seems that there will be significant economies of scale in producing this product, how costs decrease with increases in farm size also needs to be investigated. In addition, because of the crops bulkiness, the location of the processing facility to the production region will make a significant difference in whether or not producers of this crop can make a sufficient return on their investment, therefore these location economies must be investigated as well. At the current time there is no readily available information that can be used to determine if Giant Reed Grass would be a profitable crop for Georgia farmers.

Arundo donax – Management and Genetics

What we know

We know that there are private companies interested in *Arundo donax* (giant reed) because of its high production of biomass (between 10 and 20 Dtons/acre/year in Southern US), and the reported fiber quality comparable to hard wood. Results from yield trials in Florida have shown higher annual yields of giant reed compared to bamboo and switchgrass. Various non-wood pulps including *Arundo donax* have been used to produce paper in countries such as India and China for centuries. We know that giant reed is primarily vegetatively propagated in nature through rhizomes or viable nodes of mature cane. Green cane does not propagate easily. The difficulty and expense of collecting and planting large acreages of rhizomes has led to discovery and commercial production of plantlets through micro-propagation of embryogenic callus. Establishment is still quite expensive, however. Giant reed production responds well to increased water availability, but can survive under dry conditions. The range of observed populations of giant reed extends from California to the eastern coast and as far north as Maryland. It is considered a noxious weed in California, and an invasive species in other states. It is a problem along swift flowing streams beds during seasonal periods of flooding or runoff from mountain rains. Giant reed has few pests that significantly reduce growth.

What we don't know

Production: We do not know how yield is affected by location, environmental variations, soil types, various fertility factors or genetically different clones. We do know a true cost of establishment using micro-propagation and/or cane establishment. Related to this aspect we do not know the effect of plant density on first year yields and beyond. We do not know the proportion of cane to leaf at various stages of growth and how that will affect quality of material. We do not yet know if two harvests a season will increase or decrease yields and fiber quality factors compared to one end of season harvest.
Processing: We do not know the most efficient means to harvest and process the crop in the field. Do we need to separate leaves from cane in the field? Is there greater value of leaves as material for co-products or as residue for carbon sequestration? Does the high-moisture, slow-drying cane need to dried for processing? Where and how should the drying be done? How does chipping size effect fiber quality? Does transporting small wet or dry chips increase or decrease cost compared to whole cane and does chipped material reduce the risk of material becoming invasive and out of control along roads to the processing plant? Can material be stored and dried *in situ*?
Genetics: We do not know how much variability exists among populations of *Arundo donax* in the United States. Are there significant differences among populations or clones for yield and fiber quality? Is the species completely void of sexual reproduction or are distinct clones cross compatible? Is there potential for genetic improvement through somaclonal variation, mutation or transformation of somatic embryo material?
Co-products and energy feedstock use: We do not know if the plant possesses valuable chemical co-products such as natural pesticides or organic compounds that could replace petroleum products. What is the efficiency of conversion of the ligno-cellulosic biomass

to ethanol via syngas or fermentation after enzymatic pretreatment? Does the biomass provide a useful feedstock for co-firing in current coal burning electrical plants?

What should be done?:
Basically, research is needed in most areas of this crop. Even more research on fiber quality would be warranted. In the areas of production and genetics a number of research points are proposed. Research is needed to determine more cost efficient methods of establishment. 'Natural' clones' are in the process of being collected. Small yield trials of available clones will be established. Genetic diversity of clones will be measured using AFLP methods. The most productive clones will then be used to establish larger yield trials, and material from the best will be used for genetic manipulation and for harvest and processing experimentation. Other species of biomass material should also be evaluated as well – especially native species (switchgrass has been researched but yields are significantly lower than for giant reed or napiergrass). An area wide open for research is the harvesting and processing of giant reed. The material is extremely hard and silage choppers will probably not work. We will need to investigate adaptations of sugar cane harvesting equipment or wood chippers. Processing of material in the field will need to be addressed. Leaf/stem separation studies and the where the greatest values (field carbon sequestration and organic maintenance or co-products) needs research. Processing of stems into be chips and drying processes in the field need to be worked on. This point will also be important as for the invasiveness issue. If whole cane is transported, is it more conducive to invasion versus transporting small chips?
Another wide open area is the potential of arundo as an energy or co-product crop. Do the leaves contain lignocellulose conducive to efficient conversions to ethanol? Is the chopped material a candidate for syngas production? Do ash and silicon contents eliminate the biomass as a direct green energy source? Do the leaves contain valuable chemicals (some chemicals have been isolated that may be useful pesticides)? Chemical analysis of the leaves and stems will be required. Fiber for pulp and wood products will need to be tested for the different clones as well.

Arundo donax – Ecology and Invasivity

What we know.

Giant reed is a perennial C3 grass that is distributed across the southern United States from Maryland to California. Two other species are known to occur. Based on personal observations in South Georgia and north Florida, the plant thrives in disturbed wet areas but also survives on upland sites (Laurens Co.) and road cuts (Washington Co.). The plant is considered native to the eastern Mediterranean region and temperate and tropical Asia, though it now has world-wide distribution. In Georgia Giant Reed is on the proposed list of Exotic Pest Plant Species.

Reproduction is known to be asexual in the United States. Since it spreads vegetatively, the plant is well adapted to growing in disturbed riparian areas where stem sections and rhizomes can be carried downstream and take root. In California, dispersal is generally by floodwaters in the winter months when plants are dormant. Research in California indicates that rhizomes may establish any month of the year, while stem sections do not root and establish as easily. The depth to which stem segments and rhizomes get buried influences survival. Glyphosate applied post-flowering but pre-dormancy at a 2-5% solution (0.5 to 1.0 L/ha) is listed as an effective treatment for control.

Flowering had been noted in California, Florida, Georgia, and Texas (personal observation). In California, seeds were produced but were not viable. In southern Europe, seed set is poor but this germplasm may offer some genetic variability. Florets are reported to be bisexual, while seed sterility is reported from India as being caused by failures in the meiotic process.

What do we need to know?

Almost all information on this plant is from Mediterranean climates; not hot, humid areas such as the Coastal Plain region of Georgia. Most information on seed set and viability is observational in nature. Little to no work has been conducted on pollination biology, seed development, and germination. If viable seeds are produced in Georgia, will they establish and under what conditions? Further work is needed to determine if different clones exist. If so, low seed set may be due to self-incompatibility. Planting several diverse clones together may result in production of viable seed.

Further work is needed to study vegetative propagation of this species in the southeast. Clumps of *Arundo* exist on US Hwy 319 from Thomasville to Wrightsville. If the plant is not seeding in, how are these populations spreading? Plans for eradication after establishment are also needed.

Efficient methods of propagation and container production are needed if plants are to be available for mass planting. Division, stem and node cuttings, and tissue culture are possibilities. Timing may be critical for success.

What needs to be done?

Research on genetic diversity
Research on pollination biology, seed set, dormancy, germination and establishment
Research on how populations are spreading
Research on control methods for established populations or plantings
Research on propagation and container production