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PROGRESS IN DEVELOPING DISEASE CONTROL STRATEGIES FOR HYBRID POPLARS

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ABSTRACT. Hybrid poplars are being grown throughout many regions of the world for purposes including the production of fiber and energy, ornamental landscape plantings, and soil stabilization. Disease has often been responsible for planting failures resulting in poplars being labeled the universal host to many damaging pathogens. However, many of the poplar species and their hybrids are not native to the areas where they are being planted and so they do not have resistance to the local pathogen populations they are exposed to. Currently research is aimed at detecting pathogenic variation in populations of fungi affecting poplars and in gaining knowledge of the underlying genetic mechanisms of disease resistance in poplars. Significant progress is being made in breeding for disease resistance and in developing poplar clones that are better adapted to the sites on which they are being planted. There is evidence that some phenological traits of clones such as time of leaf flush and leaf fall may be used to select clones that can escape peak periods of infection by some pathogens. Somaclonal selection, a tissue culture technique coupled with a laboratory bioassay, has been used to generate clonal lines of poplars with increased disease resistance that have performed well in field tests. A biorational approach to disease control using a common soil bacterium has shown promise in laboratory and field tests against several major poplar pathogens. Progress in the above areas of disease research will enable growers to plant productive, disease resistant hybrid poplar clones.

KEY WORDS. *Populus*, *Septoria* spp., *Melampsora* spp.

INTRODUCTION

Populus species and inter- and intra-specific hybrids are increasingly being grown for fuel and fiber in many regions of North America where they are being managed as row crops under intensive agronomic cultural systems. Susceptibility to damaging diseases is second only to weed competition in limiting the successful establishment and production of high yields in these plantings. As with the development of any new crop, some of the pitfalls by nature are simply related to inexperience in growing these trees as an agricultural crop. For instance, it is often stated that "marginal" farmland is suited to the production of poplars. However, land that has been found marginal for the production of other row crops will often prove marginal for growing poplars as well. Plant stress brought on by any number of site and weather factors is a major contributor to disease outbreaks and often controls the extent of the injury sustained by the affected plants.

Hybrid poplars at times have been called "universal hosts" to numerous pathogens and insect pests. Damage from pests resulted in many past planting failures. However, research has provided pest management strategies (Ostry and McNabb 1990) and disease resistant clones (Ostry and Berguson 1993; Ostry and McNabb 1985) that have significantly reduced the failure rate of plantings. Large field trials in the north-central region of the United States across a range of sites have produced valuable information on the growth and disease resistance of a large number of commercially available clones (Hansen et al. 1994).

CLONAL FIELD TRIALS

Over the past twenty years results from extensive field plantings of hybrid poplar clones have shortened the long list of potential damaging diseases down to just a few major diseases that must be considered before planting poplars. In all regions of the United States leaf rust, caused by species of *Melampsora*, is the greatest threat. Defoliation of highly susceptible clones can greatly reduce the growth potential of affected trees and generally decrease plant vigor, predisposing them to secondary damaging agents.

Evaluations of hybrid poplar plantings have revealed the presence of species of *Melampsora* at locations they previously were not known to exist (Moltzan et al. 1993; Newcombe and Chastagner 1993a). Similar to concerns with the cereal rusts, a constant challenge will be to monitor poplar rust populations for potential new races of the pathogens that can rapidly develop and infect clones that have not been screened for resistance to that race. Even more troubling is the potential threat from non-native pathogens such as the European rust species found for the first time on poplars in the Pacific Northwest (Newcombe and Chastagner 1993b).

In the north-central and northeastern regions the fungus *Septoria musiva* has been the most damaging pathogen of hybrid poplars in nurseries and plantations. Although capable of causing a leafspot disease that can result in defoliation, it has been stem breakage at cankers caused by this fungus that has severely limited the number and variety of hybrid poplar clones that can be safely planted throughout much of North America. Fortunately, this pathogen has not been found in the Pacific Northwest where highly susceptible native and planted *P. trichocarpa* potentially could be affected.

A second *Septoria* species, *S. populicola*, is present in North America, causing a leafspot disease, but not cankers on native and planted *P. balsamifera* and *P. trichocarpa*. The distribution of these fungi on native and planted poplars in North America is not completely known because it is often difficult to distinguish one species from the other. Disease symptoms, culture morphology, and spore size are often similar and molecular fingerprinting has not proven to be definitive in separating the species. This underscores the importance of surveying pathogen populations and in preventing the spread of pathogens from one region to another.

BIOTECHNOLOGY

Populus species and hybrids have become important models responsible for the recent rapid advances of molecular approaches to tree improvement (Ostry and Michler 1993). Many promising achievements in our understanding of the genetic control of important traits such as disease resistance have been made (Klopfenstein et al. 1997). Progress in the manipulation of *Populus* cell and tissue cultures has made it possible to make great strides in genetic engineering of poplars, which has the potential to accelerate the development of disease resistant, productive clones.

Cell and tissue culture techniques have been used to induce and recover variant poplar plants that have expressed increased disease resistance. It is well known that considerable genetic changes can occur within cell and tissue cultures. Plants (somaclones) regenerated from cell and tissue cultures originating from susceptible hybrid poplar clones were found to have higher levels of resistance to Septoria leafspot than the donor clones in laboratory bioassays (Ostry et al. 1994). Replicated field tests of trees recovered from cultures have been established. Thus far the disease resistance trait has been stable among plants clonally propagated from the original somaclone using hardwood cuttings. In addition, some of the somaclones with increased disease resistance also have expressed greater growth rates than the donor clones in the field trials.

The mechanisms that control somaclonal variation are unknown. However, cell and tissue culture coupled with in vitro screening and selection techniques may have value in tree improvement programs because there is a greater chance that other desirable traits in a clone will be not be lost, unlike in classical breeding, where targeted traits may be not be passed on to the progeny.

BIOLOGICAL CONTROL

There has been a considerable amount of research on the chemical control of poplar diseases in nurseries and plantations. Although some chemicals have shown promise, the health risks to humans, wildlife, and the environment as a result of the use of such chemicals makes it desirable to develop and apply alternative control measures in the absence of highly disease resistant clones.

Promising results have been achieved using strains of the soil bacterium *Streptomyces scabies*, the cause of the potato scab disease, to reduce the incidence and severity of Septoria leafspot and canker in laboratory, greenhouse, and field studies (Schimizu et al. unpublished; Gyenis et al. unpublished). Decline in the incidence of potato scab in fields repeatedly planted to potato is a form of natural biological control in these "suppressive soils" that contain strains of *S. scabies* producing antibiotics that inhibit the pathogenic strains. Applications of this biocontrol agent as a foliar spray on potted trees exposed to natural inoculum in the field and on poplars in a plantation have been effective in reducing the incidence of Septoria leafspot and canker. Preliminary tests using the bacterium as a dip treatment for cuttings prior to storage and shipment are underway.

Suppressive strains of *S. scabies* that have been applied to several poplar clones have maintained their viability on leaves and have been recovered from treated plants several months after application. *S. scabies* overwinters in the soil and on infected plant debris. Since *Septoria* spp. also overwinter on infected debris and can be transported on planting stock, *S. scabies* may provide us with a method to reduce the amount of inoculum within plantings and prevent the movement of inoculum to other areas.

CONCLUSIONS AND RECOMMENDATIONS

Poplars are truly versatile trees that are of worldwide importance growing on a wide range sites. It should not be surprising that in the process of domesticating and applying agronomic practices to growing these trees for the production of fiber and energy that diseases may develop and eventually impact their productivity.

It is important that the rotation length and the ultimate uses of poplars are considered before they are planted. Many disease-susceptible clones are highly productive on short rotations but are not suitable for use in riparian buffers or in windbreaks where their premature failure will have a negative impact on management goals. Dedicated biomass plantations need to be managed as an agricultural row crop. This includes planting only vigorous, quality stock of highly disease resistant clones on sites that provide poplars with optimum moisture and nutrients. Before large plantings are established, clone performance and resistance to local species of pathogens must be known.

Successful culture of poplars grown under these systems will require a long-term commitment to plant improvement. This includes monitoring pathogen populations for the presence of new species or the development of new races of pathogens. How genetically improved clones, either obtained through genetic engineering or classical breeding, are deployed within a field and across the landscape must be given careful consideration to minimize putting selective pressure on pathogens and to avoid potential pest problems arising in native *Populus* populations. Finally, it is essential to guard against the accidental introduction of new pests on planting stock into areas where they are not present.

Research is rapidly providing the needed knowledge, techniques, and planting stock to develop economical, reliable production systems using poplars as an alternative source of fiber and energy to meet future needs. However, in poplar production systems as with other crops in modern agricultural systems, developing new resistant genotypes and applying effective pest management strategies are essential and will be an ongoing challenge.

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