BIOLOGICAL CONTROL OF ANNUAL BLUEGRASS

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Xanthomonas campestris is a bacterium indigenous to the US that is currently under development as a potential bioherbicide for annual bluegrass control in turf. This bacterium was discovered at MSU in 1984 on a turf sample sent into Dr. Vargas' lab for diagnosis. A previously unknown bacterium was isolated that was found to be pathogenic on annual bluegrass (*Poa annua*). Rather than looking at this as a disease problem, research was initiated to investigate its potential for biocontrol of annual bluegrass. Biological control with *Xanthomonas* offers many advantages including reduced chemical inputs and their associated risks and a high degree of selectivity. Increasing legislation and public concern make reduced chemical inputs very desirable in turf management. As well as potentially harmful effects to people and the environment, attempts to control annual bluegrass with chemicals often result in unacceptable turf damage and ineffective control. Biological control with *Xanthomonas* involves none of the risks associated with chemical use. In addition *Xanthomonas* is highly selective, causing no injury to any species other than annual bluegrass.

Several features of *Xanthomonas* combine to make it a very desirable biocontrol agent. It is a naturally occurring, widespread organism and therefore its use as a bioherbicide is unlikely to have any of the detrimental environmental effects potentially possible with the introduction of exotic organisms. This also makes testing and possible commercialization less problematic in terms of federal and state regulations. Infection with *Xanthomonas* requires the plants to be wounded. This is an ideal situation for a turf bioherbicide as turf is continually being mowed. This limits infection to areas designated for control. The host range of *Xanthomonas* is conducive to safe use in turf management as *Xanthomonas* only affects annual bluegrass. *Xanthomonas* infection is independent of environmental moisture and is systemic. Many fungal biocontrol agents are very exacting in their demands for moisture in order to work effectively but *Xanthomonas* is not. Once inside the plant it forms a systemic infection leading to wilting and death of the whole plant, regardless of how many leaves were inoculated.

The first symptoms that are seen following infection are a slight wilting of leaf tips followed by wilting of whole leaves and plants which eventually brown up and die. The wilting is thought to be caused by bacteria blocking the xylem vessels and thus preventing water from being taken up. This causes the plants to die from lack of water. If infected leaves are cut and observed under a microscope bacteria can be seen flowing out of the xylem vessels which can be used to diagnose infection before wilt is seen.

Annual bluegrass exists in more than 1 biotype. *Poa annua* var. *annua*, the predominant biotype in the South is a true annual which dies after seeding. In Michigan, however, the predominant biotype is *Poa annua* var. *reptans* which is a true perennial that is persistent and does not die after seeding. 1991 research at MSU was conducted at the Hancock Turfgrass Research Center on natural established stands of perennial annual bluegrass. Research included studies to look at the spread of *Xanthomonas* from an inoculated area, application timing on greens and fairway height turf, the effect of longterm inoculations (i.e., several years) initiated at different times of year and PGR effects on *Xanthomonas* biocontrol. In the majority of our 1991 studies, symptoms of wilt followed by death and noticeable control of annual bluegrass did not occur. Etiolated leaves from which *Xanthomonas* could be isolated were observed following inoculation by disease did not progress beyond this stage. The most successful study in terms of effective control of the perennial biotype was a study using transplanted sod flats. Flats of annual and perennial annual bluegrass were established in the greenhouse and transplanted to the field in May, 1991. Treatments were biweekly or monthly inoculations of 10^9 colony forming units (cfu) / ml *Xanthomonas* and a tetracycline treated control. Inoculations were initiated 3 weeks after transplanting to the field. The annual biotype was more susceptible to bacterial treatment than the perennial biotype and was completely dead 6 weeks after initial treatment. The perennial biotype declined steadily but more slowly than the annual biotype. Maximum control of the perennial biotype was seen in early August when approximately 85% control was achieved. However, plants remaining alive at this time were not affected by further inoculations and increased in size and vigor until the turf filled in and inoculated plots were almost indistinguishable from the uninoculated plots. The surviving plants were not resistant to *Xanthomonas*, as they could be effectively controlled if potted up and inoculated under ideal conditions. Although the plots filled in, effective early season control of the perennial biotype was achieved. It is possible that overseeding with bentgrass when the annual bluegrass plants were thinning and weakened would have led to a gradual transition from annual bluegrass to bentgrass and that the established bentgrass would have prevented remaining annual bluegrass plants from reestablishing themselves.

In conclusion, *Xanthomonas* is very effective for field control of the annual biotype of annual bluegrass and commercialization by Mycogen Corporation is underway. Field control of the perennial biotype is proving more difficult but it is hoped that early season application, possibly combined with bent overseeding and chemical treatments will result in effective control.