RESEARCH IN POA ANNUA CONTROL

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Annual bluegrass (Poa annua L.) has been recognized as a serious weed problem in turf for at least four decades. Attempts at controlling this pest with chemicals date back to the 1930's when lead arsenate, an insecticide, was found to discourage its occurrence in turf (18). Since then, numerous herbicides have been reported as promising for annual bluegrass control including: benefin, bensulide, bromacil, calcium arsenate, chlorpropham, copper compounds, DCPA, dichlobenil, diphenamide, DMPA, DSMA, endothall, fluorophenoxyacetic acids, maleic hydrazide, neburon, nitralin, PO-SAN[R], sodium arsenite, trifluralin and others (1,5,6,8,10,11,12,13,16,19). In recent years, research efforts have been concentrated on a relatively small number of these compounds. In addition, renewed emphasis has been placed on turfgrass cultural practices and other management factors associated with annual bluegrass infestation (2).

Current research in the control of annual bluegrass can be considered in three distinct categories: plant competition, chemical control and biological control.

Plant Competition

Each plant species performs optimally, in terms of yield and quality, under a specific set of environmental conditions. Most turfgrasses do best when grown in soil that provides a suitable compromise between aeration and water-holding capacity. Compaction of a turf soil restricts root growth and results in reduced plant vigor and greater susceptibility to environmental stresses. Under suitable soil conditions, annual bluegrass develops a root system comparable to that of Kentucky bluegrass and bentgrass (18). When the surface soil layer becomes compacted, however, annual bluegrass develops a shallow root system and gains a competitive advantage over preferred turfgrasses, Hence, any measures to prevent or correct soil compaction may aid in reducing the incidence or spread of annual bluegrass. The timing of these corrective measures, however, is of critical importance. Youngner (20) reported that vertical mowing and aerification of turf may promote annual bluegrass invasion when these operations are conducted during periods of peak germination. Soil compaction may also be reduced by restricting or uniformly distributing the traffic to which the turf is subjected. Strategic cup-placement and frequent movement of cup holes on greens, and enlargement of greens and tees for more uniform and reduced traffic are measures that should be considered. Restriction of golf cart traffic to roughs, construction of cart paths and alternation of mowing patterns may also help to reduce the soil compacting effects of vehicles and equipment. As tees are particularly susceptible to annual bluegrass invasion, due to concentrated divotting, some superintendents frequently overseed these areas with a mixture of bentgrass and perennial ryegrass in soil to hasten reestablishment of the turf. Although this is a time-consuming operation, results have been encouraging both aesthetically and in terms of resisting annual bluegrass infestation.

Competition with potential and existing stands of annual bluegrass is also a function of the relative growth aggressiveness and recuperative ability of desirable turfgrass species. Development of more vigorous varieties of Kentucky bluegrass and creeping bentgrass offers some promise for the future. Although the principal criteria for evaluating new varieties are density, uniformity, color, and disease resistance, some research institutions are conducting evaluations under "actual use" conditions where susceptibility to annual bluegrass invasion is a more serious concern.

Principal factors affecting a turf's resistance to weed invasion are the fertilization, watering and mowing regimes; these constitute important components of the environment in which turfgrasses must grow, compete and survive. The question of whether "green is good" is frequently raised by professional turfmen; that is, should the success of a fertility program be judged primarily by color and clipping yield, or should density and uniformity be regarded as more valid criteria for turfgrass quality? Color can frequently be altered with light applications of iron sulfate while excessive fertilizer application is known to ultimately weaken turf and, in some cases, promote the invasion of annual bluegrass (2). Similarly, overwatering and the use of cutting heights below those recommended for specific turfgrasses are also associated with increased populations of annual bluegrass in turf.

Overseeding annual bluegrass turfs with bentgrasses and Kentucky bluegrasses has been performed for many years. Interest in this practice has been stimulated by the introduction of new equipment especially suited for this purpose. Results have generally been disappointing as competition from annual bluegrass is often so severe during cool weather that new turfgrass seedlings are completely crowded out. Engel (7) theorized that overseeding during periods of reduced competition from annual bluegrass, in summer, might produce better stands of some perennial turfgrasses. Success has been reported when overseeding was performed in conjunction with applications of certain herbicides (9).

Chemical Control

Selectivity of herbicides may be based on the differential capacity of plant species to absorb, translocate or metabolize a phytotoxic substance. Plants also vary in their tolerance to a specific internal concentration of an herbicide due to greater or lesser effects of these substances on their physiological systems. Structural differences between plant species and differences in age or maturity may also provide a basis for the selective effects of some herbicides. Finally, many preemergence herbicides cause little or no phytotoxicity to mature plants but they may be quite lethal to germinating seed and seedlings.

The ideal herbicide would provide complete control of an unwanted species but have no detrimental effect on desired plants. Although there are many fine herbicides on the market, a rare few provide such perfect selectivity and, generally, only under ideal environmental conditions. Most herbicides are effective and safe for use when their applications are timed to take advantage of certain weaknesses of the weed plants and/or specific strengths of the desired vegetation. Results achieved from the use of herbicides are largely dependent upon the interactions among the herbicide, the plant, and the environment. As the herbicide is the most stable component of this "triangle", plant and environmental variability are of critical concern in determining success. Research is required to more accurately determine the effects of environmental conditions prior to, during and after herbicide application on the nature of herbicide-plant interactions.

Herbicides which are currently under investigation for annual bluegrass control include the arsenates, preemergence herbicides, bromacil, PO-SAN and endothall.

Arsenates

Calcium arsenate is currently the most popularly used herbicide for reducing or preventing annual bluegrass infestations. The principle behind this aproach is the gradual build-up of arsenate in the soil to a level that provides selective toxicity to annual bluegrass. Factors affecting this critical level are soil texture, drainage, pH and the phosphorous-arsenate balance in the soil (4). Clay and organic colloids in the soil can tie up arsenate rendering it unavailable to plants. The selectivity of arsenate is reportedly reduced in persistently wet soils; hence, poor drainage should be corrected before initiating an arsenate program. Arsenate forms insoluble iron and aluminum compounds at low soil pHs while solubility is comparably reduced at high pHs due to an excess of calcium carbonate in the soil. Phosphorous tends to counteract the toxicity of arsenate, probably due to a competition for uptake of these similar anions by plants. This is fortunate, in one respect, in that turfgrass injury from excessive arsenate treatments can be mitigated by a timely application of soluble phosphorous. Excessive arsenate applications frequently result in severe reductions in turfgrass quality, especially in bentgrass turf (9). Also, late summer applications tend to be more injurious than mid-spring applications. Arsenate applications should probably be made during cool weather when more cool weather is sure to follow in order to avoid observable turfgrass injury.

Preemergence Herbicides

Most preemergence crabgrass herbicides provide fair to good control of germinating grass plants, and many are also toxic to young seedlings of annual bluegrass and other grasses. Some herbicides inhibit root growth of grasses and may also affect the biological activity within the soil. Preemergence herbicides may be of value in situations where the mature perennial grasses are tolerant while germination and early development of annual bluegrass are severely restricted. Although bensulide has been used successfully in reducing annual bluegrass infestations in bentgrass turf (14), it has been consistent in providing satisfactory control (9). Inconsistent results appear to be the rule, rather than the exception, in evaluations of preemergence herbicides for annual bluegrass control. Recent evidence suggests that high soil phosphorous levels may reduce the control achieved with bensulide and DCPA as well as calcium arsenate (15). Future evaluations should be conducted to determine the specific factors that contribute to response variability, in order to provide a clearer picture of the role of preemergence herbicides in controlling annual bluegrass.

Bromacil

Neidlinger (17) determined that bromacil (Hyvar-X) applied preemergence to Kentucky bluegrass and annual bluegrass in seed fields provided selective control of annual bluegrass at 0.4 and 0.2 lb/A. Selectivity was considerably less following postemergence applications to these species.

Gibeault (10) reported that an application of bromacil, at 0.5 lb/A, provided complete preemergence control of annual bluegrass but allowed good germination of bentgrass and fescue that was seeded one week after application of the herbicide.

PO-SAN[R]

A combination of maleic hydrazide and chlorflurenol (PO-SAN) substantially reduced seedhead development in mature stands of annual bluegrass when applied in early spring (13). This was accompanied by some discoloration of bentgrasses and Kentucky bluegrass, but favorable color returned within 2 weeks. Other effects included: reduction of the mowing requirement; control of some broadleaf weeds; density reduction of annual bluegrass stands with some increase in the density of perennial turfgrasses; and reduction of viability in seed from annual bluegrass plants. Young seedlings of annual bluegrass were also reported killed by fall applications. Seedling competition from annual bluegrass was reduced by PO-SAN without precluding successful germination of preferred turfgrasses. Presumably, overseeding in conjunction with applications of this material may lead to reduced annual bluegrass infestation in turf.

Endothall

Reductions of annual bluegrass in colonial bentgrass fairways was reported following applications of endothall in spring at ½ lb/A (8). Higher application rates (1-4 lb/A) caused a general browning of the turf, especially in late summer, followed by selective recovery of Kentucky bluegrass presumably from rhizome tissue (19). Reinfestation by annual bluegrass occurred in bare areas where Kentucky bluegrass had not completely filled in. Recent work with granular formulations of endothall demonstrated superior selectivity over the foliar-applied liquid formulation. Selective kill of annual bluegrass was possible with granular endothall; however, the required rates of application increased with increasing soil clay and organic matter content. Further evaluation of endothall formulations is required before specific recommendations can be made.

Biological Control

Reduction of weed competition by natural predators may be possible since some organisms feed preferentially on certain plant species. The annual bluegrass weevil (*Hyperoides* sp.) was recognized as a cause of annual bluegrass injury on Long Island, New York, in 1957 (3). The insect has since spread to Connecticut, Pennsylvania and other parts of New York. Injury first becomes evident in May or early June. Larvae of the weevil sever shoots of annual bluegrass at their bases causing death while adjacent patches of bentgrass remain healthy. When the grass turns brown, the sod can be peeled back to reveal larvae, pupae and adults of the weevil about 1/4 inch deep in the soil.

The question arises as to whether this insect should be controlled with chemicals or purposely used as a biological control for annual bluegrass. The question is probably an academic one as few professional turf managers would intentionally want to distribute a serious insect pest outside its natural habitat. Where this problem exists, however, turf managers should be prepared to cope with it. It may be possible to capitalize on the selective injury caused by the annual bluegrass weevil by a program of intensive overseeding to establish desired turfgrasses in areas once occupied by annual bluegrass.

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