"TO PRE OR NOT TO PRE" — SUMMER ANNUAL GRASS WEED CONTROL STRATEGIES

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As a former assistant superintendent and now as a university educator and researcher, I have had the unique opportunity to view golf course management from several perspectives. As a golf course manager, I recognized the importance of weed-free turf, especially free of weeds such as crabgrass (Digitaria spp.) and goosegrass (Eleusine indica (L.) Gaertn.). For instance, I remember having to restrict cup placement on a green because of a severe goosegrass infestation. As a university professional, I began to explore the concept of annual grass weed control and have come to realize that this is not a decision to take lightly. Weed management strategies must be founded in a thorough understanding of weed biology, turfgrass physiology, and environmental impact. Therefore, as the article title plays on Hamlet’s famous soliloquy, does the application of a pre-emergence annual grass herbicide satisfy the criteria stated above, or are there other options?

Weed Biology
The biology of annual grass development is not a well-understood discipline in the literature. There have been very few studies which investigated the germination requirements, physiology, and morphology of weeds such as crabgrass and goosegrass. Germination timing has long been associated with phenological indicators such as forsythia or lilac bloom in the North or dogwood bloom in the South. More specifically, for crabgrass, soil temperatures generally must be between 57° and 62° F at a two-inch depth, while goosegrass prefers soil temperatures between 60° and 65° F, usually two weeks later than crabgrass. Strategically, this is very advantageous for the summer annual grasses, which establish at a time when cool-season turfgrasses are entering a period of reduced growth rate, often referred to as summer dormancy. Turfgrass root growth is less active at soil temperatures above 65° F, while shoot growth rate decreases at air temperatures above 75° F, thereby reducing the turf’s ability to compete for space, water, and nutrients. Compared to cool-season grasses, summer annual weeds are more photosynthetically efficient and begin to thrive at higher temperatures.

Once germination conditions are established and turf competition is reduced, the major limiting factor to infestation is the weed seedbank. This is of considerable importance during dry years, when moisture stress conditions prevail. For example, years in which there have been moisture deficits, several flushes of weed germination have occurred immediately following even the slightest amount of precipitation and have continued through late summer. Additionally, consider the effect of moisture stress on the competitive ability of non-irrigated or partially irrigated turf. Therefore, it is imperative to develop weed management strategies that efficiently exploit weed biology and enhance desirable turfgrass competitive ability.

Cultural Management
In general, a dense, well-maintained turf will minimize serious weed infestations. In many golf course situations the acceptable threshold level is zero — i.e., the turf must be 100% weed-free. Many superintendents don’t like to hear it, and for many it may not be practical, but increasing the height of cut will enhance turf competition and reduce weed infestation. Irrigation that allows the soil surface to dry does less to encourage weed germination, and a well-rooted turf will not be detrimentally affected. Irrigation practices should be such that turf health is not compromised. From a fertility perspective, a properly timed late-fall fertilization will provide for extended root development in cooler soils in early winter and spring. Also, avoiding early spring fertility will minimize excessive topgrowth production, thereby enhancing root growth during its most active period. Good root development improves drought tolerance during summer stress periods when the weeds are more competitive.

Pre-Emergence Control
The nature of golf course management oftentimes runs counter to optimum plant health management. Mowing below optimum cutting heights, non-refined irrigation practices, heavy play, and disease and insect pressure could result in physiological strain on the desirable plants. The result is a less-competitive turf, vulnerable to weed infestation. To minimize this weed pressure, pre-emergence herbicides are used to prevent weed establishment. Strategically, this can be an effective measure; however, it can be inconsistent based on application timing and environmental conditions, as well as possibly having an impact on turfgrass health.

Pre-emergence herbicides do not inhibit germination; in fact, they require weed germination to be effective. Following germination, the seedling absorbs the herbicide resident in the top two inches of soil. The majority of pre-emergence herbicides (pendimethalin, benefin, trifluralin, oryzalin, bensulide, prodiamine, DCPA, napropamide, dithiopyr) act by inhibiting cell division, eventually exhausting the seed reserves before the weed can emerge and begin photosynthesizing. In contrast, oxadiazon is thought to inhibit other metabolic processes not directly related to cell division; still, it exhausts seed reserves before emergence. Except for siduron, these products do not distinguish between weed or turf seedlings, requiring the turfgrass manager to delay turf establishment or overseeding operations for the appropriate amount of time.

The effect of pre-emergence herbicides on rooting has focused on establishing Kentucky bluegrass sod and bermudagrass. However, the other major turfgrass species...
have been investigated to a lesser extent. In general, pre-emergence herbicides are thought to be less injurious to established turf, though the ability to detect subtle differences in rooting remains a critical void in turfgrass research. It is possible that the influence of pre-emergence herbicides on rooting is not completely understood.

Turfgrass ecology and physiology could explain this further. Grass root tips are regions of active cell division (meristems). The root meristem could be affected if it contacts a pre-emergence herbicide that inhibits cell division. Ecologically, turfgrass rooting will be most active in the early spring when the soil is cool and topgrowth is yet to be initiated. This root development aids the turf's ability to withstand summer stress periods where evaporative demand is high and moisture is limiting. It follows, then, that an application of a pre-emergence herbicide that inhibits cell division could affect root production during a critical development stage. Delaying a pre-emergence application until soil temperatures warm, so that roots are through their active stage, would avoid injuring the new roots. Yet, if crabgrass has already emerged, most pre-emergence products will not provide post-emergence control; hence, proper timing remains critical.

**Pre- and Post-Emergence Combinations**

Providing weed-free playing surfaces requires an integrated strategy which maintains optimum plant health and incorporates properly timed herbicide applications. Utilizing a careful monitoring program, which includes soil temperature, growing degree days, and phenological indicators, in combination with a pre- and post-emergence application, could provide excellent control. As soil temperatures warm, these pre- and post-emergence applications could be made following emergence of weed seedlings and after the period of active turfgrass rooting. This strategy controls emerged plants and provides extended pre-emergence control during the season, while allowing for overseeding operations in the late summer and fall.

Research conducted at Cornell University from 1989 through 1991 identified various herbicides and herbicide combinations that are safe and effective on creeping bentgrass maintained as a %" putting green and on %" annual bluegrass/bentgrass fairway turf. In 1989, 30 days after treatment, dithiopyr (Dimension) applied to a bentgrass green at .5 lb ai/A produced slight reddening of leaf sheaths; however, injury was not considered to be objectionable, and on the fairway turf provided acceptable (>85%) season-long annual grass control. Oxadiazon (2G) injured all varieties at green height at 2.25 lb ai/A. Interestingly, oxadiazon applied alone as commercially formulated Ronstar 2G at 1.5 lb ai/A caused objectionable injury; however, the premix granular of 1.5 lb ai/A oxadiazon plus 6.0 lbs ai/A bensulide (Scott's Goosegrass/Crabgrass Control) did not cause injury to the bentgrass green. Research conducted in 1990 saw pre-emergence applications made under cooler temperatures than 1989, resulting in less phytotoxicity from all oxadiazon applications.

Post-emergence applications in all years were made at 14-day intervals and began when crabgrass reached the three-leaf stage in the fairway turf. The 1.0 lb ai/A rate of MSMA, applied with an iron chelate safener, did not produce injury, and the safener significantly reduced MSMA phytotoxicity at all rates. On fairway-height turf, annual grass control from MSMA was significantly reduced by an apparent antagonism between the safener and MSMA. Tank mix combinations of fenoxaprop (0.04 lb ai/A) and bensulide (6.0 lb ai/A at 100 gallons per acre) were safe at green height. Crabgrass efficacy was not investigated.

Fenoxaprop at 0.04 lb ai/A applied at 100 gallons per acre (gpa) slightly injured bentgrass mowed at %", but did not cause injury at %". Excellent crabgrass and goosegrass control was provided in the fairway turf. Additionally, one tank mix application of dithiopyr at 0.25 lb ai/A and fenoxaprop at 0.04 lb ai/A afforded exceptional (>95%) season-long control; however, this combination even at higher-volume applications up to 100 gpa caused severe injury to the bentgrass maintained at green height. Previous research has indicated potential synergism between dithiopyr and fenoxaprop that could explain the exceptional control and the increased turf injury.

Dithiopyr (Dimension), from Monsanto, represents the next step in summer annual grass weed control with its pre- and post-emergence activity. The previous research regarding safety of dithiopyr on creeping bentgrass greens has been substantiated by several researchers throughout the country. Some precautions do apply, such as: Older creeping bentgrass varieties (Cohansey, Sea-side, South German mixture) and colonial bentgrasses are more sensitive and have been injured from dithiopyr applications, and non-amended, high-clay-content, poorly drained greens have also been injured.

Finally, quinclorac (Drive), a new post-emergence product from BASF Corporation (expected for the 1993 season), also represents an alternative strategy to traditional weed control programs. Quinclorac is an excellent post-emergence grass herbicide that has activity on certain broadleaf weeds, especially white clover (Trifolium repens L.) and Veronica filiformis, one of the most difficult-to-control weeds in cool-season turf. Quinclorac has demonstrated little pre-emergence activity and therefore would...
A dense turf is still the best solution to controlling grassy weeds, as witnessed by this bentgrass strain.

The effect of a dinitroaniline pre-emergence herbicide applied as a post-emergence to goose-grass. In spite of the obvious club root injury typically associated with these herbicides, the plant was able to survive under well-watered conditions.

need to be applied in combination with a pre-emergence product for season-long control of germinants.

Conclusions

The first step to an efficient weed management program is optimum plant health maintenance in combination with efficient use of herbicides. An integrated approach requires an understanding of the dynamics of the turfgrass ecosystem and how it might be affected by herbicides. Incorporating herbicides into the program involves understanding their potential impact on turfgrass health and the need for proper application timing to obtain effective weed control. Proper herbicide application procedures are critical to the success of a weed control program and are often overlooked as a result of the occasional hectic nature of managing a golf course.

References


