**BIOLOGY OF ANNUAL BLUEGRASS**

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Annual bluegrass (*Poa annua* L.) is a highly variable species that invades intensively cultured turfs under conditions favorable to its germination and growth. Annual biotypes of this species (*Poa annua* L. f. *annua* Timm) tend to behave as winter annuals; they germinate and grow aggressively during cool weather of spring and fall, produce seedheads throughout the growing season but especially during late spring, and typically die during the summer from heat and drought stresses. Perennial biotypes (*Poa annua* L. f. *reptans* [Hauskins] T. Koyama) produce seedheads only in late spring and are more likely to survive summer heat and drought, providing diseases and destructive insect pests are effectively controlled. Intermediate biotypes that combine features of annual and perennial biotypes have been identified, but are usually classed as *annua* or *reptans*, depending on which features appear to predominate.

Annual biotypes are sometimes referred to as *wild-type* annual bluegrasses when they occur in the wild (i.e., uncultured or minimally cultured conditions) or are similar to those from the wild. They are also referred to as *rough-type* annual bluegrasses when they occur in unirrigated roughs or under similar conditions. In both situations, they tend to behave as winter annuals. Because of their ability to germinate and grow rapidly in voids within a turfgrass community, annual biotypes are also called *colonizing* types. Perennial biotypes are sometimes referred to as *greens-type* annual bluegrasses when they occur in greens, especially if they have persisted for many years under regular irrigation and where diseases and destructive insects are controlled with timely applications of fungicides and insecticides, respectively. Because of their ability to compete with creeping bentgrasses under greens-type culture, some perennial biotypes are also called *competitive types*. Unlike the colonizing types that fill in voids through germination and aggressive tillering growth of seedlings, competitive types grow slowly, sometimes very slowly, but the persistent addition of new tillers and determinate stolons enables them to push other turfgrasses out of the way as long as they remain healthy. Selections of greens-type annual bluegrasses are currently under study at several academic institutions (e.g., Penn State, Minnesota) and at least one cultivar (Petersen's "creeping" bluegrass) has been released for commercial distribution.

With respect to the question: "Does annual bluegrass die from the heat or from disease," the answer is: "It depends." If it's an annual biotype (i.e., wild-type, rough-type, colonizing-type), death during summer is probably directly due to the physiological effects of heat and drought stresses. If, however, it's a perennial biotype (i.e., greens-type, competitive-type), death--to the extent that it occurs under favorable cultural conditions--is probably due to diseases, such as anthracnose and summer patch, or destructive insects, such as annual bluegrass weevil or black turfgrass *Ataenius*.

Morphological differences between greens-type and wild/rough-type annual bluegrasses typically include their respective textures and densities. Some greens-type annual bluegrasses are very fine textured and form extremely dense turfs under close mowing. Their diminutive nature probably reflects some of the evolutionary changes and severe selection pressures to which hybrids (i.e., offspring resulting from crossing different parents) were subjected. Earlier, it was thought that annual bluegrass could be either diploid or tetraploid; however, if the original parents of annual bluegrass were an annual diploid such as *P. infirma*, and a perennial diploid such as *P. supina*, each with two sets of seven homologous chromosomes (2n=2x=14), the offspring from this cross would have different sets of nonhomologous chromosomes (1n=2x=14) and would therefore be a sterile dihaploid. Natural spontaneous doubling would then produce a fertile tetraploid with 28 chromosomes (2n=2x=28) that, in all likelihood, would be larger in size than the diploid parents or the dihaploid predecessor. Some regeneration of the sterile dihaploids could occur as a result of selection pressure (Huff, 1999). Therefore, the more diminutive greens-type annual bluegrasses are either dwarf tetraploids or sterile dihaploids, not diploids.

**Growth and Development**

Studies have shown that, while annual bluegrass can germinate under a wide range of environmental conditions, germination is likely to be substantially lower where temperatures are below $45^0$F or above $85^0$F, or during periods of severe dehydration. Alternating temperatures are generally more favorable for germination than constant temperatures. Annual biotypes typically have a temperature-enforced dormancy that can be overcome with a chilling treatment or over time (2-3 months). Presumably, this discourages germination of spring-produced seed during the summer months and favors fall germination, when growing conditions for new seedlings are more favorable. Perennial biotypes are nondormant and have no chilling requirement. Their germination percentages are relatively constant over time. While light favors germination, it is not absolutely necessary as long as other conditions are favorable. The availability of nitrogen and other soil nutrients favors early seedling development, but not germination. Low soil pH significantly inhibits germination.

The growth and development of annual bluegrass seedlings proceeds along several lines simultaneously. Leaf primordia develop from intercalary meristematic activity within the growing point atop an unelongated stem, called a crown. The oldest leaf primordium, located at the base of the growing point, elongates within several subtending leaf sheaths to form a new leaf. As new leaves emerge, older ones senesce, so that a constant number of leaves per shoot is maintained under a specific set of environmental conditions. As environmental conditions change seasonally, the number of sustainable leaves per shoot can vary accordingly.

The life length of shoots can range from less than 3 months to more than two years. This varies with cultural intensity; longevity is shorter in greens and longer in fairways. It is strongly influenced by the incidence of diseases, insects, and environmental stresses. Shoot density varies with biotype and cultural intensity; in greens, the density range is from 174/$in^2$ (Lush, 1988) to 1300/$in^2$ (Huff, 1999).

New adventitious roots emerge from nodes located at lower regions of the crown. While meristematic activity is largely confined to the root tips, lateral or branch roots can develop at various points along the root. Senescence can precede that of the supported shoot; this is most likely during the summer when net photosynthetic activity is reduced and, as a consequence, the availability of photoassimilates is low due to high photorespiration rates. Poor rooting may reflect unfavorable soil conditions, including high (>7.0) or low (<5.0) pH, oxygen deficiencies, and high salt accumulations. Unfavorable cultural conditions that may adversely affect root growth include close mowing, excessive nitrogen fertilization, potassium deficiencies, and excessive thatch accumulations. While often characterized as a shallow-rooted grass, the tolerance of annual bluegrass to low oxygen levels enhances its competitive ability in mixed turfgrass communities.

Situated along stems, including crowns, are axillary buds, which give rise to new lateral shoots, including tillers or stolons. As a new lateral shoots develops, the parent shoot typically bends at the base to enable the new shoot to develop more or less vertically. Often, the difference between a tiller and a stolon is one or two elongated internodes in the supporting stem, converting an unelongated stem (crown) to an elongated stem (stolon). This enables a single plant to form many shoots and accounts for the very high densities often observed in annual bluegrass populations.

The emergence of seedheads, called inflorescences, occurs after a growing point changes from the vegetative to the reproductive state. Subsequent elongation of the stem (now called a *flowering culm*) elevated the inflorescence so that developing florets (commonly called *seed*) can disperse and provide new plants when conditions for germination and seedling growth are favorable. The number of florets per spikelet varies with biotype and shoot density. In low-density populations, depending on biotype, the range was 3.1-4.2; in high-density populations, it was 2.2-3.5 (Johnson et al., 1993). Distinct flowering "pulses" typically occur, usually in mid-spring during a 14- to 18-day period. In Michigan, these pulses occurred at 363 to 433 degree days (Danneberger and Vargas, 1984). Annual biotypes are more likely to exhibit continuous flowering while perennial biotypes typically exhibit seasonal flowering, due to their greater sensitivity to photoperiod or vernalization.

Annual bluegrass is believed to be primarily self pollinated, resulting in a high degree of inbreeding. Some cross pollination can occur, however, resulting in hybridization levels estimated at 1 to 22 percent. Selfing is probably favored in the greens environment while crossing is more likely in the rough/fairway environment due to the influence of plant size on inflorescence extension. The interval between stigma exertion and anther dehiscence can be as short as 1 hour (Ruemmele, 1989); thus, pollination can take place very quickly. Annual bluegrass possesses the remarkable ability to ripen viable seed on panicles severed from the plant on the same day pollination occurs (Koshy, 1969).

## References

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