Bentgrass Seeding Rates: Survival of the Fittest

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...at no time would a capable agriculturist benefit from sowing more than [the recommended seeding rate], though seed houses will continue to recommend high rates....(Madison, 1966)

Perspective. A few months after I arrived in Wisconsin, I attended my first Wisconsin Golf Turf Symposium in Milwaukee. I truly value the Symposium because of the single topic and perspective provided by practitioners who are actually using the principles they preach. For instance, a speaker on the program provided an animated and informative lecture that included his recommendations for establishing new putting greens from seed. To my amazement, his recommendations for seeding rates were 5 to 10 times the typical seeding rates for bentgrasses to achieve a quick, fine-textured surface. I guess the above quote from Dr. Madison should have included golf course architects!

In golf course design and construction, where the architect meets the superintendent or reconstruction/renovation where the superintendent meets the golfer, the quest for rapid establishment of fine textured plants has resulted in the discarding some principles of biology and ecology. While I clearly understand the economic and political motivations behind management decisions, I wondered if there were long-term consequences that compromise the short-term benefits of excessively high seeding rates.

Background. Seeding rate is a primarily a function of seed size. However, it also depends on the turfgrass species, pure live seed (purity & germination) in a seed lot, environmental conditions at establishment, seed cost, growth habit (upright vs. prostrate) and establishment rate desired. Most cool season turfgrasses are seeded at a rate that results in approximately 10 to 25 seeds per square inch, except for the bentgrasses. There are between 6 and 8 million seeds in one pound of creeping bentgrass, while a pound of Kentucky bluegrass has 2 million seeds and a pound of perennial ryegrass only 250,000 seeds. Therefore, bentgrass seeding rates were designed to deliver 30 to 60 seeds per square inch, typically achieved by sowing 0.5 to 1.0 lbs. per 1000 square feet (M).

In 1966, John Madison conducted a study to determine the optimum seeding rate of turfgrasses. This work, like many other studies conducted by him, provided the baseline information that to this day is still relied upon. There were several interesting results including the observation that Penncross creeping bentgrass seeded at 0.5 lb. per M had the same visual cover rating at 1 month after establishment as the 5 lb. per M rate. Madison monitored seedling density over an 8 month period. At establishment high seeding rate plots had up to 10 times more seedlings than the lower seeding rates. However, during the succeeding months seedling populations in the plots converged so that at the end of eight months, all plots had similar shoot densities. Finally, Madison reported increased disease incidence associated with higher seeding rates. To summarize all this, a fine textured dense turf can be achieved more rapidly at higher seeding rates; however, there will be increased seedling mortality and disease incidence.

The convergence of the number of seedlings following different seeding rates is an example of carrying capacity. The carrying capacity is defined as the amount of life that can be supported (or carried) by a habitat (in our

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case, a soil). Theoretically, a lower seeding rate would result in fewer "strong" plants and high seeding rate more "weaker" plants. Eventually both systems reach the carrying capacity of the habitat and further population growth is subject to severe competition resulting in plant death. Ecologically, the loss of an individual plant is more than compensated for by the extended growth of the surviving plants (Lush, 1990). In other words, it truly is a survival of the fittest.

Growth Habit. How about lower than recommended seeding rates? Studies have indicated that grasses with a lateral growth habit from stolons and rhizomes form a more dense and mature turf more rapidly at lower seeding rates. For example, sod growers will typically seed Kentucky bluegrass at 0.25 to 0.75 lb./M (recommended rate is 2 lbs./M) to promote rhizome development that intertwines the sod and allows it to be harvested sooner.

Higher seeding rates to delay stand development is the logic behind the use of cool-season grasses to overseed warm-season turf. Initial establishment is dense and, because of space competition, the plants remain in a juvenile state and are able to tolerate lower heights of cut. Ultimately, the managers do not want an aggressive stand of cool-season grasses to persist, therefore the lack of individual plant and overall stand vigor is viewed as an advantage. Why else would a sane person seed perennial ryegrass at 30 lbs./M (5 times the recommended rate)?

The Bentgrasses. The introduction of more bentgrasses has raised some concerns regarding the establishment and management of cultivars other than Penncross. We have conducted several experiments over the last few years to better understand the response on the new bentgrasses to various seeding rates, with and without fungicide pretreatment.

Clearly, from a leaf texture perspective, Penncross benefits from higher seeding rates that result in a finer texture. However, our studies have indicated that these benefits are not as clear for cultivars such as Putter, SR1020, Crenshaw and Providence that were developed for their fine texture. Only at the 4 lbs. rate does Penncross leaf texture approach the same texture as the newer cultivars.

Morphologically, many of the newer cultivars were developed for more upright growth that would provide a superior putting surface, vis a vis, less potential for grain. In fact, higher seeding rates for the cultivars tested in our trials that were developed for upright growth (Putter, Crenshaw and SR1020) provided a dense turf sooner at slightly above the recommended rates. I am cautious about these results and population dynamics observed in the last year. Recall the earlier mention of carrying capacity and mortality of individual plants.

Population Dynamics. We have observed an increase in seedling survival when bentgrass seed is pretreated with a fungicide (Apron). In fact, the number of shoots per unit area continues to be significantly greater in these plots 1 year after establishment. It has been noted that certain organisms can, for periods of time, overshoot the carrying capacity. However, plants are not known to be one of these organisms.

Plants have the ability to "sense" each other by picking up radiation reflected by nearby leaves and changing their growth characteristics well before their resources are reduced. Eventually, the population will begin to thin itself out and we have begun to see this in our work, specifically with regard to increased disease incidence.

The Disease Perspective. The first experiment we conducted in 1993 supported the work of Madison with respect to seedling density, leaf texture and increase incidence of damping-off pathogens. Therefore, the second run of the experiment included treated vs. untreated seed and we observed significantly less seedling mortality. However, as observed with the first experiment, the higher seeding rate plots had more dollar spot, especially the dollar spot susceptible cultivars such as SR1020 and Crenshaw.

We observed significantly more gray snow mold in 1995 at higher seeding rates and again more dollar spot. Interestingly, there appears to be a consequence to fungicide pretreatment. Invariably, the treated seed at high rates always had a higher disease incidence than the untreated high seeding rate.

Annual Bluegrass Invasion. Recently, researchers in California studied annual bluegrass invasion into the new bentgrass cultivars. The study was seeded at 0.5 lb./M and no data collected until the stand was a year old! Annual bluegrass invasion ranged from 10 to 50% depending on the cultivar. This shines an interesting light on the interspecific competition between bentgrass and annual bluegrass and resulting population dynamics.

Summary. Managing a biological system such as a golf course leaves us at the mercy of the ecological principles at work in nature. While we might be capable of forcing our system to perform outside of the known parameters, such as carrying capacity, eventually the system seeks a balance. As the balance is attained, have we negated the short-term benefit of high seeding rate by creating long-term challenges. If we ignore the ecological principles, we must be prepared to pay the price for the survival of the fittest.