ENDOPHYTIC FUNGI CAN SERVE AS BIOLOGICAL INSECT CONTROL IN TURFGRASSES

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Plant breeders are continually developing new varieties in which desirable characteristics and plant performance are optimized. Plant performance is a reflection of the sum total of many factors, including yield or productivity, appearance, vigor, resistance to weed invasion, recovery from injury, persistence and density, and can be enhanced by improving pest resistance and tolerance of herbicides, defoliation, heat and drought.

Resistance to insect predation is a very important factor in a plant's performance, which can be controlled three ways: (1) by using insect-resistant plant varieties; (2) by chemical pest control; and (3) by biological pest control.

Plant breeders continually seek to upgrade the insect resistance of important plant varieties; however, after a new variety providing resistance is developed, usually after years of painstaking breeding, insects may sooner or later evolve that are able to feed, without adverse effect, on the once insect-resistant plant. Thus, the ultimate grower of the new variety is faced with a number of alternatives. He can either await further development of a new pest-resistant plant variety or turn to either chemical pesticides or bilogical pest control.

If the cost or environmental impact of using chemical pesticides is a prohibiting factor, an alternative is biological pest control.

Perhaps the best known use of biological pest control is the well publicized case of the screwworm fly. The discovery that screwworm flies mated only once led to the method whereby large numbers of laboratory-bred male flies were sterilized by X-ray irradiation. By subsequently releasing these sterile males, the females with which they mated could lay only infertile eggs. Thus, by exploiting the known mating habits of a particular insect pest, its numbers were effectively curtailed.

Another example of biological pest control includes the use of insect pathogens, such as certain lethal or debilitating insect viruses. Because these viruses are generally host-specific, the targeted insect pest can be readily controlled without harming beneficial species.

The advantages of biological control of insect pests are several. First, biological controls are generally self-limiting; once numbers of the target species are reduced, so too are the biological controls. Second, biological pest controls are usually host-specific and do not attack desirable species. Finally, and perhaps most importantly, biological pest controls are normally environmentally compatible, unlike chemical pesticides which may persist in the environment and kill indiscriminately.

A "new" biological pest control has recently been recognized. Certain plants host symbiotic endophytic fungi which confer, among other things, an enhanced resistance to insect predation on the host plant. For example, in perennial ryegrasses, a positive association has been demonstrated between the presence of an endophytic fungus (literally, a fungus living within its plant host) and resistance of the plant to attack by some of the most prevalent insect infestations encountered in the field - i.e., the sod webworm, the bluegrass billbug, the Argentine stem weevil, the Southern armyworm, and the chinch bug.

When purchasing seed to contain high endophyte levels, look for the following tag to ensure presence of the endophyte.

TEST DATE ______ No 00027

ENDOPHYTE ENHANCED PERFORMANCE™

When stored and used as directed the seed in this bag will produce plants having ENDOPHYTE ENHANCED PERFORMANCE.™

An endophyte is a fungus that lives within, but is not necessarily parasitic on, another plant. The presence of an endophytic fungus produces no known adverse effects to the host plant but provides many advantages which enhance turfgrass performance.

In nature plants which contain an endophyte are able to survive insect attack. Resistance has been found with insects which typically feed on the lower stem and crown of plants as these areas normally have the highest concentration of the endophyte. Plants containing endophytic fungi have shown resistance to sod webworms, armyworms, billbug, Argentine stem weevil and chinch bugs.

Transmitted by seed, plants which contain an endophyte may also provide improved stress tolerance and persistance compared to non-infected plants. Additionally, enhanced performance may include a more attractive appearance, increased vigor and density and rapid recovery from injury.

The seed in this bag was produced and tested to insure that over 80% of the seed contains the endophyte. Endophyte viability will be significantly reduced by normal seed storage practices within 18 months.

COLD STORAGE (40°F) WILL PROLONG ENDOPHYTE VIABILITY. TO RETAIN ENDOPHYTE VIABILITY SEED SHOULD BE USED WITHIN ONE YEAR OF THE TEST DATE.

In particular, perennial ryegrasses hosting an endophytic fungus are highly resistant to feeding of the larval stages of sod webworms. Plants lacking the endophytic fungus can sustain substantial injury from feeding by sod webworm larvae. Resistance in ryegrasses hosting this fungus to feeding of the larval stages of the bluegrass billbug has also been observed. Also, we have observed resistance to feeding by the chinch bug, and others have observed resistance in ryegrasses hosting endophytic fungus to the Argentine stem weevil. This endophytic-enhanced insect resistance in ryegrasses to three different orders of very prevalent chewing insects provide a broad-based mechanism for developing new plants having enhanced performance including resistance to these insects.

The exact mechanism of this enhanced resistance to insect predation has not as yet been identified, although it is suspected that such resistance could involve the generation of chemicals toxic to insects feeding on plants containing the endophytic fungi. These chemicals might be produced by the endophytic fungus or by the host plants themselves in response to the invading fungus. The latter mechanism may mediate a generalized resistance to insects feeding on plant parts having the highest concentrations of endophytic fungi or their associated toxins.

In addition to the observed resistance to predation by insects, plants hosting the endophytic fungus have displayed a certain enhanced performance which includes improved ecological fitness, a more attractive appearance, increased vigor, reduced weed invasion, more rapid recovery from injury, improved persistence, increased density, and apparently greater stress tolerance. For example, in turf trials of tall fescue and perennial ryegrass varieties and single-plant progenies established during the late summer of 1976 at North Brunswick, New Jersey, those varieties containing a high level of endophytic fungus showed dramatically improved performance after seven years. Species tested included tall fescue (Festuca arundinacea) and ryegrass (Lolium perenne). These plants were more persistent, showed reduced crabgrass invasion, produced a higher yield, had greater vigor, and displayed an improved appearance. Much of this improved performance of these fungal-endophyte-hosting plants appears to be associated with improved stress tolerance, such as tolerance of heat, drought and defoliation. Similar enhanced performance, including resistance to the billbug and the chinch bug, has been observed for hard fescue and for chewings fescue.

The particular endophytic fungus involved in the above described insect resistance and enhanced performance in ryegrass has been provisionally designated the Lolium endophyte. A similar or identical endophyte fungus present within tall fescue has been identified as Epichloe typhina and was recently renamed Acremonium coenophialum.

The life cycles of endophytic fungi have been studied in detail. The fungus begins within the seed of the host plant, adjacent to the aleurone layer. When the seed germinates, the fungus spreads into the developing seedling. Apparently, as the seedling develops, the fungus grows into the rhizomes, leaf tissue, flower stem and seeds, but avoids penetration into the roots.

As a prelude to the invasion of the fungus into its host's developing seed, the fungus concentrates its mycelia in the flower stem. As the seed developes, the fungus grows into the seed adjacent to the aleurone layer, initially avoiding the embryo. Upon germination, invasion of the seedling begins, and the fungus life cycle continues as just described. When seeds are harvested and then stored for later use, care must be taken to store them under cold, dry conditions. Long-term storage (18 months or more) of fungal endophyte-infected seed stored under normal storage practices is known to give rise to plants free of endophyte; this is due to lost viability of the fungal endophyte.

Endophyte levels in selected seed lots of ryegrass varieties are listed as follows:

<u>HIGH</u>

Repell (GT-II)
Citation II
Regal
Pennant

<u>MODERATELY HIGH</u>

Omega II
Cowboy
Prelude
All*Star
Premier

<u>MODERATE</u>

Palmer
Derby
Dasher
Pennfine
Delray
Linn

<u>LOW</u>

Manhattan II
Blazer
Fiesta
Gator
Tara
Manhattan
Elka
Citation
Ranger
Omega
Diplomat
Yorktown II