NEWS *(from page 36)*

consumption of pesticides now amounts to one billion pounds of active ingredients each year. These pesticides will be classified for "general" or "restricted" use as required by the Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) as amended in 1972.

Amended FIFRA also requires that potential users of "restricted" products be certified by October, 1976, as being qualified to use such products safely. EPA estimates that 100,000 commercial applicators and more than two million farmers will need to use pesticides designated for restricted use and will have to be certified.

To carry out these requirements, EPA issued standards for certification of applicators on Oct. 9, 1974. On Jan. 13, 1975, the Agency issued guidelines for State plans for training and certifying applicators. The present cooperative agreement will help the States to implement training programs with organizational and technical assistance from USDA.

Zoning Exception for Beker Opens Door to Florida Mine

The Manatee County Board of County Commissioners, Bradenton, Fla., unanimously approved Beker Industries Corporation's request for a special zoning exception for mining an 11,000-acre site 26 miles east of Bradenton which the company estimates contains 75 million tons of phosphate rock.

"This is a major development for us," said Erol Beker, chairman of the board and the company's president. "It guarantees us the necessary raw materials for our existing plants in Louisiana and Illinois and makes possible the expansion of our fertilizer production in the United States and abroad." Project work will begin immediately and the mine will be designed to produce three million tons per year of phosphate rock and should be completed in mid-1977 at a cost of more than $50 million.

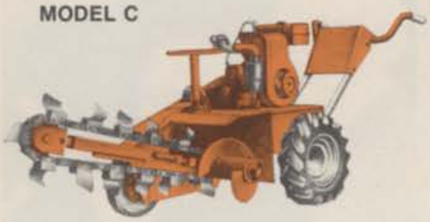
Beker Industries is a major producer of phosphoric acid, diammonium phosphate, triple super phosphate and nitrogen with fertilizer plants located in Louisiana, Illinois, Idaho, New Mexico and Canada. Beker's extensive phosphate rock deposits and mining operations in Idaho supply the rock for the Idaho fertilizer complex making Beker the only fertilizer company with rock mining operations located in both eastern and western markets.

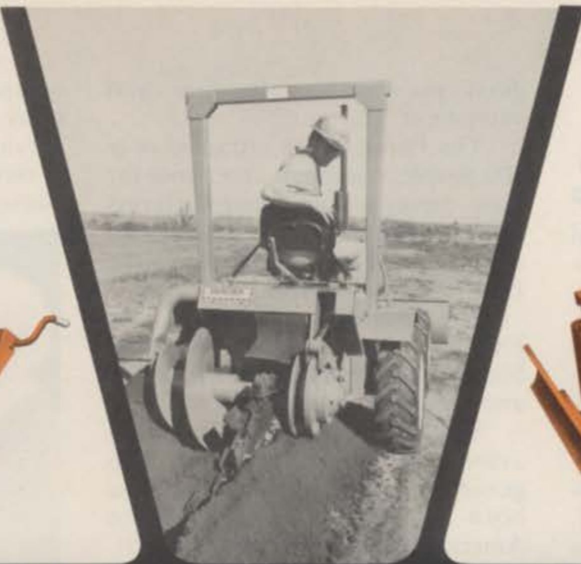
If Florida, the company presented mining proposals which include simultaneous reclamation of the property along with the construction of an approximate eight-billion-gallon fresh water reservoir for the citizens of the Manatee County area. The proposals were developed in close consultation with local area government officials to meet all environmental concerns.

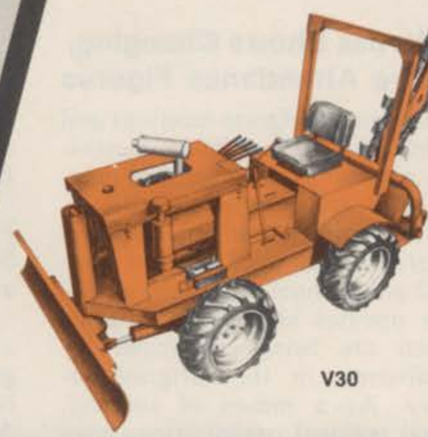
Beker has recently started up its anhydrous ammonia plants in Sarnia, Ontario and Conda, Idaho. These nitrogen plants, along with the phosphate rock operations in Florida and Idaho, place Beker in a basic raw material position for the two major raw materials needed in the production of fertilizer.

(more news on page 44)

MODEL C







V30

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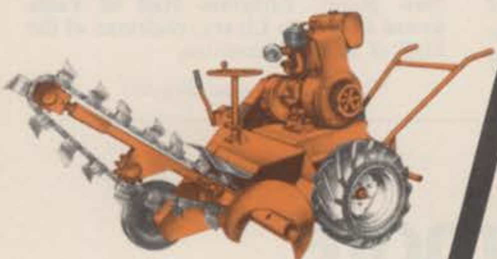

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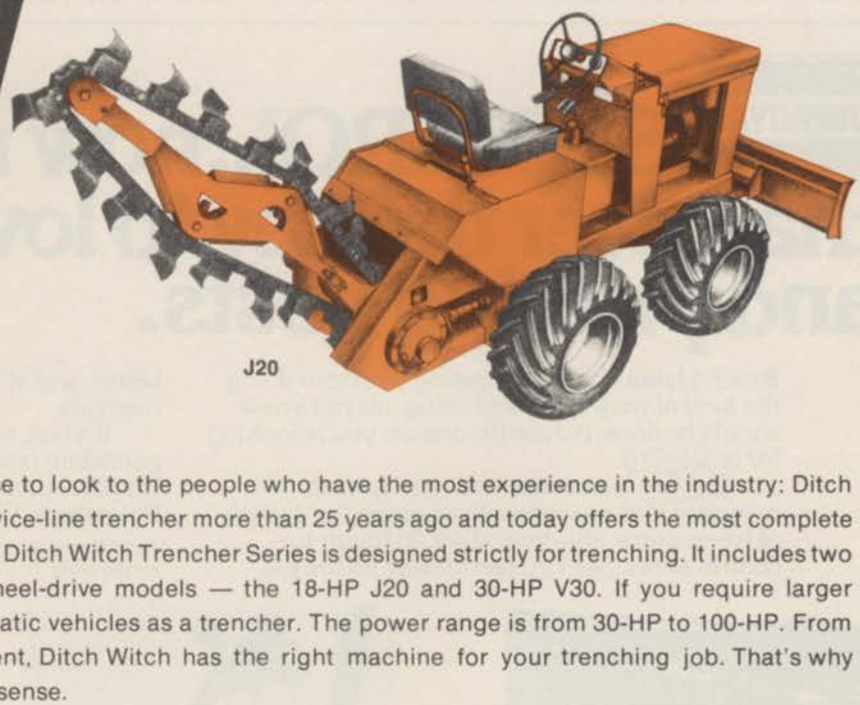

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For More Details Circle (162) on Reply Card

Turfgrass Shows Changing, So Are Attendance Figures

Regional turfgrass meetings and conferences are becoming increasingly popular as the expense of long-distance travel reaches a peak.

The national and international conferences that once supplied nearly all educational materials, equipment updates and chemical information are being challenged for effectiveness in the turfgrass industry. As a means of survival, several regional organizations have broadened their annual programs into extremely worthwhile and informative meetings.

The New Jersey Turfgrass Association recently wrapped-up a complete exposition — equipment show and educational session — for what appears to be the first in a long series of healthy turfgrass shows. Under the direction of Dr. Henry Indyk, the Expo included some 44 exhibitors and featured top speakers in areas of seed production, turfgrass maintenance, fertilizer and equipment.

The Expo, which attracted over 500 people, was a new experience for New Jersey's traditional turfgrass show. And one of the newest and most successful experiences was the Hall of Fame Award.

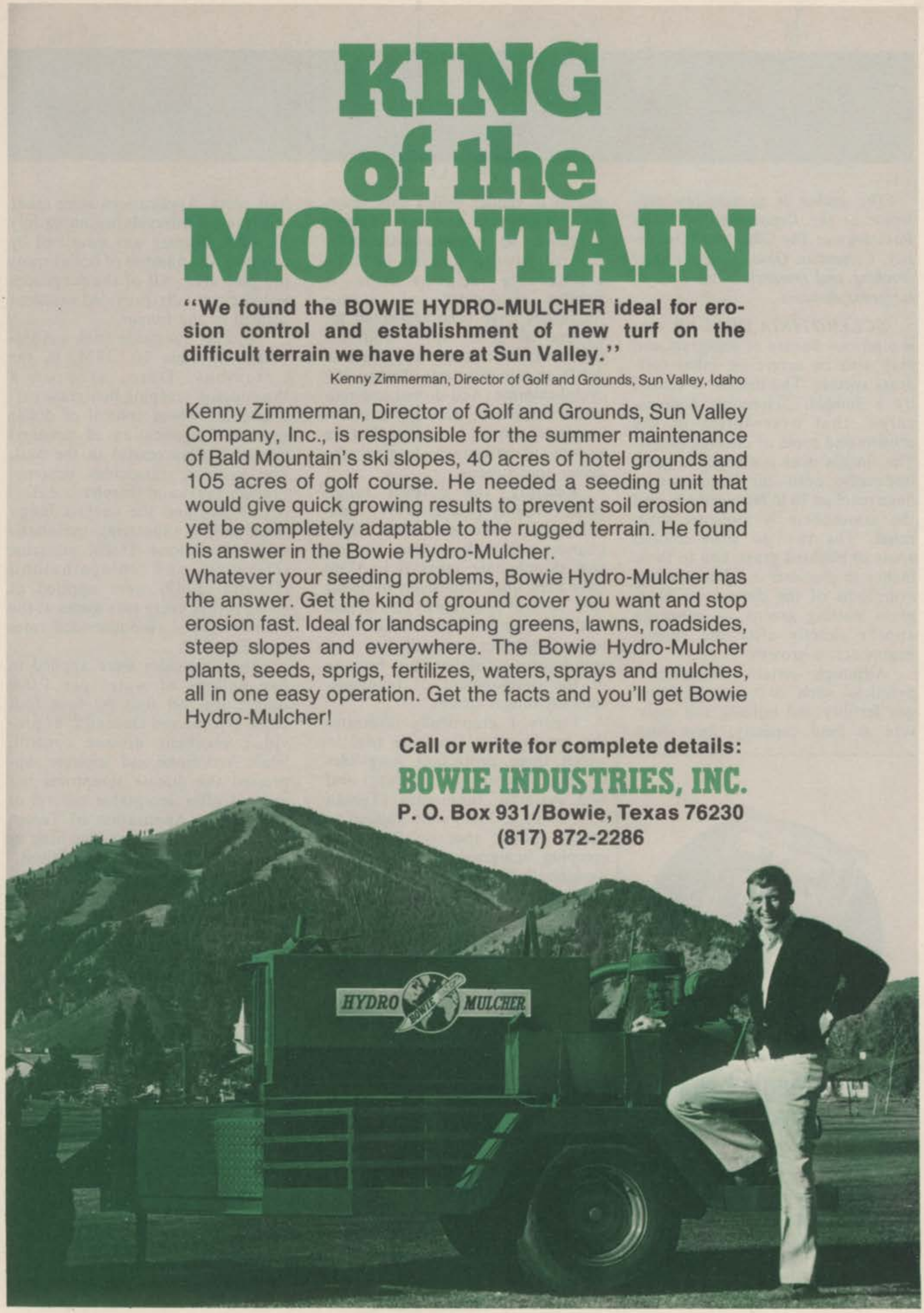
The award, presented at the Expo was in recognition of James Smith, Sr.'s many years of service and accomplishments.

Smith, whose career has been associated with more than two generations of turfgrowers, was born in Scotland and came to America as a young man.

His Scottish background and interest in golf aroused his curiosity about turfgrass growing problems. He noticed the need for a quality topdressing material for putting greens. This led him to the Agronomic Science Department of Rutgers University where he spent many hours in the laboratory with Dr. H. B. Sprague in study of soil and topdressing preparation. The ensuing topdressing product for golf greens is now sold by the parent company beyond New Jersey as far away as Maryland, Eastern Pennsylvania, Albany, New York, Western Connecticut and Long Island.

James Smith, Sr. (right) receives the first New Jersey Turfgrass Hall of Fame award from Leo Cleary, chairman of the Hall of Fame Committee.

(more news on page 50)



For More Details Circle (112) on Reply Card

DOLLAR SPOT CONTROL
Integrating Systemics and Contacts

By P. O. LARSEN

The author is an associate professor in the Department of Plant Pathology at The Ohio State University, Columbus, Ohio, specializing in teaching and research in the area of turfgrass diseases.

SCLEROTINIA DOLLAR spot is a serious disease of bentgrass and may also be severe on other turfgrass species. The disease is caused by a fungus, *Sclerotinia homoeocarpa*, that overwinters in the crowns and roots of infected plants. The fungus does not begin to grow optimally until air temperatures have reached 70 to 80 degrees F. and the atmosphere is moisture saturated. The tan- to straw-colored spots of blighted grass, two to three inches in diameter — characteristic symptoms of the disease on bentgrass putting greens — generally appear shortly after the fungus begins active growth.

Although certain management practices, such as increasing nitrogen fertility and holding soil moisture at field capacity, have been shown to reduce dollar spot severity, it is generally necessary to apply fungicides to maintain satisfactory control of the disease on high maintenance turfgrass areas. A number of contact and systemic fungicides have been registered for control of dollar spot. Anilazine (Dyrene), chlorothalonil (Daconil 2787), thiram (Spotrete, Tersan 75), cycloheximide (Acti-dione) and cadmium chloride (Caddy) are examples of contact fungicides that are known to effectively control the dollar spot fungus.

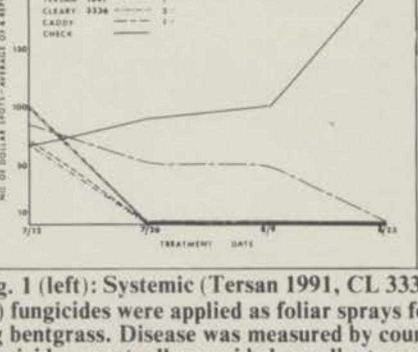
Recently, the systemic fungicides benomly (Tersan 1991), thiabendazole (Mertect 140), thiophanate methyl (Spotkleen, Fungo), and thiophanate ethyl (CL 3336) have been used extensively in dollar spot control programs. This article deals with recent reports where systemic fungicides have failed to control *Sclerotinia* dollar spot because of the development of fungicide-tolerant fungal strains.

Figure 1 graphically illustrates the results of a fungicide trial in which three protectant fungicides (Caddy, Daconil and Dyrene) and two systemic fungicides (Tersan 1991 and CL 3336) were applied to control dollar spot on Penncross creeping bentgrass. The fungicides were applied in five gallons of water per 1,000 square feet on 10 by 10 foot plots. Applications were made at two week intervals beginning July 12, 1974. Disease was measured by counting the number of dollar spots per plot area. All of the fungicides tested eventually provided excellent control of the fungus.

Another fungicide trial was initiated on June 10, 1974, in the Columbus, Ohio, area on a Washington creeping bentgrass putting green where control of dollar spot with application of benomyl has been unsuccessful in the past. The systemic fungicides benomyl (Tersan 1991) and thiophanate ethyl (CL 3336), and the contact fungicides thiram (Spotrete), cycloheximide (Acti-dione TGF), anilazine (Dyrene), and chlorothalonil (Daconil 2787) were applied as foliar sprays every two weeks at the manufacturers' recommended rates (see Figure 2).

The fungicides were applied in five gallons of water per 1,000 square feet on four by four foot plots. Dyrene and Daconil 2787 provided excellent disease control, while Acti-dione and Spotrete suppressed the disease symptoms but did not offer acceptable control of the fungus. Application of Tersan 1991 and CL 3336 provided little or no control under these conditions.

Recently, researchers at Pennsylvania State University have re-



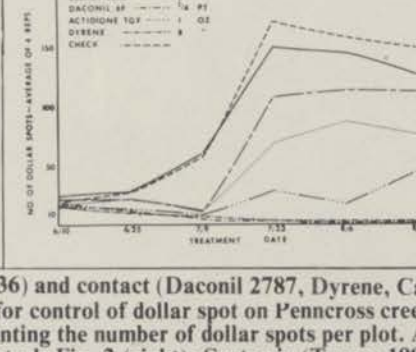


Fig. 1 (left): Systemic (Tersan 1991, CL 3336) and contact (Daconil 2787, Dyrene, Caddy) fungicides were applied as foliar sprays for control of dollar spot on Penncross creeping bentgrass. Disease was measured by counting the number of dollar spots per plot. All fungicides eventually provided excellent control. Fig. 2 (right): Systemic (Tersan 1991, CL 3336) and contact (Spotrete, Daconil, Acti-dione TGF, Dyrene) fungicides were applied as foliar sprays to plots of Washington creeping bentgrass where systemics had previously failed to control dollar spot. Dyrene and Daconil provided excellent control; Acti-dione and Spotrete suppressed but did not control disease to acceptable levels. Tersan 1991 and CL 3336 provided little or no disease control.

ported similar instances in which systemic fungicides failed to control dollar spot.[1,2] This observation has now been made in several states, indicating that tolerance of *S. homoeocarpa* to systemic fungicides is quite widespread.

In an effort to explain the occasional failure of systemic fungicides to control dollar spot, *S. homoeocarpa* was isolated from plots where systemic fungicides did not control the disease and from areas where systemic fungicides were effective. These isolates were cultured in the laboratory on artificial growth media containing various systemic and contact fungicides. *Sclerotinia* isolates from plots where systemic fungicides controlled disease would not grow on media containing systemic and contact fungicides that are registered for dollar spot control (see Figure 3A). Isolates originating from areas where systemic fungicides did not control disease grew readily on media containing systemic fungicides (see Figure 3B). These observations indicate that failure to control the fungus on the turfgrass plots with systemic fungicides was probably caused by the presence of a fungicide-tolerant strain of *S. homoeocarpa*.

Another example of tolerance of fungal turf pathogens to systemic fungicides has been demonstrated with the powdery mildew fungus, *Erysiphe graminis*, on Kentucky bluegrass.[3] A strain of the fungus was removed from a field plot of Merion Kentucky bluegrass where benomyl applications failed to control powdery mildew. This strain proved to be resistant to benomyl, thiabendazole and thiophanate methyl at concentrations that were not phytotoxic. The development of benomyl-tolerant strains of fungal pathogens has also been recorded for crops other than turfgrasses.[4,5,6]

Fungal strains that have been reported to be tolerant to benomyl were also tolerant to the thiophanate fungicides. This result is understandable, since it has been shown that both benomyl and thio-

(continued)

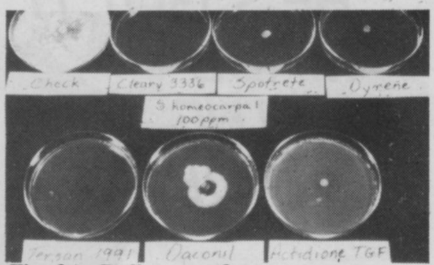


Fig. 3A: Dollar spot fungus was grown on artificial media containing 100 ppm active ingredient of systemic (CL 3336, Tersan 1991) and contact (Spotrete, Dyrene, Daconil, Anti-dione TGF) fungicides. Fungus was isolated from turfgrass where systemics effectively controlled dollar spot. No fungal growth observed with systemics.

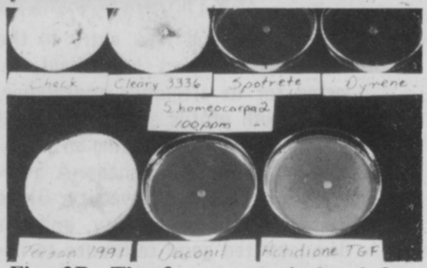


Fig. 3B: The fungus was isolated from areas where systemic fungicides did not control disease. Fungal growth was not inhibited on media containing systemic fungicides.

phanate methyl are converted to the same compound, 2-benzimidazole carbamic acid methyl ester, in plants,[6,7] and are quite similar with respect to their ultimate fate and modes of action in plant tissue.

Strains of *S. homoeocarpa* tolerant to Dyrene and cadmium fungicides have been reported,[2,8] indicating that fungicide tolerance is not strictly limited to the systemic fungicides. However, tolerance to systemic fungicides has been reported more often than tolerance to contact fungicides.

Various explanations have been offered for the fact that tolerance to systemic fungicides develops more frequently than tolerance to contact fungicides. Contact fungicides generally are active at several sites in the metabolism of the fungi they inhibit, whereas systemic fungicides are usually only effective at one or a few specific sites in the metabolic pathways of a fungus. This characteristic increases the potential for fungicide tolerance to develop with systemics, since only one or a few mutations in the fungus at chromosome sites governing fungicide sensitivity could render it insensitive to systemic fungicidal action. Mutations at several chromosome sites would be required to change the fungicidal capabilities of a contact fungicide which possesses broader based modes of action.

The relative concentration of fungicide to which a fungus is exposed influences the development of fungicide-tolerant fungal strains. With contacts, relatively high concentrations of fungitoxic materials are found on the leaf surface. This would lessen the opportunity for natural selection of fungal mutants having a low level of fungicide tolerance. Systemic fungicides are usually applied at lower concentrations than contact fungicides, and once inside the plant, tend to accumulate in leaf tips and margins, leaving the central leaf areas relatively free of fungicide. This uneven distribution of fungicide enhances the potential for development of fungal types having tolerance to low concentrations of fungicide.

Systemic fungicides do not cause mutations to occur in the normal fungus populations. Instead, the mutations occur in a random fashion. Reproduction in fungi occurs much more rapidly than with higher plants and animals and, therefore, the opportunity for random mutations occurring is increased. This encourages the natural selection of fungal mutants possessing tolerance to systemic fungicides. Furthermore, the occurrence of random mutation at several fungal chromosome sites, resulting in tolerance to contact fungicides, would be less likely than mutation at one or a few sites, resulting in tolerance to systemics.

If it is determined that fungicide-tolerant strains of *Sclerotinia* are present in a turfgrass area, it is recommended that further use of systemic fungicides to control dollar spot be discontinued. An alternate contact fungicide should be chosen that can effectively eliminate the tolerant form of the fungus over a period of time.

When fungicide-resistant fungi have not been observed with dollar spot, it is suggested that alternate applications of systemic and contact fungicides registered for dollar spot control be used in an integrated control program to prevent the build-up of fungicide-tolerant fungus strains. The systemic fungicide will continue to eliminate the majority of the dollar spot fungus population that is sensitive to systemics, while the contact fungicide will be used primarily to prevent the build-up of systemic fungicide-tolerant strains of *S. homoeocarpa.*

The systemic fungicides have proven to be extremely effective and valuable tools for plant disease control and have a number of advantages over the contact fungicides: the interval between applications is generally longer with systemics; systemics are translocated inside the plant and have a curative effect, whereas the contacts are on the plant surface and are preventive; and, since systemics are internal, they are less vulnerable to wash-off or to inactivation by sunlight than are the contact fungicides.

When systemic fungicides are used wisely in an integrated control program alternated with broad spectrum contact fungicides, the opportunity for build-up of fungicide-tolerant fungal populations will be minimized and the advantages of using systemic fungicides may be realized. —

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NEWS *(from page 44)*

Budworm Target of Maine's Bacillus Thuringiensis Tests

Biological insect control may be put to an important test this spring as the Maine Agricultural Experiment Station plans to combat a massive outbreak of spruce budworms in the northern part of that state with aerial applications of *Bacillus thuringiensis* (B.t.).

According to John Dimond, a professor of entomology at the University of Maine who is heading up the project, present plans call for at least six 1,000-acre test plots using six-, eight- and 10-billion international units of B.t., each applied at rates of one-quart and one-half gallon per acre.

The spruce budworm outbreak, which also afflicts much of the eastern Canadian provinces, is Maine's most serious insect problem. The budworms have infested 5.5 million acres of spruce/fir forests in Maine, 3.5 million of which are serious enough to warrant immediate attention.

Since a budworm outbreak in the late 1950's, the State Department of Forestry has conducted regular spraying programs using Zectran, and experimental use of Sevin last year. The State plans to spray again late this spring, probably also using fenitrothion. The B.t. project test plots will be established in the same general area as the State's control program.

Dimond's project is being well-received by local environmental groups since B.t., composed of live spores, is non-phytotoxic and non-toxic to animals. It is hoped that data obtained in Maine will help substantiate efficacy claims for B.t. and speed up EPA registration for spruce budworm control.

"Bacillus thuringiensis is an environmentally preferred method of control. If we can show it to be as effective as chemical insecticides, then we'd certainly think of it as a preferred material to use," Dimond said.

According to Dimond, for best results, B.t. must be applied early, so current plans call for spraying when the tree buds are breaking which would be about the first week of June.

Dimond said B.t. effectiveness