Making its way to the marketplace:

A natural product for the control of annual weeds

Though primarily a feed material for commercial livestock, corn gluten meal has demonstrated viability as a reliable "weed and feed" product for many turfgrass areas.

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During the last few years there has been increased public interest in environmental issues conceming the use of pesticides. This particularly has been felt by the turf industry because members of the general public may be involved in the application of pesticides to their own lawns or they may see these materials being applied on golf courses or by lawn care companies. As a result, natural producrs—which generally are perceived as being safer than traditional synthetic pesticides—are generating more interest.

In 1986, a research project involving food-grade cornmeal as a growth medium for a microorganism produced some observations that led to the patenting of a natural-organic product for the preemergence control of annual weeds. The objective of this work had been to establish a *Pythium* fungi in the soil of a new golf course green tnat had been constructed at the lowa State U**niversity turfgrass re**search area. The effects of this pathogen then were observed on creeping bentgrass *(Agrostis palustris) t*hat was to be seeded on the infested soil.

Testing methods

The *Pythium* was cultured in the laboratory for several weeks on the commeal and then taken to the field area where it was placed on the surface and tilled 3 to 4 inches deep. Along with the inoculated cornmeal plots, plots of the same size were treated with fresh cornmeal that had not been treated with Pythium. The same total amount of cornmeal was used in the two separate treatments. In addition. a third control plot to which no cornmeal had been applied was established. Three cultivars of creeping bentgrass then were seeded in strips over the top of the plots.

The attempt ro establish Pythium in the treated plots was a failure, and normal germination occurred in those areas. Normal germination also was observed in the control plots. However, in the plots that had received the fresh cornmeal, establishment was reduced greatly.

The cause of this inhibition was uncertain. One possible explanation was thar there was some type of organic compound contained in the fresh cornmeal that was destroyed by the activity of the fungal organism.

To test this idea, several samples of processed corn grain were obtained for further testing. These included starch, corn

Creeping bentgrass then was seeded over the top of the treated plots, and germination was observed. Tne results of the greenhouse trials showed that the inhibitory substance was clearly in the corn gluten meal.

Close observation of the grass plants in the greenhouse showed that the shoot (the aboveground portion of the plant) formed normally in all plots. However, the corn gluten meal stopped root formation. In pots treated with an effective rate of corn gluten meal, no rooting occurred, and all plants died when water was witheld and the surface of the pots was allowed to dry.

A byproduct of the wet-milling process, corn gluten meal is a 60 percent corn protein material that is approximately 10 percent nitrogen (N) by weight. It is sold as a feed material for cattle, poultry and several other species of livestock, and has been used in fish food for commercial fish production. It also is a primary constituent of some dog food products. Corn gluten meal is produced as a fine, yellow powder, but can be pelletized for easier application to the soil.

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Effects on other species

The next step in the research was to screen the effects of corn gluten meal on a series of other species. It was found that there were some differences in sensitivity, but that the material was effective in stopping or inhibiting root formation at the time of germination in a wide variety of both monocotyledonous (grasses) and dicotyledonous (broadleaf) species, including crabgrass (Digitaria *spp.).*

Corn gluten meal then was screened on mature Kentucky bluegrass (Poa pratensis) to determine whether it had any detrimental effects on grasses once they were fully established. It was found that not only did the material not damage the mature grass, but that it made an excellent natural-organic fertilizer.

Later work conducted over a series of years in the field repeatedly has shown that corn gluten meal is comparable to the best commercially available natural fertilizers. (Data comparing corn gluten meal to other fertilizer materials have appeared in the annual lowa Turfgrass Research Reports since 1989. It appears in these reports under the coded name ISU Experimental.")

The observation that corn gluten meal can inhibit the establishment of germinating weeds and at the same time serve as a fertilizer for mature grasses led to the suggestion that the material could be used as a natural "weed and feed' product for lawns and other turf areas, as well as for garden and other crop production systems where weeds are a problem. Field trials demonstrated that this was possible and a patent was applied for on the concept in 1989. Patent 5,030,268, titled *Pre-emergence Weed Control Using Corn Gluten Meal,* was issued in 1991.

Continuing field work has shown that rates of corn gluten meal in the range of 20 Ibs./1,000 sq. ft. will reduce crabgrass infestation in Kentucky bluegrass turf by 50 to 60 percent in the first year. As rates are increased, almost total control can be achieved. However, timing is important because microbial activity is known to destroy the activity of the active component. Therefore, it is recommended that the application be made close to the time of weed germination. Moisture is necessary to activate the material, but extended wet periods can reduce its effectiveness, as is the case with synthetic preemergence herbicides.

Application rates and recommendations

Current recommendations are that corn gluten meal be applied at 20 lbs. product/1,000 sq. ft. At 10 percent N by weight, this is an N application rate of 2 lbs, N/1.000 sq. ft. This will reduce significantly germinating weeds in the first year and with time should bring this type of weed problem under control.

Figure 4 shows the second year's data from a field trial on the control of crabgrass in Kentucky bluegrass turf. The repeat applications in 1992 were made to the same plots. Though the high rates of application in this study were far beyond what would be used in the turf industry, they were included to look for any possible detrimental effects to the Kentucky bluegrass turf from overapplication.

No damage was observed during the two years. Of greatest interest is the 2 lbs. N/1.000 sq. ft. rate (20 Ibs. product/1,000sq. ft.). Crabgrass was reduced by 60 percent in 1991 and by 85 percent in 1992 at that application rate.

It should be mentioned that the material provides no postemergence control of weeds. Any weed that has germinated and formed a root will not be controlled by corn gluten meal. In addition, as is the case with any weed and feed material, the weeds that do gemainate will benefit from the nitrogen in the corn gluten meal.

The mechanism of weed control centers on the growth regulating inhibition of root formation at the time of germination. It has been observed in both the greenhouse and the field that if the soil surface remains wet during the termination period, affected plants may recover and resume rooting. A short drying period is needed for the death of weed seedlings during the critical time when no root system has formed.

As is the case with other natural substitutes for synthetic pesticides on the market, corn gluten meal will not provide as complete control as synthetics and is likely to cost more. However, it does provide a natural substitute for those who choose not to use synthetic herbicides for preemergence weed control.

Other research efforts

In 1989, another major project was initiated to find the chemical structure of the active component responsible for the inhibition of root systems. Doctoral candidate Dianna Liu has been working for three years

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on the project and in early 1992 identified five chemical structures associated with the root-inhibiting response. Synthetic samples of these materials were obtained and the same root-inhibiting response as observed with the naturally occurring materials has been demonstrated.

These active components will open the door to many other areas of research. For instance, the corn gluten meal possibly could be fortified to increase its effectiveness at lower rates of application so that less material would be required to achieve complete weed control.

A second doctoral student, Bryan Unruh, presently is conducting studies to determine the mode of action of these materials at the cellular level. This work potentially could lead to the discovery or development of similar compounds of use for weed control.

The active component may be useful in its pure form for weed control in cropping systems for which the corn gluten meal is cost-prohibitive. Research by Dr. Jack Dekker of lowa State University's agronomy department has shown that corn gluten meal is active against many important agronomic weeds of significance in corn production. He also has shown that some corn hybrids are susceptible to its effects whereas others are tolerant. When the active component is available in larger amounts, corn hybrids should be identified on which it can be safely tested.

Strawberries, along with other fruit and vegetable crops, present a more immediate opportunity for the use of corn gluten meal in its natural form. These crops have a much higher value and could provide a practical market for corn gluten meal when proper timing and appropriate application methods have been established. Two years of work on strawberries has been conducted in the greenhouse, and field work on this and other crops was planned for the l993 season.

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The idea of using corn gluten meal as a natural weed control has gained a great deal of attention in the United States and other countries. Presently there is much interest among environmental groups in restricting pesticide use, particularly in urban environments where large quantities of these materials are used on lawns and gardens. Because of this, a ready market should be there when the material becomes available for sale. The present goal is to have corn gluten meal ready for the turf market in the early months of 1994.