BIOTECHNOLOGY CROP RESEARCH UPDATE

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Thank you for this opportunity to speak today. I want to tell you about the status of crop research in biotechnology. First, I will talk briefly about the applications of biotechnology to agriculture, then I will turn to a brief description of two projects at Agracetus which illustrate the kinds of improvements biotechnology will bring to agriculture. The first of these is our work in insect resistance; the second is fiber quality. For you in the cranberry business, I am afraid I will have to ask your indulgence as most of our work is directed at major feed crops. We do see applications of this work that will eventually benefit cranberry production, but you will have to be patient.

Agracetus is a small plant research company located in Middleton, Wisconsin with a staff of about 70. Founded in 1981, we have recently become a wholly-owned subsidiary of W.R. Grace & Co. Our research focuses on plant genetic engineering using techniques of recombinant DNA. Corn, soybean and cotton are our major target crops. Our projects also include a research effort to develop new microbial biopesticides that will reduce the need for chemical fungicides now relied upon for plant disease control.

Applications of biotechnology to agriculture fall into two broad categories--products that will be of direct interest to the grower and products that will be of interest to the processing industry that purchases the agricultural commodity. Grower applications include seed for improved crop traits such as insect resistance, disease resistance, herbicide resistance and improved tolerance to stress. Processor traits include improved oil or protein quality, and improved processing efficiency. Biotechnology will also make possible new products derived from plant sources that were not possible before.

Insect resistance

As an example of an improved agronomic trait of interest to growers, let us consider current research toward development of plants that carry their own built-in resistance to insect attack. Some plants have a natural resistance to certain insect predators. However, for most crops of economic importance, nature was not so generous with similar resistance. Corn and cotton account for the major use of insecticides in the U.S. today; thus they are attractive initial targets. Cotton along accounts for about $200 million per year in chemical insecticide sales. About half of this use is to control the pests known as the tobacco budworm and the cotton bollworm. These pests are from the insect order called Lepidoptera. These are commonly referred to as caterpillars and they are the larval form of moths and butterflies. In the larval form, these insects are responsible for extensive damage to agricultural and forestry production. Gypsy moth, corn borer, armyworm and tent caterpillar are a few of the common names associated with this class of pest. The fruitworm of cranberry is a lepidopteran pest.

Scientists have identified and isolated a gene for a toxin protein active only against this order of insects and inserted that gene into plants such as cotton, tobacco and tomato. Genes are the fundamental building blocks of cell function. Each gene carries instructions for production of a particular protein within the cell. In total, the genes prescribe the master plan for the creation of necessary cellular metabolism. This particular insect protein gene was taken from a common soil bacterium called *Bacillus thuringiensis* or B. t. for short. B. t. is a bacterial predator of caterpillars. This toxin gene has been found to be the active protein that enables the B. t., once ingested by the caterpillar, to poison the gut of the insect. This bacterium has been used for more than two decades as a bacterial pesticide to control a variety of caterpillar pests. Its safety is well studied. Indeed, it has a reputation as among the safest insecticidal materials available because of its natural origins and its high selectivity to target pests. As a biological product, it rapidly breaks down in sunlight and leaves no residues. The problem with B. t. for growers is that the very factors that make it safe also limit its effectiveness as an insecticide - it's difficult to get it to the right place at the right time. As a result, B. t. has never taken more than a 1% share of the U.S. insecticide market.

With biotechnology, we expect that to change. By taking the gene responsible for the insecticidal activity of B. t. and transferring it to the plant, scientists have put the active ingredient precisely where it is most needed when the plant needs it. Seed products are still in development, but preliminary field results are promising. Most companies expect the first such insect resistant seed products to reach the market by about 1995.

At Agracetus we have been working with Dr. Brent McCown, a tissue culture expert at the University of Wisconsin, and we have successfully inserted a highly active form of the B. t. gene into cranberry. During 1990, we will be evaluating the degree to which the gene produces this protein toxin in the cranberry plants regenerated from these experiments. If insecticidal activity can be measured in the laboratory, we will proceed with field testing. Details of exactly how effective this new cranberry variety could be in eliminating use of some chemical insecticides in the field are not yet known. I hope to have a favorable follow-up report for you in another year or two.

Fiber Quality

Admittedly, cotton is not very relevant to cranberry production. However, we all wear cotton fabrics and we have in common an interest in strong lightweight breathable cottons that, depending on the time of year, will keep us cool or keep us warm. I want to tell you about our work in cotton fiber quality because it illustrates an approach to how we might use biotechnology to solve more complex crop improvement problems. Fiber quality is a complex multigenic trait. Unlike the insect resistance research described above, improving fiber will not be so simple as adding a single gene and getting stronger, longer or finer fiber. A major problem has been even finding a place to start since no one has previously identified genes known to be related to fiber production.

At Agracetus, we are working to improve the quality of the fiber produced by the cotton plant so as to optimize the efficiency and quality of the yarn spinning process. This means basically finding genes that make the fiber longer, stronger and finer. Modern textile spinning is dependent on a complex set of requirements that must all be in balance in order to spin strong high quality yarns at an economical cost. Thus, this is a trait of primary interest to the textile industry rather than the grower (although the grower certainly aims to produce a fiber product that meets his customer's needs). Foreign competition and improved machinery are forcing textile mills to optimize the highest quality yarns from the raw cotton fiber and do this at the lowest cost.

We have identified several genes from different types of cotton that we believe to be associated with the fiber development process. In all, we have nearly

20 such genes. To do this, we have pioneered a method of analysis based on isolation of the cotton messenger RNA. This is the intermediate carrier material that takes the information from a gene and directs the machinery of the plant cell to produce a specific protein product. We have exhaustively analyzed this messenger RNA from cotton at different times in the cotton's life cycle and in different varieties of cotton that have widely different fiber traits. Based on an analysis of the differences, we have narrowed the search considerably for genes associated with this complex trait. The 20 such genes we have obtained are ready to be inserted into cotton to evaluate the changes in fiber. We can not be certain we will have a useful result, but we are very encouraged with the prospects for this work.

We believe this method is important because it is likely to be transferable to finding genes associated with other multigene traits such as oil quality, protein quality or processing traits that improve food shelf-life or control costs.

Conclusion

Biotechnology is an almost overworked word in some circles. No doubt you have been hearing for years that it has been coming and that it will change everything in mysterious ways. Well, the fact is it is coming and it will have a major impact. But it is not happening so fast that you won't be able to keep up with it. The research I have described in insect resistance and fiber quality are but two examples of how scientists are taking our expanded understanding of cellular biology and genetics and applying it to new opportunities in agricultural production. I encourage you to keep your ears open to learn as much as you can about this technology in the coming years. As you learn more, your understanding will greatly increase and the mystery will be replaced by confidence and optimistic curiosity.