Breeding canola for success

Traditional plant-breeding companies and biotechnology firms in the U.S. and Canada are scurrying to find a foothold in the nascent U.S. canola industry. Executives at these companies are so confident that canola will succeed that they've invested in breeding programs to develop varieties suited specifically to the U.S. One company—Calgene Inc. of Davis, California—has gone so far as to say that all of its canola development efforts are targeted to U.S. growing conditions.

A look at import figures for canola oil is enough to encourage companies, according to Andrew Baum, Calgene's vice president of operations, who noted that in the coming year, the U.S. will import the equivalent of 350,000 acres' worth of canola and that figure could increase rapidly in the coming years. Canola is market-driven at this time, especially as more food companies evaluate the oil, Baum said.

Hopes for canola's success are based on scientific reasons as well as marketing ones, according to researchers. They say rapeseed is an easy crop to manipulate and is one from which commercial hybrids could readily be developed.

Hybrids are the result of crossing two unrelated breeding lines. These crosses generally result in offspring that are more productive than their parents. Companies are particularly interested in rapeseed hybrids because, at least in theory, they could yield up to 40% more seed than the open-pollinated varieties now grown commercially.

"Yield increases will occur faster in rapeseed than in soybeans because we will be able to exploit hybrid vigor in rapeseed in this century and not be able to do so with soybeans," according to Wallace Beversdorf, a crop scientist based at the University of Guelph. Beversdorf, who formerly worked at Allelix Inc., a Canadian biotechnology company, explained that initial success with increased rapeseed yields would self-perpetuate. Companies would put more research dollars into canola in the same way developers of hybrid corn reinvested in their crop, he added.

Although a number of companies are running field trials on hybrids, there are no hybrids commerically available in the U.S. and Canada. However, Pacific Seed, a division of the Continental Grain Co., marketed hybrid varieties in Australia this year. Beversdorf believes spring-type hybrids will be available in North America by 1990, but winter hybrids will be delayed until 1993 or 1994.

ContiSeed's General Manager David Holman said his company's first hybrid variety, CS002, is a spring-type and should be available for sale in North Dakota in 1989. This year, ContiSeed contracted nearly 1,000 acres of CS002 in Canada and the U.S. to evaluate the crop's performance under field conditions. Because the seed is still undergoing registration trials in Canada, the company had to obtain permission from Agriculture Canada before it could contract for the crop in the prairie provinces. ContiSeed had five other spring hybrids under government testing this year.

Allelix, meanwhile, had 16 spring hybrids and five winter hybrids in licensing trials in 1987. "If results pan out, we'll have small amounts of hybrids available for commercial test markets in 1989," Ian Grant, Allelix's manager of seed products, said. Like ContiSeed, Allelix is field-testing its hybrids in North Dakota and Minnesota. It also has conducted tests in Idaho, Washington, Texas, Kansas, Colorado, Georgia and Florida.

Grant cited two reasons for testing in the U.S. First, if the company finds hybrids suitable for the U.S., it could introduce them quickly instead of waiting for them to be accepted in Canada. (Before a variety can be sold commercially in Canada, it must go through three years of testing under the watchful

eyes of Agriculture Canada.) "The barrier to a variety's entrance into the market is much lower in the U.S. than in Canada," he said. The second reason has to do with regionalization—the only way to find out which hybrids are suited to particular areas is to test them.

The introduction of hybrids will allow companies to tailor-make varieties suitable for specific regions of the U.S., industry representatives said. "Moving from the northern U.S. to the southern U.S., there are three distinct belts for which we could develop varieties," Holman said. In the northern belt, spring types similar to those suited to Canada would thrive best. These would be planted in the spring and harvested in late fall. In the central belt, winter types, sown in the fall and harvested the following summer, would work. The southern-most parts of the U.S. need a spring type that could be seeded in early winter and harvested early enough to allow another crop to planted the following spring. Although spring types will be available first, winter varieties would eventually dominate due to U.S. climatic conditions, Holman said.

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Although successful hybrids are the ultimate goal, companies have not abandoned work with open-pollinated varieties. Robert C. Jorgensen, director of product development at DNA Plant Technology Corp. (DNAP), said DNAP will test an open-pollinated, high-oleic spring variety in 1989. Calgene hopes to have a high-yielding, open-pollinated winter variety available commercially in two to three years, Baum said. Meanwhile, Sigco Research Inc., a research arm of Lubrizol, has begun a breeding program and is concentrating on open-pollinated varieties, according to Jennifer Mitchell Fetch, the company's plant breeder.

As companies attempt to make scientific and commercial inroads in the U.S. market, research efforts continue in Canada's public breeding sector. Canadian public sector researchers are concentrating on breeding resistance to sclerotinia and blackleg, reducing chlorophyll levels in seed and developing cultivars which are low in linolenic acid, Agriculture Canada's Keith Downey said. Work also is being done to develop cultivars with more than 30% linoleic acid and others with higher oleic acid levels.

Most recently, work has begun on *Brassica juncea*, an oilseed species common in India, Bangladesh and Pakistan. Although the species is not of canola quality, work is being done to make it so, Downey said. Researchers are interested in it because it is drought-resistant and high-yielding under a wide range of conditions; it also has better resistance to blackleg, a fungal disease that is spreading in parts of Canada. *B. juncea* has yellow seeds which means the seed coat is thinner. A thinner seed coat means less fiber and a higher proportion of oil and protein-rich embryo, Downey said.

Agriculture Canada researchers also want to alter canola characteristics by transformation, the process of introducing foreign genetic material into the genome of a target organism. "Canola, together with all the *Brassica* oilseed crops, is one of the few economic crop plants that responds to all the biotechnology techniques," Downey said.

Canola's oil profile and resistance to herbicides and insects could be enhanced through transformation, according to Downey, who pointed out that genes which impart resistance to several herbicides already have been transferred into canola.

Agriculture Canada is working with Monsanto Co. to develop canola which is tolerant to glyphosate, the active ingredient in the herbicide Roundup. Monsanto transformed spring varieties developed by researchers at Agriculture Canada in Saskatoon and by scientists at the Alberta Wheat Pool and began field testing them in Canada this year. "Now researchers need to determine whether the presence of foreign genes will extract a cost from the plants, thus making them less productive," Downey said.

There are no canola varieties that are naturally tolerant to Roundup, according to Paul F. Johanson, Monsanto's director of plant sciences, but he said the company wants to develop varieties with Roundup tolerance. "We're evaluating whether the new gene will express well enough in canola to confer Roundup tolerance," he added. "We don't expect this year's tolerance level to be at commercial levels, but this is the first major test in canola, and it should tell us a lot."

Using *Agrobacterium tumefaciens* as the vector, Monsanto researchers introduced the EPSP synthase gene from another plant species into canola. EPSP synthase produces an enzyme necessary in the biosynthesis of aromatic amino acids. Under normal conditions, Roundup herbicide binds to the enzyme and shuts down the biosynthetic pathway, causing the plant to die. By introducing the EPSP synthase gene with proper plant gene promoters, Monsanto scientists believe the gene will cause the plant to produce enough EPSP synthase to supplement that which already is produced by canola. Herbicide tolerance is conferred by overproducing EPSP synthase, Johanson explained.

Johanson cautioned that Monsanto's work is still in the research phase, but said if it proves successful, seed could be available for the 1994 crop. "When commercial glyphosate tolerance is developed, a large portion of the Canadian canola acreage could be available for weed control with Roundup," Johanson said. "The market opportunity is large enough to make the research viable."

—Gillis