The Status of hybrid systems and biotechnology applications in Canada

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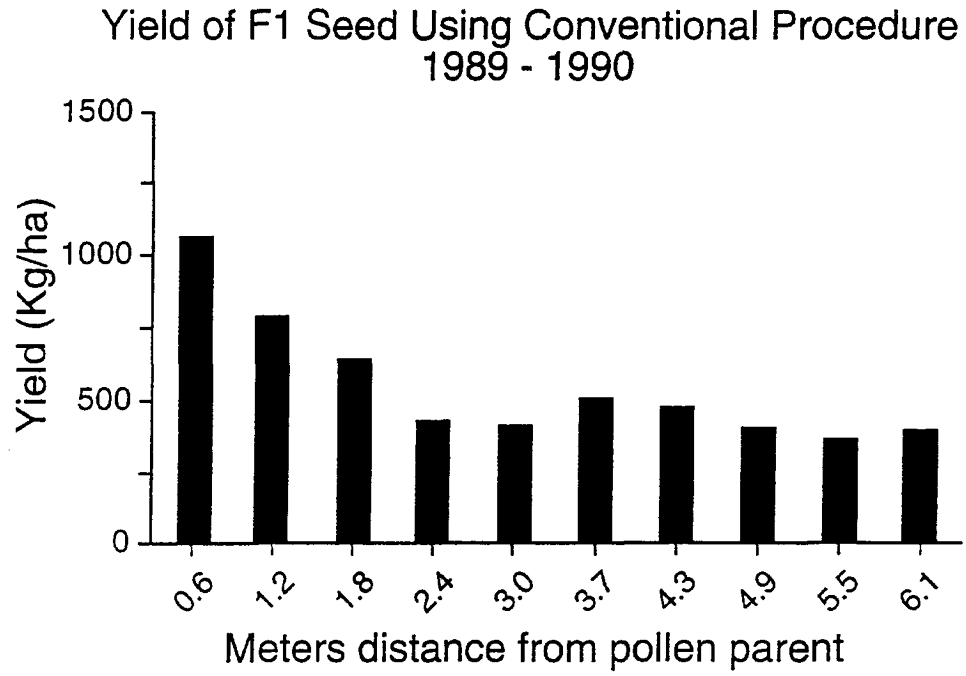
Canadian plantings of canola will likely set a new record in 1993, with an expected 3.7 million ha (9.3 million ac.) to be sown. Due to the wet, cold fall of 1992, many producers will plant *Brassica rapa* to ensure they obtain top grades for their production and avoid the heavy discounts applied to seed with high cholorophyll content.

A number of spring, *B. napus* hybrid varieties have been registered in Canada and are in commercial use. Some, those from ICI Seeds, are based on the Polima cms system, and others, from King Agro, are based on self incompatability alleles or SI hybrids. To date, none of the hybrids have captured a significant market share. Part of the reason has been the high price of the hybrid seed and the uncertainty that the hybrid variety can consistently deliver sufficient yield advantage to interest the average grower, due in large part to the extreme variability and stress frequently encountered in the continental climate of western Canada. There is also competition from new, high yielding, open pollinated varieties that have narrowed the yield advantage of the hybrids. It is also believed that both the pol cms and the SI hybrids presently in production have not been able to deliver the full level of heterosis that might have been expected from crosses of the same parentage but without the pollen control system. Using the patented SI system of King Agro, half the plants in the commercial production field are self incompatable. We have observed that such plants tend to produce fewer seeds per pod under western Canadian conditions. In the Polima system we have found that the pol cytoplasm can reduce the hybrid's performance unless a great deal of effort is expended to find maintainer and restorer genotypes that are compatable with the cms cytoplasm. One such line is ACS-H2, from the Saskatoon Research Station, which, although Polima cms based, has been the highest yielding entry in official trials for the past two years.

Another problem which hybrids face in western Canada is that seed yields in the hybrid seed producing field have been much below that expected from a wind and insect pollinated crop. Seed yields drop rapidly as the distance between the male and female rows increase (Fig. 1). This is particularly true in cms hybrids where honey bees tend to avoid male sterile flowers or "steal" their nectar without pollinating the stigma. One of the proposed solutions to this constraint is to mix 10 to 15% of a strong male parent with the male sterile A line seed and sow and harvest the male and female lines together for commercial sale of hybrid seed. Data to date from the experiments of Dr. Hutcheson from the Saskatoon Research Station and Dr. McVetty from the University of Manitoba have shown that the performance of the hybrid is little affected by the presence of 15 to 20% or even more of the male parent when mixed in and sown with the hybrid. Indeed, in official trials, the mixed hybrid with a 20:80 mix of male and hybrid seed respectively yielded 94.5 and 98.1% of the pure hybrid, based on 10 and 15 station years of data gathered in 1991 and 1992, respectively. This system of hybrid seed production is being commercially pursued this crop year.

Fig. 1



In the last two years, the level of hybridity in these mixed hybrids has been above 75%. Of course, a strong restorer line is a prerequisite for the success of such a system. It should also be noted that the vigor of the hybrid plants reduces the proportion of restorer line plants that survive in the commercial field.

The mixing procedure being introduced in Canada is significantly different from that proposed by some European breeders. The mixing system that had been put forward in Europe involves overcoming problems with male fertility restoration in the hybrid by adding 15 to 20% of pollen donor plants to the hybrid seed, which will be sold to the commercial producer. Canadian breeders have not investigated this type of mixing, mainly because they foresee problems in obtaining sufficient pollen movement in western Canada to pollinate all the flowers of the male sterile hybrid.

Given some of the problems still facing the hybrid system in rapeseed and canola, research is still underway to develop other cms hybrid systems. However, none as yet have surfaced as completed systems.

In the biotechnology area, doubled haploid production systems are being used in *B. napus* by several breeding organizations. Recently a consortium of seed companies and research institutions have funded a research program designed to produce, in commercial quantities, doubled haploids of *B. rapa*. Dr. Keller, the program leader at the Plant Biotechnology Institute in Saskatoon, has indicated

very positive results with certain breeding lines. These doubled haploids could be used directly as parents for *B. rapa* hybrids. However, Dr. Kevin Falk in his Ph.D. thesis at the Research Station in Saskatoon, demonstrated that in *B. rapa* synthetic varieties could rival the performance of hand-crossed varietal hybrids. He applied this principle to his *B. rapa* breeding program at ICI Seeds, resulting in some outstanding entries in the 1992 *B. rapa* official trials. Thus, hybrid *B. rapa* may have a difficult time displacing synthetics as a breeding strategy for this species.

Transgenic *B. napus* strains that contain herbicide tolerance genes for glyphosate (Roundup) or glufosinate ammonium (Basta or Ignite or Harvest) are now in their second year of official trials, and could be commercialized as early as 1995. However, there are still numerous regulatory hurdles to be overcome before full-scale production of this material can go forward.

Some other developments in western Canada that are unrelated to hybrids and biotechnology are of sufficient importance to be reported here. Dr. Rakow and his student, Abdul Rashid (Rashid and Rakow 1993) have succeeded in producing an agronomically vigorous pure yellow seeded *B. napus* strain by combining the genes for yellow seed from *B. juncea* and from *B. carinata* into a vigorous and fertile resynthesized *B. napus* plant. Yellow seeded strains of *B. juncea* and *B. carinata* were each crossed and backcrossed to a black seeded variety of *B. napus*. The backcrossed progeny were then selfed and the two interspecific strains intercrossed. Selfing the F1's of the double interspecific cross produced F2

progeny with seed that was either black, yellow brown or yellow in color (Fig. 2). A total of 91 yellow seeded plants were recovered from the total F2 population of 4,858. The number of yellow seeded plants that segregated in 6 of the 20 F2 families studied, closely approximated a 1:15 ratio, which supports a two-gene model and the hypothesis that one yellow seeded gene from the A genome in *B. juncea* and another yellow gene from the C genome of *B. carinata* have been integrated into the A and C genomes of *B. napus*. This *B. napus* material provides a new source of yellow seededness and should result in yellow seeded *B. napus* varieties within a few years.

The Saskatoon Research Station has also been working to further reduce the total glucosinolate content (alkenyl and indolyl) in canola seed. Feeding studies conducted by Dr. Bell at the University of Saskatchewan with some of the advanced material has supported the need for a further reduction of these anti-nutritional compounds.

There are many other areas that we might discuss, including canola or double low *B. juncea* and *Sinapis alba*, new transgenic modifications and disease resistance, but due to the shortage of time we will have to leave these for the next Congress.