Sinapis alba: A New Oilseed Crop For The Prairies

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Why oilseed *Sinapis alba*

Market demand for edible oilseeds is increasing steadily. For Saskatchewan and Canada to participate in this growing market, canola production must increase. The presently grown canola species *Brassica napus* and *B. rapa* will not be able to meet anticipated increased future demand. These species require low temperatures and evaporation rates for optimum growth and high productivity. Their area of production is restricted to the cooler, less drought stressed areas of the prairies. A possible solution to these production constraints is the development of canola-quality oilseed yellow mustard *(Sinapis alba).*

Yellow mustard, which is grown as a condiment crop on the western Canadian prairies, has many advantages over canola. It is more heat and drought tolerant than canola and can therefore be grown on the dry prairies, south of the so-called "canola belt". Yellow mustard also has several important agronomic advantages including larger seed size, short stature, resistance to shattering and moderate to excellent resistance to a number of serious canola diseases including blackleg *(Leptosphaeria maculans), Alternaria* black spot, *Rhizoctonia solani* pre-emergence damping-off and post-emergence seedling root rot, and white rust *(Albugo candida).* Yellow mustard is resistant to flea beetles *(Phyllotreta cruciferae)* and exhibits good tolerance to diamondback moth *(Plutella xylostella)* and root maggot *(Delia* spp.). This tolerance to insect attack reduces or eliminates the need for insecticides against these pests. The development of canola-quality yellow mustard will provide growers in the southern prairies with an alternative to cereal production and will benefit the canola industry as a whole by increasing and stabilizing the supply of canola for international and domestic markets.

Canola-quality S. *alba* will have significant value as a high protein supplement. The international market for animal feed rations is valued at $2.7 billion, of which oilseed meal is approximately 13%. This market is expected to grow as animal protein consumption continues to increase around the world. Much of the local protein supplement requirement is met with imported soybean meal due to a shortage of locally produced product. In 1998, 21,000 tonnes of soybean meal was imported into Canada, valued at $10 million. *Sinapis alba* also has potential to supplant soybean as a high protein supplement for human consumption. It can have versatile applications in human diets as a protein additive in prepared meats, dairy products, sauces, pastes, soups and possibly as new vegetable protein products. Non-food industrial applications are also possible. This research will reduce the need to import soybean meal supplement and allow Canada to capture a larger share of the international market for high quality protein supplements. It is also an opportunity for market and crop diversification.

The objectives of this project are to develop a) high yielding canola-quality strains of *S. alba* and b) high yielding, high protein content, canola-quality strains of S. *alba* as a source of high quality animal feed and possibly for human consumption.

Germplasm evaluation

Germplasm evaluation and development is an important activity, particularly for a new breeding program. One hundred and thirty-five accessions of S. *alba* were evaluated for agronomic performance and seed quality in 1997 and 1998. Analysis of the field (1997 and 1998) and laboratory (1997) data indicates that most accessions exhibited agronomic traits similar to the check varieties AC Base and Viscount, averaging 39 days to flowering (DTF), 79 days to maturity (DTM) and a mature stand height of 138 cm. Most germplasm accessions were more vegetative in growth habit than AC Base. There were some notable variants for these agronomic traits. Three lines were earlier (33-35 DTF, 74 DTM) and shorter (<120 cm) than the rest of the lines in the trial; these lines were also very uniform. A very late maturing line (50 DTF, 102 DTM) was also identified. This line was also short, uniform and had a distinct morphotype with relatively little vegetative growth. Protein content was on average comparable to adapted condiment mustards (34%, whole seed basis), but four accessions with higher protein contents (38-40%) were identified from the 1997 trial. Oil content in these accessions was on average lower (25.6%) than in adapted condiment mustard cultivars (26.6%). Useful variations among the germplasm accessions will enable expansion of the germplasm base and provide a source for traits of interest such as high protein. Variability for high oil content was absent in this material. Genetic diversity among accessions may allow us to identify sources of heterosis for seed yield and quality parameters.

High oil content canola-quality germplasm

High oil content canola-quality S. *alba* was developed by introgressing genes from three germplasm pools into one population: i) a low erucic acid line (BHL-926) developed at the Saskatoon Research Centre by Drs. D. Woods and K. Downey in the 1970s; ii) a low glucosinolate line developed in Poland (Krzymanski et *al.* 1991); and iii) a high oil content (36-38%) line developed in Sweden (Olsson 1974). Canola-quality strains of S. *alba* have been developed containing no erucic acid, no hydroxybenzyl and no benzyl glucosinolates. The fatty acid profile of these strains is excellent with potential to develop strains with very high oleic acid (80%) and very low linolenic acid (4%) content. Crossing canola-quality lines to the Swedish high oil content parent resulted in an increased oil content of 3%, which is still 4-5% lower than the high oil parent (38%). There is potential to further increase oil content utilising the Swedish high oil line.

High protein content germplasm

The second project objective requires the development of populations with high protein content. Adapted condiment mustard lines are a valuable resource for this breeding program. Selection for increased protein content was made from elite Saskatoon Research Centre condiment yellow mustard lines. In the second cycle of recurrent selection for increased protein, 1092 lines were evaluated in 1997 for agronomic performance and seed quality. Twenty-six lines with high protein content (>38%, whole seed basis) were selected. The average meal protein content of the selected lines was 52.7%, which was higher than the protein content in the check cultivar AC Pennant (47.9%). A crossing block consisting of 2600 plants (100 plants from each of the selected high protein content lines) was established in the field in 1998 to initiate a third cycle of recurrent selection for increasing seed protein. In addition, a replicated field trial was conducted in 1998 to determine agronomic and seed quality characteristics of the 26 advanced high protein breeding lines. The agronomic rating of the lines

was good to excellent, with height (135 cm), days to flowering (38) and days to maturity (79) similar to AC Base. Attaining the goals for high protein content will be readily accomplished through recurrent selection. Introgression of canola-quality traits into high protein lines has been initiated.

Summary

Canola-quality strains of S. *alba* have been developed that have no erucic acid and no hydroxybenzyl or benzyl glucosinolates. The fatty acid profile is excellent with potential for high oleic acid and low linolenic acid content. The oil content has been increased from 29-33% by crossing with a high oil content strain from Sweden. Protein content has been increased from 48-52% (meal basis) in selected high protein lines by recurrent selection in condiment mustard breeding lines. The immediate breeding challenges include introgressing canola-quality traits into a good agronomic background with high seed yield and high oil or protein content.

References

Krzymanski J., T. Ratjska, I. Byczanska and K. Krotka. 1991. Development of Low Glucosinolate White Mustard *(Sinapis alba* syn. *Brassica hirta).* Proc. 8'h Int. Rapeseed Cong., Saskatoon, Canada. 5: 1545-1548.

Olsson, G. 1974. Continuous Selection for Number of Seeds per Pod and Oil Content in White Mustard. Heriditas 77: 197-204.

Raney P., G. Rakow, and T. Olson. 1995. Development of Low Erucic, Low Glucosinolate *Sinapis alba.* Proc. gth Int. Rapeseed Cong., Cambridge, UK. Vol2: 416-418.

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