RAPESEED BREEDING AT THE UNIVERSITY OF IDAHO

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ABSTRACT

The University of Idaho has been involved in breeding rapeseed cultivars suitable for the Pacific Northwest, and other regions of the United States, for over fourteen years. The group develop both fall- and spring-planted high erucic acid and canola cultivars. During this time a vast amount of germplasm and expertise has been collected by those who have worked in the breeding group. Separate breeding efforts are carried out in developing oilseed cultivars from *Brassica napus*, *B. campestris*, *B. juncea* and *Sinapis alba*. Recent achievements in the breeding group include: (1) developing lines with extreme winter-hardiness in the juvenile stage to allow for later fall planting; (2) Developing *S. alba* (yellow mustard) lines with less than 15 μm of total glucosinolate per gram of defatted meal; (3) developing *S. alba* lines with less than 1% or more than 60% erucic acid; (4) re-synthesizing *B. napus* with increased oleic acid content and (5) developing fertile hybrids between *S. alba* x *B. napus*.

INTRODUCTION

The University of Idaho (UI) has been involved in breeding spring and winter rapeseed cultivars for the last 14 years. Over this period a number of cultivars have been developed for production in the Pacific Northwest (PNW) and other regions of the United States.

There are very few crops suitable for dry-land production in the PNW region. The main crops are small grain cereals (wheat and barley). Over time there has been a tremendous build up of disease in cereal crops caused by monoculture. For this reason, the breeding group began investigating alternate crops for the region in 1978, and found a tremendous seed yield advantage in winter rapeseed. In addition it was found that inclusion of rapeseed into a cereal crop rotation had benefits in subsequent cereal crop yield. Breeding efforts intensified after 1985, with the ruling of the Food and Drug Administration that granted "Generally Recognized as Safe" (GRAS) status to canola so that genotypes low in erucic acid could be used for edible consumption.

The overall objective of the breeding group is to develop well adapted and high yielding *Brassica* cultivars suitable for edible or industrial oil production. The group is presently developing oilseed cultivars from four species (*Brassica napus*, *B. campestris*, *B. juncea* and *Sinapis alba*) to extend the area of oilseed *Brassica* production and provide the farming community with more options. Greatest breeding efforts are, however, directed in developing cultivars from winter and spring *B. napus* and *S. alba*.

BREEDING METHODOLOGY

A modified bulk\pedigree breeding scheme is used by the breeding team to advance selections in the *B. napus* and *B. juncea* programs. F_1 seeds are obtained by artificial hand pollination between selected parental lines in the greenhouse each year. Approximately 1000 cross combinations are made each year. F_1 populations are increased to F_2 bulk seed lots in randomized and replicated greenhouse genetic evaluation trials. This operation also provides larger quantities of seed for field planting.

Cultivar development in *S. alba* and *B. campestris* mainly utilizes open pollinated bulk populations, mass selection and recurrent phenotypic selection. Attempts have been made to examine the feasibility of developing synthetic cultivars from these species.

Field testing is a major part of the varietal development scheme. Randomized plot trials are carried out at a number of different locations throughout the PNW. These evaluation tests compare potential new breeding lines alongside commercial cultivars. The breeding scheme currently evaluates approximately 25 acres of research plots each year. The most promising lines are on-farm tested using larger scale trials and agromony trials to maximize the genetic potential. Meticulous testing and selection is carried out on later generations to ensure uniform breeders' seed. This is then used to plant foundation seed.

DEVELOPING *BRASSICA NAPUS* CULTIVARS

Traditionally rapeseed in the PNW region has been planted on summer fallow ground. Although the practice of summer fallow has declined in recent years, it is still a necessity in many USA Northwest dry-land regions. In addition, many farmers like to set aside small areas of summer fallow to help suppress weeds and disease in following crops. Therefore, the breeding group are still heavily involved in developing winter *B. napus* cultivars suitable for August/July planting on summer fallow ground.

To increase the potential acreage and provide the farmer with greater flexibility and choices, a spring rapeseed breeding program was initiated in 1991 and the first regional trials of our lines will be carried out in 1995.

A third type of cultivar development involves producing winter types which could be planted on recrop ground. These cultivars would be planted later in the fall but without the use of summer fallow. Until recently most growers and researchers considered re-cropping with winter rapeseed unfeasible because of problems associated with planting on recrop ground. The first is low moisture, due to water depletion from the previous crop. Secondly, the farmer must plant late in the season, generally mid- to late-September, after suitable fall rains. Thirdly, genotypes must be very winter hardy at a small stage of plant growth. Studies have been conducted in the last few years to address these problems.

In 1993, a large number of germplasm lines, were screened for cold tolerance at a small stage of growth. The best lines were retested in 1994 in a early and late planting study. The aim of this study was to identify lines which could be planted later

in the fall, from mid to late September, and yet establish sufficiently to survive the winter. Therefore, successful selections will require rapid emergence and early establishment in order to be competitive with weed populations and to survive winter climatic conditions. Initial results from these trials have showed that there are indeed potential genotypes that can survive the winter at a small stage of growth.

Additional experiments were conducted on these germplasm lines along with advanced breeding selections, to evaluate early planting on summer fallow compared to late planting on recrop. This would address the feasibility of planting on recrop, where moisture is limited. Half the lines tested on recrop land failed to produce any yield. However, there were a few selections which did produce yields exceeding 1,800 kg/ha.

DEVELOPING *SINAPIS ALBA* CULTIVARS

The breeding group have been interested in developing yellow mustard cultivars for several years. This species has been traditionally grown as a condiment crop, and the UI has developed a number of condiment cultivars. *S. alba* has several advantages when grown in the PNW region: (1) high seed yield; (2) resistance or tolerance to all insect pests; (3) very competitive with weeds; (4) disease resistance; (5) drought and heat tolerant and (6) shatter resistance. However, this species has several deficiencies if it is to be considered as an oilseed crop. Oil content is only around 20-25% of seed yield compared to over 40% in *B. napus*. In addition, the oil quality is intermediate (*i.e.,* neither edible or high erucic) and glucosinolate content in residual meal is too high to consider the meal as animal feed. Over the past three years the breeding group have addressed these deficiencies and have developed breeding lines with greater than 35% oil content, less than 1% erucic acid content, greater than 60% erucic acid content and less than 15 μm of total glucosinolate per gram of defatted meal. Within the next few years it is hoped that we can combine these genotypes to develop an edible oil and/or an industrial oil *S. alba* cultivar.

INTERSPECIFIC AND INTERGENERIC HYBRIDIZATION

Researchers have conclusively shown that *S. alba* has many desirable agronomic traits which would be beneficial if transferred to canola (*Brassica napus* or *Brassica campestris*). *S. alba* is resistant, or tolerant, to all the major insect pests of *Brassica* crops in the PNW region. It is also tolerant of high temperatures, drought conditions, is shatter resistant and is a high yielding crop. However, *S. alba* is considerably lower in oil content and lacks the high oil quality and seed meal quality of canola. Mature plants were produced and hybrid seed harvested from the cross combinations *S. alba* x *B. napus* using embryo rescue techniques. This new species could have tremendous potential for combining the excellent oil and glucosinolate qualities of *B. napus* with the agronomic characters of *S. alba.*

Interspecific hybridization between selected *B. campestris* and *B. oleracea* germplasm has been used to re-synthesis *B. napus* with unique oil types. Specific emphasis has been directed to reducing linolenic acid and increasing oleic acid.