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Domestication of New Overwintering Oil Crops

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Introduction

There has been a search for crops with new oil qualities to supply the food, fuel and chemotechnical industries (Appelqvist, 1971 ; Princen, 1983 ; Hondelmann & Dambroth, 1987). Much is also expected from the gene technology as a tool for «tailoring» of new oil qualities (Stymne, 1995).

In a cooperative program at SLU, the four departments of Agricultural Engineering, Crop Production Science, Food Science and Plant Breeding Research, aim at introducing new oil crops to agriculture not by contributing new specialized oil qualities, but by a crop better adapted to modern agriculture in Scandinavia regarding winter hardiness, nitrogen uptake during autumn, winter and spring, low-input cultivation, etc. Preliminary studies have found three species of genera *Barbarea* and *Lepidium* suitable for domestication (Merker & Nilsson, 1995). These species are represented in the Scandinavian flora and show excellent adaptation to the Scandinavian climate. The species are *Barbarea verna, Barbarea vulgaris* and *Lepidium campestre*.

Breeding Strategy

The traditional oil crops of today, *Brassica napus* and *Brassica campestris*, originate from more southern latitutdes. They have, to some extent, been adapted to our northern climate by breeding. In this program, we proceed from species that are already winterhardy and occur in the intended area of cultivation. Instead of adapting oil crops to climate we adapt new species to agriculture - i.e domestication. This approach is believed by us to be much easier, since climatic adaptation is a very complex trait, while agronomic traits of a crop usually show monogenic inheritance, as in the case of the *Lupinus* (Gustafsson & Gadd, 1965). The improved winter hardiness compared to the *Brassicas* enables safe cultivation even in Central Sweden, and will make the new crops a powerful complement to the *Brassicas*. In field trials *Barbarea vulgaris* and *Lepidium campestre* showed 100 per cent winter survival (Merker & Nilsson, 1995), while *Barbarea verna* varied between 0 and 80 per cent.

Most of the genetic variation necessary to succeed in an undertaking of this magnitude, has been discovered in natural populations. The single most important character is shattering resistance. Variation for this trait has been isolated and is awaiting further genetic and agronomic studies.

Cropping Systems and Yield

Our ambition is to find an effective cultivation technique suitable for a sustainable agricultural system. The new species are being undersown in the spring, under for instance barley, and harvested the next cropping season. With such a cropping system we keep the acreage green during the winter avoiding leakage of plant nutrition (MacDonald et al., 1989 ; Jensen, 1991). We also gain two harvests, the barley and the oilseed, at one initial cost.

The species still have the wild characteristics of small seeds and seed dormancy. Thus, sowing must be carried out with extra care. The seed dormancy is very pronounced in most accessions of *Barbarea vulgaris* and *Lepidium campestre* (Merker & Nilsson, 1995), and fractionating of seeds has been used to investigate germination and dormancy. After the species have been established with different plant densities, the plant stands are submitted to different plant nutrition strategies. The structure and development of the plant stands are being studied.

The most important yield parameters are the density per square meter, the number of fruits per plant and 1,000 seed weight (g). From field trials (Merker & Nilsson, 1995), we found the 1,000 seed weight to be approximately 0,5 g for *Barbarea vulgaris*, 1,0 g for *Barbarea verna*, and 2,5 g for *Lepidium campestre*. The same trials indicate that the yield potential for all three species is comparable to that of *Brassica napus*.

Quality

The oil quality of the resulting crops can be changed to suit whatever need industry may have once the domestication is done. Variation within and between species of the two genera is available to traditional breeding. Mutations can be used to delete undesirable traits, and gene technology may be able to utilize further variation from the Plant Kingdom.

The undomesticated plant material contain high amounts of erucic acid in the oil and high levels of glucosinolates in the meal. The oil content of the seeds is about 30 per cent for the *Barbarea species* and a mere 20 per cent for *Lepidium campestre*. It is intended to develop one *Barbarea* species for food (with high oleic and linoleic acid content) and one *Lepidium* species for technical use (high linolenic acid content), but we keep the oil quality in a very open mind. Investigations include chemical analyses for oil, starch, glucosinolates, protein, fibers and ash.

Pathogens

Observations at the Department of Plant Breeding indicate that the pollen beetle (*Meligethes* spp.) does not use the potential oil crops from the genera *Barbarea* and *Lepidum* as host plants (Merker and Nilsson, 1995). This behaviour might change as the occurrence of the species increases. Obtaining knowledge of the ecological balance between the new oil crops and their potential pathogens is another important research field at the department.

Field observations indicate some fungal pathogens of importance, but also variation in susceptibility between different accessions of plants.

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