1 Introduction

Production and distribution of faba bean

Faba bean (*Vicia faba* L.), also referred to as broad bean, horse bean or field bean, has been cultivated in 2002 on nearly 2.4 x 10^6 ha world wide (FAO 2002). In developing countries faba bean is used mainly for human consumption. Feeding value of faba bean is high, and is considered in some areas to be superior to that of field peas or other legumes. *V. faba* is known to have been cultivated from the early Neolithic, from India to the Western Mediterranean countries (Cubero 1973, Cubero 1974). It is generally accepted that the geographic origin of *V. faba* was the Near East (Duc 1997). Ladizinsky (1975) argued that assuming the Middle East as place of origin of the broad bean is inconsistent with archaeological evidence. He suggested Central Asia to be the center of origin of *V. faba*.

The *V. faba* species is divided into two sub-species: ssp. *paucijuga* and ssp. *eu-faba*. The latter subspecies comprises three botanical types differing in seed size. Small seeded types with 1000-seed weight less than about 500 g (*V. faba minor*) are found in the Ethiopian area and have been favored by North European agriculture. Medium seeded types (*V. faba equina*) have developed throughout Middle East and North Africa with large seeded types with 1000-seed more than 1000 g (*V. faba major*) concentration in Egypt (Duc 1997).

With a world production of 3.7 million tons according to the 2002 FAO year book, *V. faba* ranks among the most important grain legumes. China contributes 41% of the faba bean world wide production, whereas Europe contributes 15%. However, the total harvested area of faba bean decreased in China and Europe over the past 20 years (Figure 1). Yield instability (Figure 2) and low prices are the main reasons for the decreasing harvest area.

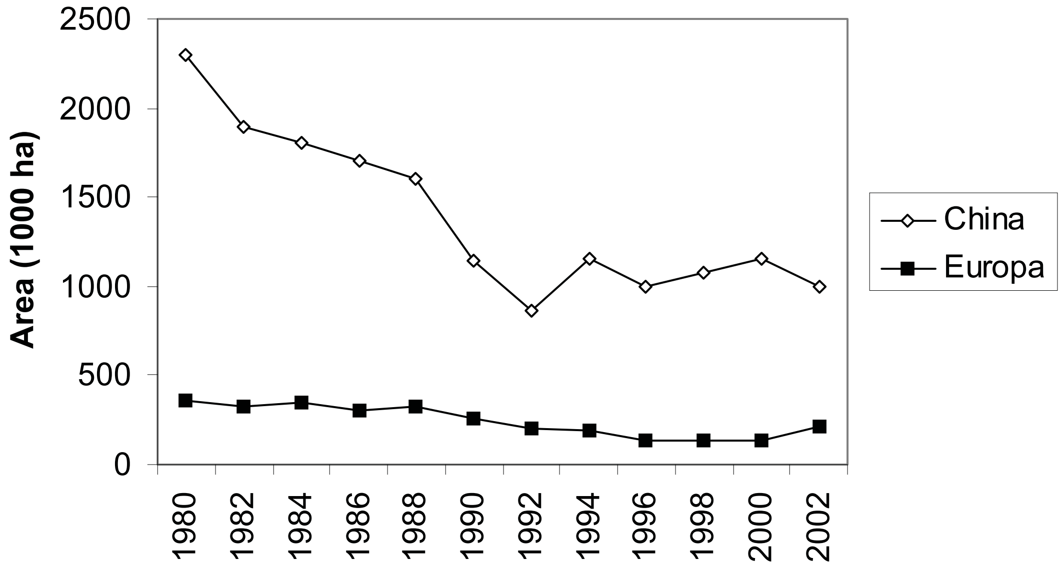

Figure 1. Total harvest area of faba bean in the period 1980-2002 (FAO 2002).

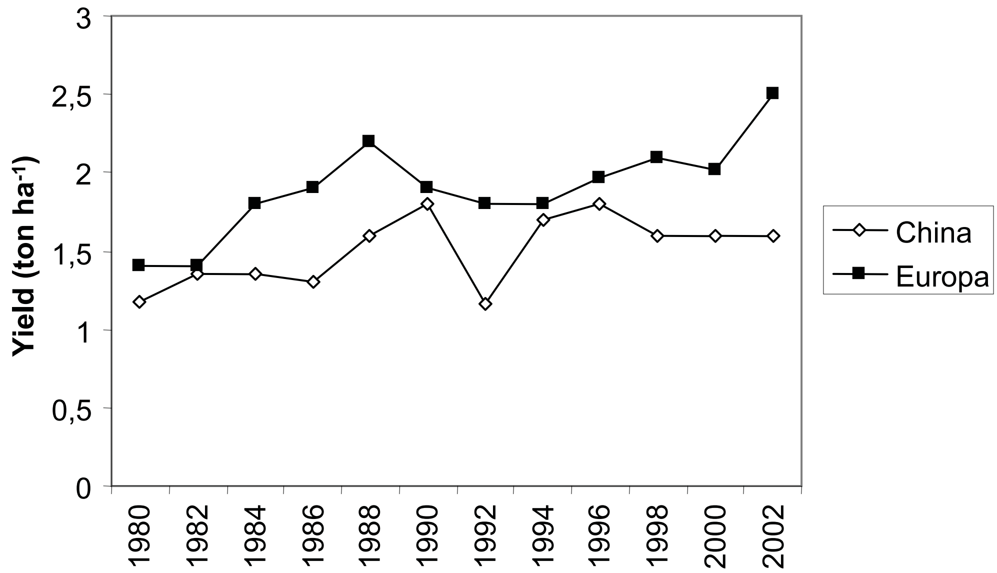

Figure 2. Yield of faba bean in the period 1980 – 2002 (FAO 2002).

In Europe, since 2001, interest in faba bean has been reinforced due to the organic farming demand, interest in poultry feed and demand for food safety and as replacement for pea in soil infected by *Aphanomyces* (Duc and Marget 2002). Bond et al. (1985) suggested that its low fertilizer and pesticide requirement makes this crop environmentally acceptable in sustainable agriculture.

Breeding

The creation of the International Center for Agriculture in Dry Areas (ICARDA) in 1977 was also a strong support to faba bean breeding research. ICARDA has collected and maintains more than 9000 accessions. It is the largest world collection and is used by many breeding programs. Other collections are maintained at the Institute of Genetics and Crop Plants Research at Gatersleben in Germany, Consiglio Nazionale delle Richerche (CNR)-Bari in Italy, Escuela Técnica Superior de Ingenieros Agronomos de Montes (ETSIA)-Cordoba in Spain, Institut National de la Recherche Agronomique-France (INRA)-Dijon and Rennes in France (Ward and Chapman 1986, Duc 1997).

Nowadays, the most important breeding goals in faba bean are breeding for disease resistance, improved yield, improved seed protein quality, improved drought and frost tolerance (winter beans). Difficulties in pollination control, the limited gene pool and the fact that faba beans have for a long time been a crop with minor breeding input has led to a slow progress in varietal improvement (Bond 1987). Today, breeding programmes of *V. faba* could be supplemented with recombinant DNA technology with the purpose of introducing genes conferring fungal resistance or the improvement of nutritional quality of seed proteins. Böttinger et al. (2001) reported the successful production of stable transformed lines of faba bean by using an *Agrobacterium tumefaciens*-mediated gene transfer system. However, they argued that this method is extremly time consuming and of relatively low efficiency.

Interspecific hybridization in *Vicia faba*

Bond et al. (1994) argued that the sensitivity to biotic and abiotic stress causes the yield instability of *V. faba.* In view of insufficient genetic variability for these traits, chances of conventional breeding approaches to improve this crop for these traits are limited. Treopoulos et al. (2003) warned that there is a continuous genetic erosion due to the fact that bean breeding is based only on populations within the species. Some other *Vicia* species (vetches) are expressing winter hardiness, disease and drought tolerance to a higher degree than *V. faba* (Bond et al. 1994 and Cubero 1982). Therefore, interspecific hybridization with species closely related to *V. faba* could be applied to widen the existing genetic variability in this crop. However, many attempts to obtain interspecific hybrids between faba bean and other related species by the sexual and somatic system have been unsuccessful (Link et al.1995, Tegeder 1996, Zenkteler et al. 1998).

Appropriate selection of the vetch species, among genotypes within species and between species, to be used in interspecific hybridization can be crucial for the success. The phylogenetic relationship among the vetch species and *V. faba* are one criterion to select a vetch as hybrid partner for faba bean. Even more decisive than the phylogenetic relationship, interspecific pollen tube growth and ovule and pod development are regarded as important parameters for selecting hybrid partners. The phylogenetic relationship in some *Vicia* species is shown in Figure 1.

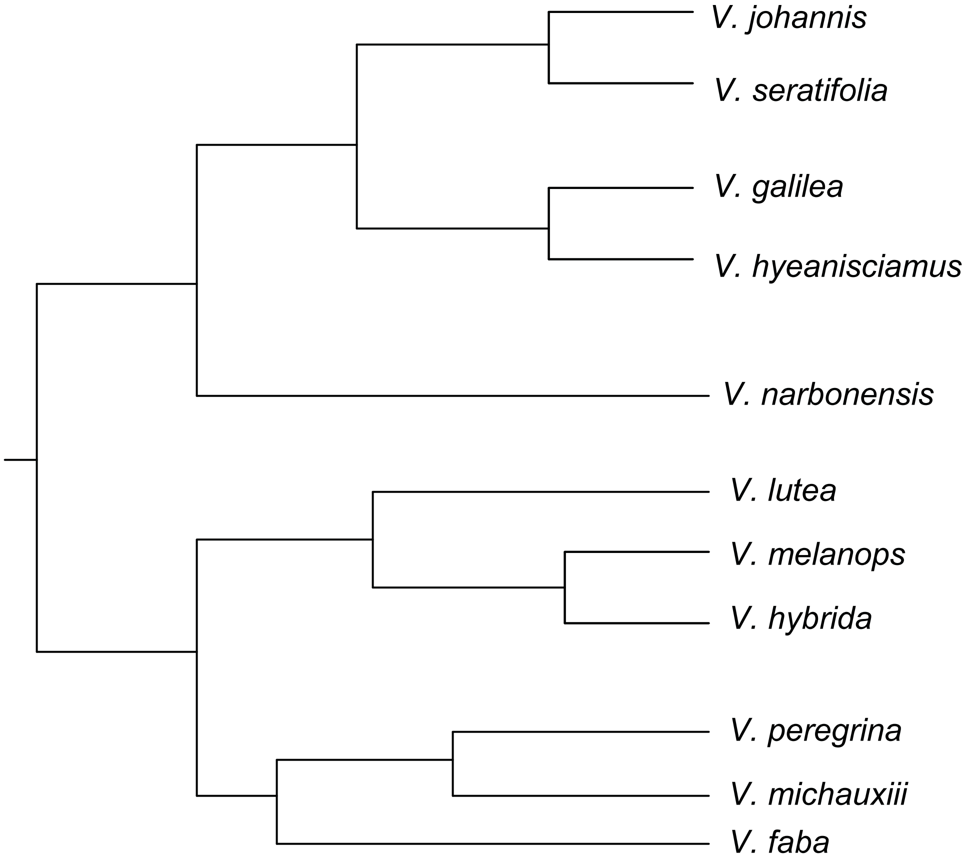

Figure 1. Phylogenetic relationship of *Vicia* species based on RFLP and PCR data, the figure is modified from Van de Ven et al. (1993).

Some researchers concluded that postzygotic barriers prevent development of embryos which were derived from interspecific crosses between *V. faba* and its related species. Indeed, they observed that the ovules were fertilized in at least some of the interspecific combinations among *V. faba* and its related species (Ramsay et al. 1984, Ramsay and Pickersgill 1986, Roupakias 1986 and Zenkteler et al. 1998). Van Tuyl and De Jeu (1997) suggested that application of phytohormones to flowers in combination with embryo rescue technique following wide crosses can overcome postzygotic barriers in a range of crops. However, at present no information about the applicability of this system to *Vicia* species has been reported.

2 Objectives

The objectives of this study were:

1) to optimize the *in vitro* culture conditions using rescued embryos from different faba bean genotypes as a prerequisite for successful interspecific sexual hybridization in *V. faba*,

2) to study the effects of phytohormone treatment of flowers with the aim to postpone premature pod abscission following interspecific pollination in *V. faba*, and

3) to perform a large scale interspecific pollination experiment using previously identified highly responding *V. faba* genotypes and related *Vicia* species with the aim to produce interspecific *Vicia* hybrids.

3 Plant material

The study was based on nine genotypes of *V. faba* and 11 related *Vicia* species obtained from different gene banks and institutes (Table 1).