Pollen Tube Growth in Interspecific Crosses between *Capsicum* Species

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Additional index words. crossing barrier, fertilization, incongruity

Abstract. Crossing barriers between white- and purple-flowered species were examined. Four accessions of *Capsicum annuum* and three of *C. pubescens* were reciprocally crossed with one to four accessions of *C. baccatum*, *C. cardenasii*, *C. chacoense*, *C. chinense*, *C. eximium*, *C. frutescens*, *C. galapagoense*, and *C. praetermissum*. *Capsicum chacoense* is the only white-flowered species that inhibits *C. annuum* pollen tube growth but allows *C. pubescens* pollen tube penetration into the egg cell. *Capsicum cardenasii* and *C. eximium* exhibit similar crossabilities with *C. annuum* and *C. pubescens*: pollen tubes of *C. cardenasii* and of *C. eximium* can penetrate the egg cells of *C. annuum* but not vice versa, and pollen tubes of *C. pubescens* can penetrate the egg cells of *C. cardenasii* and of *C. eximium* but not vice versa.

The crossabilities between domesticated *Capsicum* spp. and close relatives are well documented by Pickersgill (1980). Two groups have been distinguished, the white-flowered species, including the domesticated *C. annuum*, *C. frutescens*, and *C. baccatum*, and the purple-flowered species, with *C. pubescens* as the main representative. In general, crossing barriers exist only between the species of these two groups. It is not known which part in the process of fertilization or embryo development is inhibited. More knowledge about these barriers may be helpful in developing techniques for the introgression of genes from the purple-flowered species into *C. annuum*.

Interspecific crossings were made between four accessions of *C. annuum*, four of *C. baccatum* (including two of *C. baccatum pendulum*), one of *C. cardenasii*, two of *C. chacoense*, three of *C. chinense*, two of *C. eximium* (including one of *C. eximium tomentosum*), three of *C. frutescens*, one of *C. galapagoense*, two of *C. praetermissum*, and three of *C. pubescens*. All accessions of *C. annuum* and *C. pubescens* were reciprocally crossed with all accessions of the other spe-

ties. Crosses between accessions of the other species were made as indicated in Fig. 1. For each cross between two accessions, ≈ 10 pollinations were performed.

The pollen tube growth in styles and ovaries was determined according to Kho and Baer (1968) on six preparations per cross. Two days after pollination, styles and ovaries were sampled and soaked in 1 M NaOH for 1 h at room temperature. The preparations were thoroughly washed with water and incubated in a solution of 0.1% aniline in 0.1 M K_2PO_4 . Subsequently, they were placed

in a drop of glycerin on a slide and squashed under a cover slip. Pollen tube growth in styles and ovaries was determined by fluorescence microscopy.

Pollen tube growth was easily assessed in the preparations and quantified into four classes: 1) penetration into the egg cell, 2) barrier in the ovary, 3) barrier in the style, and 4) barrier on the stigma.

The variation of pollen tube growth within a flower, between flowers, between crosses, and between accessions was rather small. The main variation was observed between species. Although few accessions per species were used in this study, the results can be expressed per species rather than per accession. The following conclusions can be drawn (see Fig. 1):

1) When white-flowered species are crossed with *C. annuum*, all pollen tubes can grow into the egg cell, except the cross *C. chacoense* $\times$ *C. annuum*, where pollen tube growth is inhibited in the ovary.

2) Pollen tubes of the white-flowered species cannot grow through the style of the purple-flowered *C. pubescens*.

3) Pollen tubes of *C. pubescens* cannot enter the egg cells of the white-flowered species, except those of *C. chacoense*.

4) *Capsicum cardenasii* and *C. eximium* show similar incongruity in crosses with *C. annuum* and with *C. pubescens*. Pollen tubes of *C. cardenasii* and *C. eximium* can penetrate the egg cells of *C. annuum* but not vice versa, and pollen tubes of *C. pubescens* can penetrate the egg cells of *C. cardenasii* and

Fig. 1. Polygon for pollen tube growth in *Capsicum* spp. Arrows point in direction of female parent. The connections between the species indicate where pollen tube growth was restricted. (—) Penetration into the egg cell, (- - -) barrier in ovary, (.....) barrier in style, (- . - .) barrier on stigma.

Received for publication 31 July 1990. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked advertisement solely to indicate this fact.

of *C. eximium* but not vice versa.

Most of our results are in agreement with those of Pickersgill (1980). However, she reported unilateral incongruity between *C. eximium* and *C. pubescens* in the opposite direction. She obtained no viable F_1 seeds from the cross of *C. chacoense* $\times$ *C. pubescens*, while we observed pollen tubes penetrating the egg cells of *C. chacoense*. Our observation does not necessarily mean that the F_1 seeds will be viable. The barrier between these two species could occur after fertilization.

Capsicum chacoense seems to take a position between the two groups of *Capsicum* spp. It is the only white-flowered species that inhibits pollen tube growth of *C. annuum* but not that of *C. pubescens*. Hence, *C. chacoense* may prove useful as a bridge species between the two groups.

We found barriers preventing the growth of pollen tubes into the egg cells. This indicates, in general, that a cross between

such species is unlikely to produce viable F_1 seeds. However, the possibility cannot be excluded that certain environmental conditions or ontogenetic changes favor the success of such pollinations. One example is the cross of *C. frutescent* $\times$ *C. pubescens*. In our study, we did not find pollen tubes of *C. pubescens* entering the egg cells of *C. frutescens*. Yet, Pickersgill, (1980) described F_1 hybrids raised by embryo culture, indicating that pollen tubes had reached the egg cells. Boukema (1980) also reported a successful cross of *C. chacoense* $\times$ *C. annuum*. Apparently, pollen tubes may overcome the barriers in the ovaries that we observed. Several experimental approaches, such as bud pollination or in vitro pollination, have been applied in other crops (Namai, 1980; Sink et al., 1978). Such approaches might also be successfully applied in *Capsicum* breeding programs aimed at the introduction of a character from incongruent species.

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