Restoration of Pseudo-self-compatibility (PSC) in Derivatives of a High-PSC x No-PSC Cross in Nemesia strumosa Benth*

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Summary. Mean PSC increased following each generation of recurrent selection in F1, F2 and F3 Nemesia strumosa families derived from a cross of a 100% PSC plant to an unrelated 0% PSC plant. The first 100% PSC individuals occurred in the F4. Populations derived through sib pollination tended to have higher PSC means than lines derived through self pollination. One F3 family showed a three-fold higher PSC level when pollinated in the greenhouse than when pollinated in the growth chamber, while another F3 family similarly pollinated showed no change in PSC.

Key Words: Self incompatibility - Pseudo-self-compatibility - Inbreeding - Selection

Introduction

Self incompatibility acts as a physiological barrier to inbreeding by preventing self fertilization even though the plant has functional gametes. In the gametophytic system, incompatibility is controlled by a series of S alleles. When the S allele in the pollen matches the S alleles in the style, the pollen tube fails to reach the ovary. Various disruptions of the self-incompatibility reaction may occur, however, resulting in seed set from incompatible pollinations; these disruptions have been termed pseudo-self-compatibility (PSC). A common type of PSC, caused by multigenic modifiers and influenced by environment, produces a wide range in ability to produce self seed, from very few seeds in some plants to many seeds in others.

Several researchers have studied the genetics of PSC. Atwood (1942) and Leffel (1963) found no relationship between particular S alleles and level of PSC in Trifolium. Inbreeding with selection to obtain plants consistently high in PSC has often been unsuccessful (Ockendon 1973; Duncan et al. 1973). Townsend (1965), in studies of the inheritance of PSC in tetraploid Trifolium hybridum, found that the mean PSC level of a progeny was somewhat similar to that of the parent plant, although a wide range in PSC occurred. After selfing for three generations, the overall level of PSC was high. Similarly, Takahashi (1973) selfed Petunia hybridra plants of various PSC levels and although the progeny obtained showed a wide variability in PSC, many were similar to the parent. Crossing a highly compatible with a highly incompatible plant yielded an F1 progeny with a PSC level slightly lower than that of progeny obtained by selfing the highly compatible plant. Nasrallah and Wallace (1968) inbred lines of cabbage for 10 years and found plants which bred true for high and low PSC. A cross of a high PSC plant as female with a low PSC plant gave an F1 progeny with high PSC, while the reciprocal cross gave an F1 with low PSC. This suggests a maternal effect. However, the F1 from the cross with the high PSC plant as female set more seed when backcrossed with pollen from the high PSC parent than with pollen from the low PSC parent, suggesting a pollen effect.

Nemesia strumosa Benth., a member of the Scrophulariaceae, has the gametophytic incompatibility system (Riley 1933). Henny and Ascher (1976) found low levels of PSC in selected populations of Nemesia and, through inbreeding and selection, increased mean PSC from 2.0% in an F1 to 70.1% in the F4. Since the PSC increased from very low to very high in so few generations, Henny and Ascher suggested that a relatively small number of modifying genes were involved. Intercrossing Nemesia plants high in PSC produced a progeny segregating both high and intermediate level PSC plants. This broad progeny distribution is similar to that observed by Townsend (1965) and Takahashi (1973). In contrast, a high crossed with a
low gave a progeny of mostly low PSC plants, indicating that PSC in *Nemesia* is phenotypically recessive. Takahashi's *Petunia* data show somewhat the same recessive nature, although not so great as in *Nemesia*. The style determines the level of PSC: pollen from *Nemesia* plants of any PSC level produce a strong self-incompatibility reaction on a self-incompatible style.

All of the plants used by Henny and Ascher were originally derived from three plants. Because of the close relationship of the descendants of these plants, all might be expected to carry recessive modifiers for the self-incompatibility reaction and crosses among them might give especially high PSC progeny. To determine whether these genes could be transferred to an unrelated incompatible line, a 100% PSC individual was crossed to a 0% PSC plant from a population which lacked PSC. This 0% PSC population was obtained from a commercial source. The resulting F₁ had a mean PSC level of 0.9%, which was lower than any of the F₁ progenies of similar crosses among the related plants. This raised the question of whether high PSC plants could be obtained through inbreeding this F₁ progeny. Our purpose, therefore, was to select and inbreed PSC plants in an attempt to increase PSC to levels comparable to those of the original material.

**Materials and Methods**

*Nemesia strumosa* seeds were placed in petri dishes lined with filter paper saturated with 100 ppm gibberellic acid. After soaking for 24 to 48 hours, the seeds were planted in sphagnum moss and placed under mist until germination. When the second or third set of true leaves appeared, the seedlings were transplanted to a 1:1:1 peat:perlite:soil medium. Each seedling received a three-number code: the first two numbers indicating the family and the last number the seedling.

Pollinations were performed the day of anthesis. In order to average environmental effects, no more than two pollinations of each self or cross were done on the same day. Flowers to be cross pollinated were emasculated the day before anthesis to prevent contamination by self pollen. All unused flowers were removed each day to avoid contamination from insect pollination and to insure uniform floral age at pollination. Routine checks for pollen fertility were made. Maximum seed set for each plant was determined by using the plant as female in a compatible cross. Mean self and cross seed sets were based on at least nine and four pollinations, respectively. To calculate the % PSC for each plant, the mean self seed set was divided by the mean compatible cross seed set and these values were plotted in a frequency histogram.

Progeny B-1, produced by crossing the 100% PSC plant 73-20-34 with the 0% PSC plant B74-1-2, was the source of our plants (Fig. 1). Self or sib pollinations of individuals from B-1 gave rise to three F₂ families, 75-3, 76-1 and 75-2. The highest PSC plant in each of these F₂ families was selfed to yield the three F₃ families 76-2, 76-4 and 76-3. To produce the F₄, high PSC plants of families 76-2 and 76-3 were selfed and sibbed. This gave rise to the self progenies 77-5 and 77-3 and the sib progenies 77-6 and 77-4.

**Results**

Mean PSC increased gradually from the F₁ generation B-1 to the F₃ generation 76-2. Progeny B-1 had an overall mean PSC of 0.9% (Henny and Ascher 1976). Self pollination of B-1-7 produced the F₂ progeny 75-3 with a mean PSC level of 6.8% and a range extending from 0% to 23.9% (Fig. 2). In the F₃ family 76-2, the mean PSC of the plants when pollinated in the growth chamber was 9.3%, only a small increase over the F₂. The range extended from 0.0% to only 20.6% (Fig. 2). Seed set from compatible pollinations remained high although many of the plants were partially male sterile. However, when family 76-2 was pollinated in the greenhouse, the mean PSC