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Hypothesis of S Supergene and Breakdown of Self-incompatibility with Homomorphic Variants in Buckwheat

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[Introduction]

In many flowering plants, self-incompatibility (SI) is an important system to prevent inbreeding and to promote outbreeding. In most species studied, the SI system is controlled by a single locus; S. SI is primarily a reaction between haploid pollen grains or pollen tubes and diploid stigmas or styles. SI is classified into two distinct types by whether the SI response is related to floral morphology, such as style length, anther height and pollen size (heteromorphic SI), or not (homomorphic SI). The incompatibility response is based on the interaction between pollen and style or stigma. This response in the heteromorphic incompatibility system has a close relationship with flower morphology. The purpose of this study was to develop the methodology for the transfer desirable agronomic traits from a wild annual species (*F. homotropicum*) into elite lines of cultivated common buckwheat. Therefore, attempts were made to develop autogamous buckwheat by combining conventional breeding methods with tissue culture techniques.

[Materials and Methods]

The self-compatible lines with the non-brittle pedicel trait are more useful for genetic analysis and surpass other lines as parental lines for breeding. The production of new buckwheat cultivars with good agronomical traits would be accelerated by using the self-compatible lines.

[Results and Discussion]

We found that a self-compatible line that was produced by an interspecific cross between common buckwheat and *F. homotropicum* shows the pollen-style interaction in accordance with the *S* supergene hypothesis. The flower morphology is long homostyle and the pollen size is similar to that of thrum. The pollen tubes of the self-compatible plants were compatible with the styles of the pin plants but incompatible with the styles of thrum plants. On the other hand, the pollen tubes of pin flowers were incompatible with the styles of the long homostyle plants, but the pollen tubes of thrum flowers were compatible with the styles of the long homostyle plants. These reactions can be explained by assuming that the genotype of the S^h allele is *giSIPPA/giSIPPA*. The orders of *g* and *iS* and of *iP*, *p* and *a* were not revealed. The segregation pattern was studied in the F_1, F_2 and BC_1F_1 generations. The F_1 hybrids segregated 5:5, which fits a ratio of 1:1 for homomorphic:thrum type flower types, indicating a single dominant gene for homomorphism. The F_2 plants were produced to define the homomorphic gene and to examine the genetic basis of it. Homostyly appears to be controlled by a single dominant gene as the F_2 progeny segregated 42:15, which fits a 3:1 (homomorphic: pin type flower types) ratio. This confirms the results obtained earlier whereas the findings focused on a single dominate gene controlling homosyly. Homomorphism was controlled by a single allele S^h, while the pin/thrum-complex was governed by a single genetic locus *S*, with two alleles, *S* and *s*, which control *Ss* (thrum-type) as well as the *ss* (pin-type), respectively. Corresponding to the incompatibility mechanism in *Fagopyrum*, this represents the case of a single locus *S* with three alleles, S^h, *S* and *s*, and the phenotypes, homomorphic, pin and thrum. It can be characterized by relationship of dominance, $S > S^h > s$.

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