

REGULATION OF INFLORESCENCE MERISTEM FATE IN PEA

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ABSTRACT

We are using the garden pea (*Pisum sativum* L.) as a model system to study genes involved in determining legume inflorescence architecture. In pea, one to several flowers are typically produced from a secondary inflorescence meristem (I2) at each node. In some lines I2 activity is extended resulting in multiflowered lines which produce a variable number of flowers. This extended indeterminacy is useful for exploring the developmental genetics of inflorescence architecture in legumes. One goal of our research is to separate the environmental and genetic effects on flower number in pea. With this mechanistic knowledge, it should then be possible to understand inflorescence architecture in pea using defined genetic pathways. In addition, we are also interested in identifying new floral phenotypes following plant growth regulator treatments to pea floral mutants which might have agronomic or ornamental significance.

The *pim-1* mutant exhibits plasticity in inflorescence development. Instead of producing one to two flowers at each node, the floral meristem of *pim* mutants develops as an inflorescence meristem, resulting in numerous floral-like structures produced at each node. The absence of *PIM* expression delays the production of floral meristems, resulting in an architectural change from a simple raceme to a compound cyme. The extent of non-floral development of inflorescence branches of *pim-1* is under the influence of photoperiod, temperature and gibberellins. For example, when treated with short day conditions, elevated temperatures, or gibberellin A3, the fourth order structures (I4s) of *pim-1* plants tend to develop vegetatively (Fig. 1). *PIM* also may have a role in suppressing secondary axillary bud growth. Vegetative or floral axillary buds develop within *pim-1* axils that have already produced an inflorescence or floral shoot. Thus, *PIM* may function to integrate environmental signals and autonomous signals, converting complex infloral structures into a single flower.



Figure 1. Phenotype of fourth order floral development in a daylength-sensitive *pim-1* line: left, untreated plant, right, following treatment with 2 ug GA3.

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We are also working with multiflowered lines of pea which produce multiple flowers because of extended I2 activity or increased flower production at each node on an I2. The *ultra* line (Fig. 2) produces up to twelve flowers under short day growth room conditions and 2-3 flowers under long day growth room conditions.

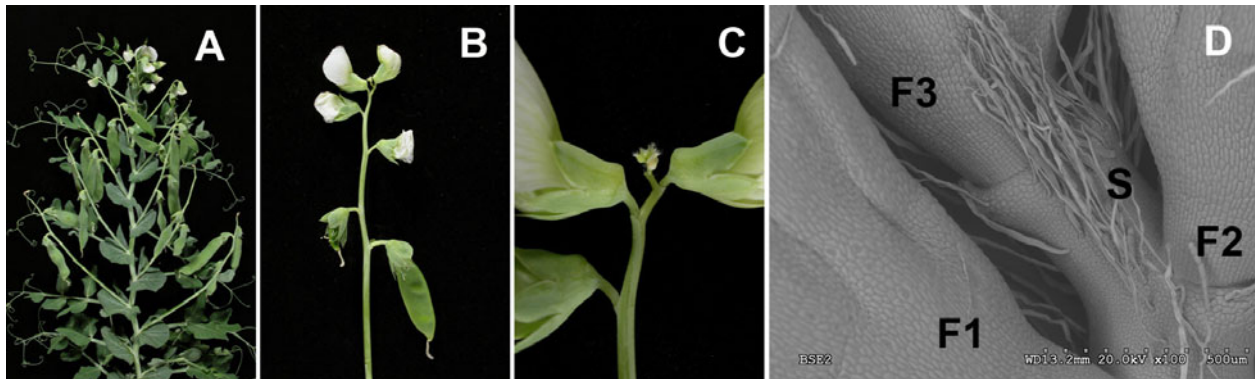


Figure 2. Flowering of *ultra* under short day (A-C) and long day (D) growth room conditions. A) flowering primary shoot, B) I2 at the node of floral initiation (NFI) showing 6 developing flowers and pods with one flower at each node on the I2, C) cluster of flowers produced by the I2 meristem, D) three flowers (F1, F2 and F3) produced by the I2 under long day conditions before terminating as a stub (S). The *ultra* line was identified in an F2 population in our lab from a cross between the *pim-1* mutant (identified as a spontaneous mutant in Northfield, MN) and the determinate (*det*) line (originally obtained from G. Marx). Seeds used in this study were from an F6 generation.

As described above, the number of flowers per node can be increased by extending the activity of the I2 meristem. However, the number of flowers in pea can also be increased by increasing the number of third-order flowers produced at each node on the I2 utilizing the one of the *cochleata* mutants of pea. We crossed the *ultra* line with the *coch-p* line (originally obtained from the John Innes Pisum Collection) and analyzed the F2 progeny grown under winter greenhouse conditions. *ultra* and *coch-p* segregated as two independent genes (WT=61, *ultra*=26, *coch-3*=25, and *ultra coch-3* = 4; Chi-Square=3.05). The I2 of *ultra coch-p* double mutants produced up to 6 nodes before terminating as a stub with many nodes bearing 2 flowers, rather than the typical one flower per I2 node produced by wildtype pea plants (Fig. 3).

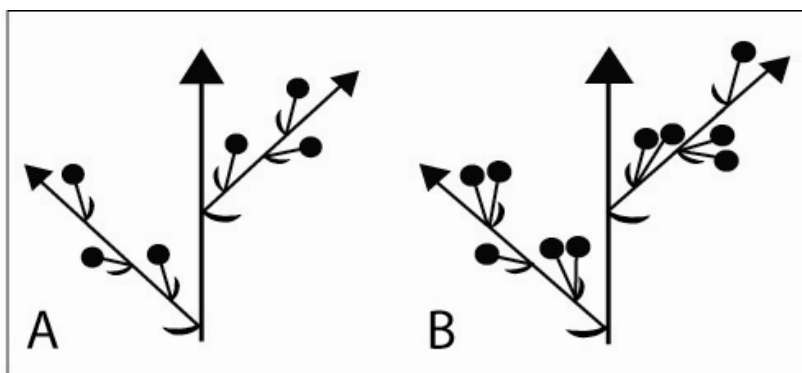


Figure 3. Flowering of *ultra* and *ultra coch-p* segregates. A) *ultra* plants produced one flower (solid circles) at each node of the I2, B) *ultra coch-p* plants produced 1 to 2 and sometimes 3 flowers (solid circles) at each node of the I2. The large triangle symbolizes the primary inflorescence meristem (I1) and the smaller triangles represent the secondary inflorescence meristem (I2).

Some flower abortion was observed in the double mutants and current investigations are focused on whether plant growth regulator treatments may decrease floral abortion and improve flower, fruit and seed yield.