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Understanding resource allocation in Brassica

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The primary purpose of a plant is to reproduce and to pass on its genes to the next generation. Plants are extremely plastic organisms that respond to the environment in which they find themselves, but a large part of their development is under genetic regulation. In order to maximise reproductive success the plant has to balance the extent to which it grows vegetatively, how long it spends photosynthesising, how many reproductive structures it invest in, and how much resource (protein, lipid, carbohydrate) it puts into each seed (Bennett et al., 2011a,b). If the plant gets its strategy wrong it risks producing seeds that are too under-resourced to be viable, or having an excess of photosynthate that gets trapped in vegetative tissue and never makes it into a seed. Added to this, humans have practiced artificial selection of crop plants with the aim of improving resource allocation and enhancing reproductive potential of the plant, with the result that there are many varieties of each species of crop.

Our laboratory has been investigating resource allocation in Brassica napus using the Defra-funded Oregin field trial which was grown at Rothamsted Research over two years (www.oregin.info). Brassica is an interesting crop to work with as it has been domesticated for far less time that the cereal crops and as a result its growth habit is relatively uncoordinated across the plant, but extremely well coordinated within each pod. Bennett et al. (2011b) showed that manipulation of architecture in the related plant Arabidopsis significantly altered resource allocation to the pods. We now wish to discover if the diversity present in Brassica crops gives the potential for enhancing resource allocation to seeds.

The trial consisted of 61 lines of winter oil seed rape grown in a randomised block design. In year one, two levels of nitrogen were applied; in year two only the lower level of nitrogen was used. We have measured a range of physiological traits throughout the growing season that we believe will be important in helping our understanding of plant development and resource allocation, namely: leaf senescence and chlorophyll content of tagged leaves, pod senescence, pod dehiscence, branch number, plant height, pod length, seed number per pod, seed weight per pod, seed weight per plant, vegetative dry matter per plant.

A number of key questions should be addressed:

- Does leaf and pod senescence affect the extent of pod filling?
- Is leaf senescence related to pod senescence?
- Is resource allocation related to plant architecture?
- Is pod senescence related to pod shatter?
- Is pod filling related to pod shatter?

Understanding the answers to these questions will help us to determine which architectural and developmental traits should be manipulated to enhance seed yield in Brassica crops.

References:

Bennett EJ, Roberts JA, Wagstaff C (2011a) The role of the pod in seed development: strategies for manipulating yield. New Phytologist Tansley Review. 190: 838-853.

Bennett EJ, Roberts JA, Wagstaff C (2011b) Manipulating resource allocation in plants. J. Exptl. Bot. In press