Updates 2017
New da1 mutants and maize yield paper.

Control of Plant Seed and Organ Size

Da1 Transcription Factor

Increased seed and biomass yield

Evaluation and Licensing Opportunities

For further information on this technology and evaluation / licensing opportunities please contact:

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Tech ID: 07.436 & 13.565

Patent Literature

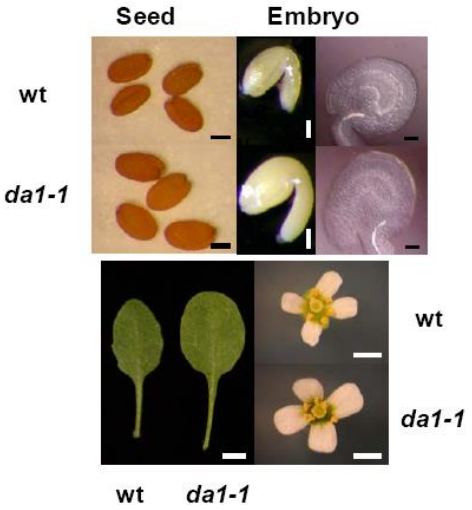
07.436
Publications: WO2009/047525, US2011-0004962.
Grants: AU 2008309345, MX 329810, EP 2201121, US 9,624,502, BR PI0818534-4, CN ZL200880115291.1, IN 305397, AU Div 2016202110

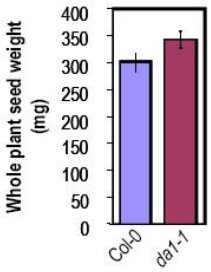
13.565
Publications: WO2015/067943, EP3068794, CN105814075A, US-2016-0272989-A1
Grants: US 11,118,188, CA 2,929,569, EP3068794

Genetic factors affecting seed/organ size have often been found by genetic mapping and gene cloning studies, but commonly such factors increasing size are associated with a decrease in other components such as seed number and fertility. Now, Prof Michael Bevan and colleagues at the John Innes Centre in Norwich, UK have discovered and characterised a novel gene, DA1, that controls the size of seeds and other organs in plants without compensatory effects on other components of yield.

Prof Bevan and colleagues have discovered that the DA1 protein is key regulator in determining the final size of seeds (and other organs) by restricting the duration of proliferative growth. Moreover, the inventors have discovered that *da1-1*, a mutant allele of the wild-type DA1 gene, acts as a dominant negative interfering mutation for DA1-related (DAR) proteins, and causes a ***marked increase in seed/organ size***, without negative compensatory effects. The DA1 gene and its mutant alleles act maternally and have been structurally and functionally characterised. The DA1 protein contains two UIM motifs, which may have the function of binding ubiquitin and promoting ubiquitination. Moreover, expression of the DA1 gene is induced by the phytohormone abscisic acid (ABA), and the *da1-1* mutant is insensitive to ABA, providing indication that ABA negatively regulates organ growth through DA1. Overexpression of *da1-1* in a wild-type background causes an increase in seed and organ size, without any associated decrease in seed number or fertility. This provides a simple mechanism to engineer changes in seed and organ size in transgenic plants.

The dominant *da1-1* allele increases organ size in Arabidopsis





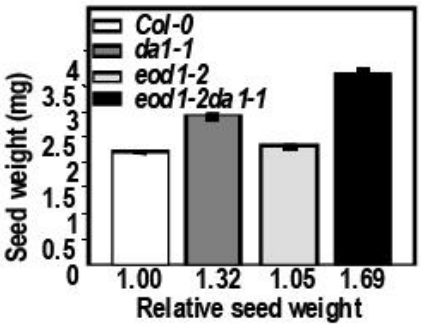
Seed yield is increased 16% by *da1-1*

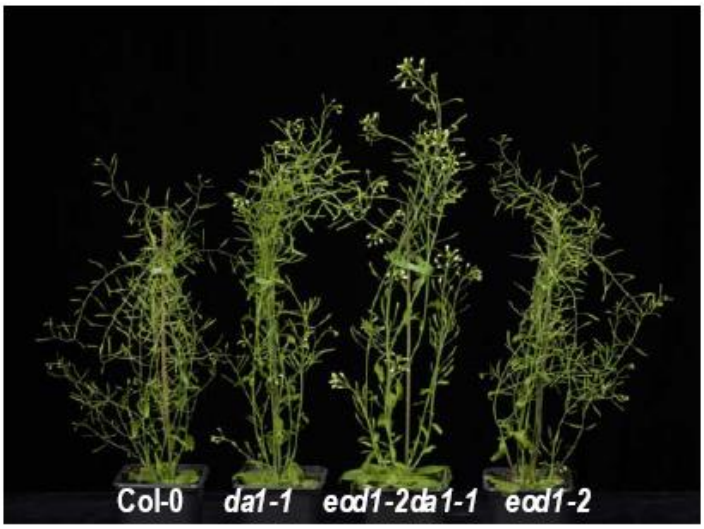
Update

New da1 mutants have now been described by Mike Bevan and colleagues. These represent alternatives to da1-1 mutants as additional approaches to deploying this technology. These new mutants are described in new patent applications filed by PBL (Tech Id 13.565). Details available on request.

In addition, the John Innes Centre team have found that mutations that reduce or abolish the function of EOD1/BB, synergistically enhance the large organ phenotypes of *da1-1*. EOD1/BB encodes an E3 ubiquitin lyase, "Big Brother" or "BB", and is known to suppress organ growth (Disch, S. *Curr Biol* 16, 272-9 (2006). When E3 is inactivated the effect of dominant negative DAR alleles such as *da1-1* is even more pronounced. It would appear therefore that DA1 acts in parallel with *EOD1/BB* to limit the size of seeds and organs. The JIC group have characterised EOD1/BB and propose sites for inactivating it via mutation or other targeted approaches. While it is not essential to reduce or abolish BB expression, to implement the DA1 technology, it does offer a two pronged approach to maximising increases in plant organ size.

***da1-1* interacts with the *eod1* mutation to synergistically increase biomass**





Researchers at Shandong University have independently demonstrated that the maize *da1* mutation increases yield by 15% in maize field trials over 3 years, through increased grain number, grain weight and starch content.

The DA1 technology is assigned to and the subject of patent applications filed by PBL. PBL has granted rights in certain crops, while other species remain available – please inquire for details of availability.

The technology has applications in:

- **Increased crop grain/seed yield** by transgenesis, mutagenesis and/or molecular-assisted breeding strategies
- **Increased crop biomass, plant longevity and productivity** – vegetative, horticultural and bioenergy crops
- **Increased organ size** – fruit and vegetable crops, flowers

Technology offered:

- DA1 gene technology, combined DA1/EOD-BB strategy, and know-how for transgenic and non-GM crop plants
- PCR and molecular marker tools and know-how for molecular breeding approaches

References:

Xie G, Li Z, Ran Q, Wang H, Zhang J (2017). Over-expression of mutated ZmDA1 or ZmDAR1 gene improves maize kernel yield by enhancing starch synthesis. *Plant Biotechnol J*: doi: 10.1111/pbi.12763. [Epub ahead of print].

Xie G1, Li Z1, Ran Q1, Wang H1, Zhang J1.Li Y, Zheng L, Corke F, Smith C and Bevan MW (2008). Control of final seed and organ size by the DA1 gene family in Arabidopsis thaliana. *Genes and Development:* 22 (10), 1331-6.