

The Canon of Potato Science:

42. Flowering

Raj Kumar

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What is it?

Flower formation represents a transition from the vegetative to the reproductive phase of development. Flowering is a phase in the life of a plant when the shoot meristem is induced to develop sepals, petals, stamens, and carpels instead of leaves. In this process two stages must be distinguished from each other: the induction of flowering and the differentiation of inflorescences and flowers. During flower induction plants must be exposed to certain external conditions for a defined period of time. The time interval is known as the induction period and the efficacious external conditions as the inductive conditions. The natural, inductive external conditions can, in many cases, be replaced by treatments with certain chemicals.

The cultivated potato, like many other plants in higher latitudes, is a long-day plant. Potato flowers under long days, moderate temperature and high humidity. Potato is induced to flower by increased day length. Under low latitudes conditions, i.e. in tropical and sub-tropical conditions, potato is grown under short-day conditions. Although flower primordia of potato can rise in total darkness, a photoperiod of 14–18 h and night temperatures of 15–20 °C favour flower production and berry setting in potato. In the tropics and sub-tropics, conditions conducive to flowering and fruiting are available only at high altitude (> 1500 m above mean sea level) when the crop is grown during the summer season. Short-day environment suppresses flowering of potato. Temperature conditions also influence photoperiodic response.

Why is it Important in Potato Science?

Potato is generally propagated vegetatively through tubers. A reproductive phase is required for breeding cultivars with a desirable combination of traits by crossing

R. Kumar (✉)
Crop Improvement Section, Central Potato Research Station, Jalandhar 144003, India
e-mail: rajcprs@hotmail.com

parents with useful traits. To study the inheritance of various traits and for various genetic manipulations hybridization between parents is required which can be done if the genotypes produce flowers. Potato forms a polyploid series from diploid ($2n=2x=24$) to hexaploid ($2n=6x=72$) with the cultivated species *Solanum tuberosum* being a tetraploid ($2n=4x=48$). Diploid species are self-incompatible outbreeders and tetraploids and hexaploids are mostly self-compatible allopolyploids. Male sterility is a serious constraint in potato breeding. Pollen sterility, ranging from partial to complete absence of pollen grains, is very common in potato. Almost one-third of the potato cultivars derived from *Solanum tuberosum* ssp. *tuberosum* do not form berries. Crossability groups occur, each defined by a hypothetical endosperm balance number. In traditional breeding of cultivars crosses are made between pairs of parents with complimentary traits. However, parents will have genes introgressed from wild species or primitive cultivars. With the help of various genetic studies, which involve crossing, breeders will be able to design better breeding programmes.

Why is it Important for the Potato Industry?

The economic importance of genetic improvement of the potato cultivars for traits like yield through conventional breeding is immense. Increasing the use of potato for processing requires cultivars with low reducing sugars and high dry matter. In potato there are problems of pests and diseases due to the vegetative way of propagation. To manage these, the available diversity within the genus *Solanum* is required to be used in developing superior cultivars through breeding. To develop potato cultivars with various desirable characters and to introduce desirable genes from other genotypes including wild and primitive relatives, hybridization is involved. Flowering of large number of genotypes, flower fertility, berry setting and viable seed production are required for the success of a hybridization programme.

In some circumstances cultivars based on true seed (TPS) propagation are an attractive proposition. Potato propagation by true potato seed offers a tremendous advantage over the existing system of potato production where tubers are used as a means of propagation. Reduced seed costs, flexibility of planting time (no problems with physiological age of seed tubers), and freedom from viral diseases are the advantages of such propagation. Profusely flowering parents are required for successful potato production by true seed.

Scientific Developments

Under conditions unfavourable for flowering, various methods such as planting on bricks, removal of tubers and grafting have been suggested for induction of flowering in non-flowering genotypes, although the success of these treatments is not guaranteed.

Extension of photoperiod has been found beneficial in favouring bud retention and flowering. Photoperiod controls several responses like flowering and tuber formation. *Arabidopsis thaliana* CONSTANS (AtCO), a flowering-time gene which accelerates flowering in response to long days, impairs tuberization in potato

(*Solanum tuberosum* ssp. *andigena*) under short day inductive conditions. AtCO over-expressing lines required prolonged exposure to short days to form tubers.

Gibberellins are known to substitute for long-day requirements in some plant species and short day can not be replaced by gibberellins. Various workers have tried gibberellin-containing mixtures to induce flowering. In the sub-tropical plains of India, flowering could be induced in some genotypes using extended photoperiod and gibberellic acid (GA₃) containing mixtures with auxin (2,4 D), and with auxin (IBA) and cytokinin (kinetin). GA₃ in combination with Gapol (a mixture of various compounds including the auxin indole acetic acid) was found beneficial in flower development in a non-flowering cultivar Marijke in Mexico. Gibberellic acid (GA₃) has also been used in enhancing flowering in normally flowering genotypes. Flowers induced by various workers using GA₃-containing treatments, however, were in many cases either sterile and/or did not set berries. The flower sterility observed may be due to hormonal imbalance. In the Indian sub-tropical plains silver thiosulphate (STS) in combination with extended photoperiod has been reported to be useful in inducing fertile flowers in non-flowering genotypes followed by good berry setting. This treatment was also found useful in enhancing flowering in normally flowering genotypes. The increase in flowering by STS was due to both an increased number of inflorescences and an increased number of flowers per inflorescence.

Further Reading

- Almekinders CJM (1992) The effect of photoperiod on flowering and TPS production in the warm tropics. *Potato Res* 35:433–442
- Almekinders CJM, Struik PC (1996) Shoot development and flowering in potato (*Solanum tuberosum* L.). *Potato Res* 39:581–607
- Jones HA, Borthwick HA (1938) Influence of photoperiod and other factors on formation of flower primordia in the potato. *Am Potato J* 15:331–336
- Kumar R, Kang GS, Pandey SK (2006) Induction of fertile flowers in potato (*Solanum tuberosum* L.) by silver thiosulphate anionic complex. *Euphytica* 149:27–33
- Lozoya-Saldaña H, Miranda-Velázquez I (1987) Growth regulators, photoperiod and flowering in potatoes. *Am Potato J* 64:377–382
- Martinez Garcia JF, Virgós-Soler A, Prat S (2002) Control of photoperiod-regulated tuberization in potato by the *Arabidopsis* flowering-time gene CONSTANS. *Proc Nat Acad Sci USA* 99:15211–15216