

The Canon of Potato Science:

25. Minitubers

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Published online: 18 May 2008
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What are they?

The potato plant is versatile in the ways it can be multiplied: some of the most common propagules used are meristems, nodal cuttings, sprout cuttings, stem cuttings, tubers and true seeds. Potato plants can be grown for multiplication in the field, in green- or screenhouses and under artificial conditions in an *in vitro* or hydroponics facility. The type of facility needed and the way of multiplication very much depend on the phase of the seed production system. One of the most popular ways to produce pre-basic seed is to grow minitubers in the greenhouse from *in vitro* plantlets produced from nodal cuttings. Nodal cuttings can be produced aseptically in large numbers by *in vitro* laboratories specialized in rapid multiplication. Minitubers are usually defined as the progeny tubers produced on *in vitro* derived plantlets. The term refers to their size as they are smaller than conventional seed tubers but larger than *in vitro* tubers (or microtubers) produced under aseptic (laboratory) conditions on artificial media. The size of minitubers may range from 5–25 mm although in current systems larger minitubers also have become common. This size range coincides with a weight range of 0.1–10 g or more. The purpose of this phase of the seed production system is to produce as many minitubers above a certain minimum size (or within a certain size class) per *in vitro* plantlet as possible.

For the production of minitubers the quality of the transplant (the original *in vitro* plantlet) is very important. Essential is that the transplant is true to type and that it is entirely free from any disease. Moreover, the *in vitro* plantlet should be sturdy, properly induced for a balanced growth between shoot and tubers, and equipped with large and healthy leaves and with active roots. Therefore proper

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pretreatment and growing conditions during the last cycle of production of *in vitro* plantlets from nodal cuttings are crucial.

Minitubers are either produced on a solid (soil) medium or in soil-less production systems. Among the latter different types of cultures are used including aeroponic cultures, hydroponic cultures, and nutrient film cultures. In greenhouse production on soil media the number of minitubers produced per *in vitro* plantlet is usually rather low. Numbers usually range from 2–5 per *in vitro* plantlet but this figure strongly depends on the cultivar and the management of the crop. Repetitive harvesting techniques increase the number of minitubers harvested per plantlet but they are difficult to perform when plants are grown in soil. The soil-less systems allow frequent harvesting and with these systems the number of tubers per individual plant can be very large (up to 40 per *in vitro* plantlet) and the resulting progeny tubers can be very uniform in weight.

The size of the minituber is important. The size affects the duration of the dormancy, the vigour of the seed tuber, the number of stems that can be successfully produced, the rate of emergence, the number of surviving plants and stems, the vigour of the individual stem and its yielding ability.

The health standard of the minitubers is high as they are produced under controllable conditions from aseptically produced *in vitro* plantlets. In some seed systems later generations of minitubers can be produced from the first generation of minitubers and still be classified as in the highest grade of seed tubers.

Why are they Important in Potato Science?

The production of minitubers has highlighted the importance of seed tuber size for a number of physiological phenomena, including dormancy, rate of emergence, shoot:root ratio, relative rate of growth, number of stems, secondary tuber formation and other physiological disorders, tuber number, tuber resorption, lateral and sympodial branching, etc.

The production of minitubers has also shed new light on inter-stem competition. Despite the fact that minitubers are small they still have a considerable number of eyes and therefore, if properly treated, can produce many sprouts per individual tuber. The vigour of these stems will be limited by the availability of resources from the mother tuber between sprouting and emergence. What type of matter (energy source, protein source, nutrient source) actually will cause these limitations and how these different compounds are allocated to the developing sprouts or emerging stems can easily be investigated by the use of these minitubers.

As the number of minitubers per individual *in vitro* plantlet is such an important yield component, the agronomy of the crop is often aimed at increasing the number of tubers. Alternative techniques, uncommon in conventional seed tuber production have been investigated, such as continuous hilling, tipping, continuous earthing up, associated with shallow planting, etc.

The production of minitubers from *in vitro* plantlets has also indicated how important the hierarchy of tubers arising from the same stem can be: although the

size of the shoot system of *in vitro* derived plantlets grown in the greenhouse would suggest that the yielding potential is large, the number of minitubers per *in vitro* plantlet is usually well below the normal numbers in conventional crops. This is partly due to the fact that - despite the low numbers of stolons and tubers produced - many tuber initials are being resorbed. Therefore, the production of minitubers has triggered a lot of interest in the effects of management of the *in vitro* plantlet crop on tuber formation. Also the number of progeny tubers per individual plant grown from a minituber is often lower than in conventional crops and requires special attention while managing the crop.

Why are they Important for the Potato Industry?

Minituber production has found its place in the seed production systems all over the world as it creates a bridge between the *in vitro* rapid multiplication based on nodal cuttings and the field multiplication of seed tubers. Minitubers are more flexible, can be stored and mechanically planted, and show a larger vigour than either microtubers or *in vitro* plantlets. Yet, as they are produced under controlled conditions they have a very high health status. Minitubers are usually sold to specialist growers who use them for further multiplication for later generations of seed tubers. As the price of minitubers is rather high they will only be used under conditions with very little chance of seed degeneration and with a maximum rate of multiplication. It is essential to enhance crop establishment and canopy cover when using minitubers as seed tubers in the field, especially when the growing season is limited in length due to frosts (at the beginning or at the end) or aphids.

Minitubers form a high quality type of propagation material (in terms of health status, true-to-typeness, and vigour) that can be produced in large quantities, and can be easily stored and multiplied further. It is also an excellent type of material for first multiplication in the field. The production systems of minitubers have become so efficient and cheap that large quantities can be produced at relatively low prices, thus allowing a strong reduction of the number of field generations. Minitubers are therefore especially attractive in areas with a high rate of seed degeneration. In some areas already the third or fourth field generation is used for processing into French fries.

Scientific Developments

The minituber technology is well established but there will be more research needed on the proper pre-treatment of the *in vitro* plantlets to be used and the management of the crop grown from these *in vitro* plantlets to further increase the number of minitubers per *in vitro* plantlet, especially (but not exclusively) in systems where these plantlets are put on soil media in the greenhouse. Stolon-to-stolon competition and tuber-to-tuber competition within one single plantlet especially require further research. Also the tuber formation phenomena on plants produced from minitubers need to be investigated further.

Further Reading

- Lommen WJM, Struik PC (1992) Production of potato minitubers by repeated harvesting: effects of crop husbandry on yield parameters. *Potato Res* 35:419–432
- Lommen WJM, Struik PC (1994) Field performance of potato minitubers with different fresh weights and conventional seed tubers: Crop establishment and yield formation. *Potato Res* 37:301–313
- Ranalli P (1997) Innovative propagation methods in seed tuber multiplication programmes. *Potato Res* 40:439–453
- Struik PC, Wiersema SG (1999) Seed potato technology. Wageningen Pers, Wageningen, The Netherlands
- Struik PC, Lommen WJM (1999) Improving field performance of micro- and minitubers. *Potato Res* 42:559–568