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The Canon of Potato Science:

23. Transplants

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What is it?

Various methods are utilised for the production of potato seed tubers. Next to the conventional seed production systems which utilise normal seed tubers, methods using nodal cuttings are preferred for seed tuber production purposes. This is because they conserve the genetic make-up of the parent plant since new plants are produced from existing buds.

The fastest seed production scheme with the highest multiplication rate per unit time involves four phases: Multiplication *(in vitro)*, Normalisation *(in vitro)*, Transplant production *(ex vitro)* and Tuber production (Field) phases. Transplants can, therefore, be defined as rooted *in vitro* derived plantlets which have been acclimatised *ex vitro* to be transplanted into the field or other facilities to produce tubers.

In vitro propagated transplant crops are widely used as starting material in seed production systems in potato and in many other crops. The status of the plantlet at the end of the *in vitro* phase is important as it may affect further performance of the transplant. Different experiments have shown that the leaf area of the *in vitro* plantlet (an important characteristic of its vigour) could be influenced by different treatments. Adding Alar (daminozide) in a low concentration to an *in vitro* medium often leads to stronger *in vitro* plantlets with well developed leaves and more uniformly distributed roots than a medium without Alar. Surprisingly, increasing nitrogen content of a medium may decrease leaf area and reduce stem elongation and may decrease chlorophyll content. Studies have also shown that *in vitro* manipulation of leaf area enhances plant performance in later stages of growth as leaves are the site of determinant physiological processes occurring in plants, including photosynthesis and transpiration. *In vitro* treatments affected leaf area or ground cover of transplants at the end of the transplant production phase mainly through their effects on leaf area or ground cover at the beginning of the phase. All

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these results stress the importance of a high early (initial) leaf area for achieving potato transplants with a high leaf area at the end of the transplant production phase. The increase in leaf area with time usually follows a logistic growth in the normalisation, transplant production and tuber production phases.

Why is it Important in Potato Science?

Conventional potato seed production systems have low rates of multiplication and carry a high risk of disease infection with increasing number of field multiplication. In areas where one crop of potato is grown in one year, the multiplication rate is only 12–20 per year as compared to 30 to 40 in wheat, 40 to 60 in barley and 150 to 240 in maize. Therefore, several years of field multiplication are required to produce the total quantity of potato seeds needed when starting from limited stock. In commercial varieties 10–15% of the total area must be used for seed production.

Micropropagation techniques have widely been introduced during recent decades to overcome these disadvantages. These techniques produce large numbers of disease-free transplants within a short period of time and losses due to infection hardly occur since production takes place under aseptic conditions. These facts, therefore, indicate that large numbers of disease-free transplants can be propagated within a short period of time to produce the desired quantity of seed tubers.

Transition of plantlets from *in vitro* (normalisation phase) to *in vivo* conditions (transplant production phase) stimulated leaf growth tremendously and to some extent stem growth. This indicates that the limitation of growth at the end of the normalisation phase has been overcome and plants started to grow vigorously in the transplant production phase.

The most important factor that positively affected leaf area growth of transplants was a high initial leaf area of the plantlet after planting which may have resulted from either natural variation among plantlets or from *in vitro* treatments applied. Transplant growth at higher temperatures (26/20 versus 18/12 °C) during transplant production resulted in a higher leaf area at the end of the transplant production period.

Potato tuber yield was improved directly by promoting leaf area of transplants or indirectly by changing assimilate partitioning between the above ground parts of the plant and tubers in the field phase. The pattern of dry matter distribution could also be influenced by the temperature conditions during transplant production. Thus, production of transplants should be adjusted to the expected effects of growth conditions in the tuber production phase.

Why is it Important for the Potato Industry?

The conventional way of propagating potato involves the repeated multiplication of potato seed tubers and the multiplication rate is very low. Potato is susceptible to viral, bacterial and fungal diseases and the seed stock gradually degenerates with increasing numbers of field multiplication. Healthy basic seed, therefore, needs to be maintained and multiplied several times in the field to produce commercial seed in the amount required. This obviously limits potato seed production in many regions

of the world, especially in those where degeneration is rapid. Routine production of disease-free seed tubers is costly and difficult but necessary to maintain adequate yields of ware potatoes.

Micropropagation, which involves the production of transplants, is one of the techniques widely used nowadays to produce large quantities of healthy and genetically uniform *in vitro* plantlets for seed tuber production purposes. As a tool for production of potato seeds, micropropagation has been expanding rapidly in the recent past and almost all seed producing areas in North America and Europe have either built one or modified the existing infrastructures to accommodate this type of propagation. The reasons for this are obvious:

a) large numbers of disease-free plants can be produced in a short period (25 fold multiplication per 8 weeks);
b) losses due to pests, diseases etc. hardly occur, because production takes place under aseptic conditions;
c) multiplication can take place whole year round in small, controlled environment with easy storage of propagules; and
d) multiplication rate is constant within a variety — enabling good planning of the work.

Scientific Developments

Micropropagation techniques involving the production of transplants are well established nowadays in the potato technology. However, further research is required on how morphological and physiological changes of transplants are affected by different treatments in earlier phases. Knowledge on these aspects will help to develop protocols to manipulate the propagules at different propagation stages in order to direct growth and development of the transplants and affect yield in the tuber production phase in the greenhouse or in the field.

Strategies to optimise the production and use of transplants and reduce the costs of production should be focused on achieving leafy starting material, reducing the stress during changes in environment and optimising conditions during tuber production.

Further Reading

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