Clonal Selection in Potato Seed Production

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Multiplication of potato clones

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Clonal Selection in Potato Seed Production

Objectives. Study of this bulletin should enable you to:

- explain clonal selection,
- specify its application,
- demonstrate procedures,
- plan a clonal selection program.

Study materials.

- A virus-diseased potato plant to explain transmission of systemic infections.
- A healthy potato plant for comparison.
- Slides and/or flip charts.

Practicum.

- Identify plants in a potato field to start clonal selection.
- Practice planting of a clonal selection field.
- Practice elimination of undesirable clones.
- Prepare a clonal selection program based on your home situation.
Questionnaire.

1. Why is a clone defined as all tuber progeny from one potato plant?
2. What does “systemic infection” mean?
3. Why does a systemically infected plant produce a diseased progeny?
4. What is the principle of clonal selection?
5. Which of the two principal seed production steps, basic seed or certified seed, may include clonal selection?
6. Why must basic seed be multiplied into certified seed?
7. Why is clonal selection useful to control PVX and PVS, and why is it of doubtful value for PLRV and PVY?
8. What is the particular value of virus testing in clonal selection?
9. How can the efficiency of a clonal selection program be increased, that is, how can the amount of basic seed be increased or the number of multiplications be reduced?
10. What resources are needed to begin a clonal selection program?
11. In initial selection of most desirable plants, which diseases would you consider? Why?
12. Why should you store tubers from each selected clone separately?
13. In the first multiplication, what are the advantages and disadvantage of the hill unit method as compared with the single tuber method?
14. Why are the best tubers of the first multiplication most useful to reinitiate another multiplication cycle?
15. Why should tubers be planted in order of descending size if no uniform seed tuber size can be maintained?
16. Which factor makes clonal selection expensive?
17. See the second example in section 5: How would one additional multiplication of certified seed change the calculation of a clonal selection program?
Clonal Selection in Potato Seed Production

1 Introduction
2 General principle
3 Application
4 Procedure
5 Calculation of a clonal selection program - Examples
6 Additional reading

1 Introduction. High quality seed is a major factor to ensure satisfactory yields. Clonal selection is a tool to produce high quality seed. It is done by initially selecting high quality tubers and then multiplying each clone separately. Any evidence of disease results in discarding the entire clone. Although simple, the procedure is costly and therefore may be more appropriate for a seed production station than for an individual farmer. However, in certain situations farmers can benefit by using this method.
2 **General principle.** Clonal selection has many variations of the same principle. The following description is general and the procedure may be altered.

A clone comprises "...all descendants derived asexually from a single individual, as by cuttings, bulbs..." (Webster's *New World Dictionary*). Thus, all potato plants derived asexually by multiplication from one individual potato tuber form a clone. A clone is genetically uniform.

Health of seed tubers as well as genetic characteristics are of major concern. In seed potato production most virus diseases are "systemic," that is, they affect the entire host. They are transmitted from one tuber multiplication to the next. A diseased tuber produces a diseased progeny and the clone remains infected.

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In seed potato production health of seed tubers as well as genetic characteristics are of major concern.
Multiplying a healthy clone depends upon the initial selection of a healthy tuber. However, an originally healthy clone may become infected unless proper precautions are taken.

Select a healthy tuber for its desired characteristics. All progeny of this one tuber throughout all multiplications makes up a clone when identity is maintained. A clonal selection program uses many original tubers, thus in each variety many clones are involved.

Each clone is multiplied separately. Eliminate clones with undesirable characteristics such as disease, poor yield, lack of vigor. Retain and multiply only the most desirable clones.
3 Application. Clonal selection is useful at a certain stage of seed potato production. In a well established program, seed potatoes are produced in two principal steps:

- basic seed step,
- certified seed step.

Basic seed step. At the beginning of seed multiplication an original stock of healthy plant material is increased by several multiplications to produce basic seed. This increase is commonly carried out by a seed production station or by selected private seed growers. One method for producing basic seed is clonal selection.

Certified seed step. Basic seed is too costly to use directly for consumer potato production. It is normally multiplied at least twice to produce certified seed for the farmer. These multiplications are usually by experienced seed growers.

Practical clonal selection depends on the local situation. Proper clonal selection produces seed relatively free of contact viruses, such as potato viruses X and S (PVX, PVS). In other seed production methods these viruses are difficult to detect and they spread easily from plant to plant. If these diseases are not important, the clonal selection process is of doubtful value. Insect transmitted viruses, such as potato leafroll virus (PLRV) or potato virus Y (PVY), which cause symptoms relatively easy to see, can be eliminated by roguing.

Clonal selection is used to control contact transmitted viruses which seldom cause easy-to-recognize symptoms. Virus testing for PVX and PVS in the first two or three multiplications of basic seed is usually of value. Virus testing requires the use of antisera and/or indicator plants. Because this process may be more costly than the benefits derived other selection methods may be considered. Rapid multiplication techniques may increase the efficiency of a clonal selection program. Virus testing and rapid multiplication techniques require more sophisticated facilities and trained personnel.
4 Procedure. A clonal selection program begins with any source of healthy tubers. At the beginning of a clonal selection program a reasonably healthy potato field is most frequently used. More sophisticated seed production programs sometimes use small amounts of imported seed or materials from rapid multiplication or tissue culture techniques. Once the clonal selection program is in progress, a multiplication cycle may be restarted by extracting the best and healthiest tubers from an earlier multiplication.

Initial selection. Careful selection of the most desirable plants is the most important initial step. These plants should be free of diseases important for a particular seed production program; diseases of minor importance may be ignored. Initial selection includes observation of plant material during the growing season, at harvest and after storage.

Early in the season during rapid growth shortly before or at beginning of blossoming, select and mark (with stakes) more plants than will ultimately be needed. Later discard those plants that are undesirable.

At harvest carefully select the best plants from those staked. Selection is based on high yield, typical tuber type, tuber uniformity, and freedom of visible diseases.

Each set of tubers from one plant is a clone. Store each retained clone separately to maintain clonal identity. After storage and before planting, eliminate clones that did not store well and do not appear of good quality. These retained clones begin the multiplication cycle.
**First multiplication.** Two methods are possible to start this cycle, the plant unit method or the tuber unit method.

In the **plant unit method** all tubers of a progeny from a selected plant are planted, each progeny separately from the other to maintain clonal identity. This method is used when only a few clones are needed or when field space is not limiting. Any disease incidence leads to elimination of the entire progeny resulting in loss of many plants. A composite leaf sample from all plants in the clone may be used to detect contact virus infection using appropriate virus detection methods.

In the **tuber unit method**, only one tuber is retained and planted from an initially selected plant. This method is useful when many clones are necessary. Disease incidence leads to elimination of only the infected plant. A composite sample taken from each stem of the plant may be used to detect contact virus infection.

The single tuber method can be replaced by the **hill unit method** when the developing program produces healthier clones.

At planting, wide spacing between and within rows facilitates inspection of plants and reduces possibility of transmission from plant to plant. Selection during growing season and harvest follows the same rules as indicated earlier. During the first multiplication, reduction in plant number may be considerable due to elimination of disease infected plants. Tubers of each clone are again stored separately. Only the most desirable clones are carried onto the second multiplication.
Second multiplication. From the retained clones of the first multiplication enough of the best tubers or plants are selected to reinitiate another multiplication cycle. The rest of the tubers are planted together, each clone separate from the other. Plant spacing may be less than in the first multiplication.

There is no consensus on whether all tubers of a clone, or equal tuber numbers per clone should be planted. Planting equal numbers gives rows and plots of equal size. This makes field layout clearer and yield comparisons easier. Excess tubers left over from this system may be added into the final multiplication. On the other hand, planting all tubers accelerates multiplication process and helps to identify those clones with the highest multiplication rate.

Plant tubers of uniform size or plant tubers in order of descending size. This gives a more uniform arrangement of plant sizes within a row and makes inspections more conclusive. Irregular planting of different tuber sizes results in non-uniform plants that are difficult to inspect and evaluate.

During the growing season, at harvest and after storage, inspect for disease infections, uniformity, plant and tuber type as before. Composite samples of leaves are taken from a percentage of the plants to detect contact viruses. If only one plant of a clone is infected or otherwise undesirable, the entire clone is eliminated. This is necessary because all plants of a clone are derived from one mother plant, and it is probable that the infection originated from the mother plant which passed the infection on to all tubers, although not all of them may show symptoms. Also new (current season or "primary") infections may spread so quickly that elimination of the entire clone is justified. Insect transmitted viruses should not always cause the entire clone to be eliminated, but only those plants with symptoms if detected while the plants are small. If detected when the plants are touching, neighboring plants are also eliminated.
Third and following multiplications. Clones are planted as indicated for the second multiplication. With each multiplication, the area needed per clone increases. It is evident that due to the strict elimination principles, clonal selection may be too expensive when applied indiscriminately in every situation. For these later multiplications consider restricting clonal elimination to the most serious incidences of disease and other undesirable characteristics. In less severe cases, eliminate early only the infected plants, or neighboring plants when vines touch. Thus, the type of disease and growth stage of the crop are important considerations for elimination.

The number of multiplications necessary to produce the required amount of basic seed depends on the multiplication rate of a particular variety under the particular environmental conditions and population density. Each additional multiplication not only increases the amount of tubers, but also disease infections and expenses. For sanitary reasons, as well as economic considerations, the number of multiplications should be restricted to a minimum.

Final multiplication. In the final multiplication, clonal identity is abandoned. All clones of the same variety are planted together. Elimination is limited to individual plants. The harvested product of this multiplication is Basic Seed. The tubers produced in the previous multiplications can be called Prebasic seed; i.e. Pre-basic 1 (= first multiplication), Pre-basic 2 (= second multiplication), Pre-basic 3, etc. The basic seed, in order to have an impact, must be further multiplied by farmer seed growers.
5 Calculation of a clonal selection program - Examples. Clonal selection is only effective when it meets the total demand for basic seed required. The demand of basic seed depends on the area the consumer potato crop is to be planted with certified seed. Two examples demonstrate calculation procedure.

First example. The following assumptions illustrate an easy calculation.

Given:

- Consumer potato area: 1000 ha
- Seeding rate: 2 t/ha
- Average seed tuber size: 50 g/tuber
- Multiplication rate: 10
- Number of multiplications for production of certified seed: 3

From these figures answer the following questions:

- Amount of basic seed required?
- Number of multiplications for production of basic seed?
- Minimum number of clones required?
Calculation. For a consumer potato area of 1,000 hectares the amount of certified seed needed is:

\[ 1\,000\,\text{ha} \times 2\,\text{t/ha} = 2,000\,\text{tons of certified seed required.} \]

This amount of seed is produced in three multiplications assuming a multiplication rate of 10 from basic seed:

\[ \frac{2\,000\,\text{t}}{10 \times 10 \times 10} = 2\,\text{tons of basic seed required.} \]

At an average tuber size of 50 g/tuber, 2 tons of basic seed correspond to:

\[ \frac{2\,000\,\text{kg}}{0.050\,\text{kg/tuber}} = 40,000\,\text{tubers.} \]

40,000 tubers may be produced in 4 multiplications assuming a multiplication rate of 10 according to the following formula:

\[ \frac{40\,000\,\text{tubers}}{10 \times 10 \times 10 \times 10} = 4\,\text{initially selected tubers.} \]

Result:

- amount of basic seed required = 2 t
- number of multiplications for production of basic seed = 4 multiplications
- number of clones required (minimum) = 4 clones

Note. These 4 clones (originating from 4 initially selected tubers) constitute the minimum number required. That means a minimum of 4 clones must be maintained throughout the entire clonal selection process. Because some clones are likely to be eliminated, the initial number of clones should be much higher than 4.
1st. multiplication
8 clones – 8 plants
80 tubers
pre-basic 1

2nd. multiplication
7 clones – 70 plants
500 tubers
pre-basic 2

3rd. multiplication
5 clones – 500 plants
4,000 tubers
pre-basic 3

4th. multiplication
4 clones – 4,000 plants
40,000 tubers
basic seed

Clonal selection program according to the first example in section 5.
Second example. Of more practical value than the first example are the assumptions of this second example.

Given:

Consumer potato area 1 000 ha
Seeding rate 2 t/ha
Average seed tuber size 50 g/tuber
Multiplication rates
  Basic seed 7
  Certified seed 5
Number of multiplications
  Basic seed 4
  Certified seed 2

From these figures calculate the following data (practice calculation procedure):

Amount of basic seed required at the end of 4 multiplications (result = 80 tons).
Minimum number of clones required in the first multiplication (result = 666 clones minimum).
Additional reading.


CIP's Technical Information Bulletins constitute one of several categories of CIP technical information. Their principal objective is to provide any type of agricultural programs with technical information on all aspects of potato industry to support transfer of technology from and to farmers' field. The information is destined for an intermediate professional level (B.Sc., "ingeniero agrónomo"), but it is written in a form that is easily adaptable to farmers' level. The publications are open for any type of application. However, CIP aims specifically at the following objectives:

a) to support individualized study,
b) to support application of known and new technology,
c) to support practice oriented experimentation,
d) to support formal courses,
e) to support provision of information materials to farmers.

To facilitate additions and changes the bulletins are commonly delivered in loose-leaf form or with binding rings. The objectives, study aids, practicum and questionnaire attached in front of most bulletins may be useful when the information is applied to support the objectives (a) and (d).

CIP would like to learn from your experience with the Technical Information Bulletins in order to adapt them more adequately to your need. Please answer the following questions and send this sheet back to CIP.

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2. Where did you receive it from? ...........................................
3. What is your job? .................................................................
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5. Should other information be included? Which one? .................
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7. Did you utilize the information in one of the forms suggested above:
   a), b), c), d), e)? In which other form? ....................................
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