Seed Potato Certification Authority
Best practice guide for storage and handling of certified seed potatoes

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1. Introduction

Practices adopted during packing, storage, cutting and transportation of seed can have a significant bearing on seed quality. For this reason the Authority has developed this guide to establish what might be considered best practice for the handling and storage of seed potatoes in New Zealand. This guide is intended to inform both seed growers as well as ware growers of factors that can affect seed potato quality and how to best manage these. This is part of the Authority's and the Potato Sectors commitment to ongoing improvement of seed potato quality.

The New Zealand Seed Potato Certification Authority provides certification that seed lines do not exceed acceptable pest and disease tolerances during growth and certifies trueness to variety. The certification applies to the seed at the time of final tuber inspection. The Authority does not provide any assurances of how the seed is handled after the point of certification.

2. Process flow for seed storage

The diagram (Figure 1) summarises the key steps from seed potato harvest through storage to the point of planting the tubers as a ware or process crop. The purpose of the diagram is to identify the stages where proper handling and storage conditions can minimise the degradation of seed quality. Or put another way, the stages where improper handling can damage the seed.

3. Physiological ageing – a key issue in seed quality

A key factor affecting the performance of a potato crop is the physiological age of the seed piece. Potato tubers that are subject to severe or ongoing stress during their lives tend to age at a rate that differs from their chronological "age". Anything that raises the respiration rate of the tuber (such as high temperatures, disease, wound healing) will cause tubers to age more quickly (Bohl *et al*, 2000). A tuber that has been stored for 6 months may have a physiological age that reflects these 6 months of careful storage, or if it has been subjected to stresses it may be physiologically much older.

3.1. What is the effect of physiological aging?

Effects can vary between varieties, but it is generally true that compared to young seed old seed will:

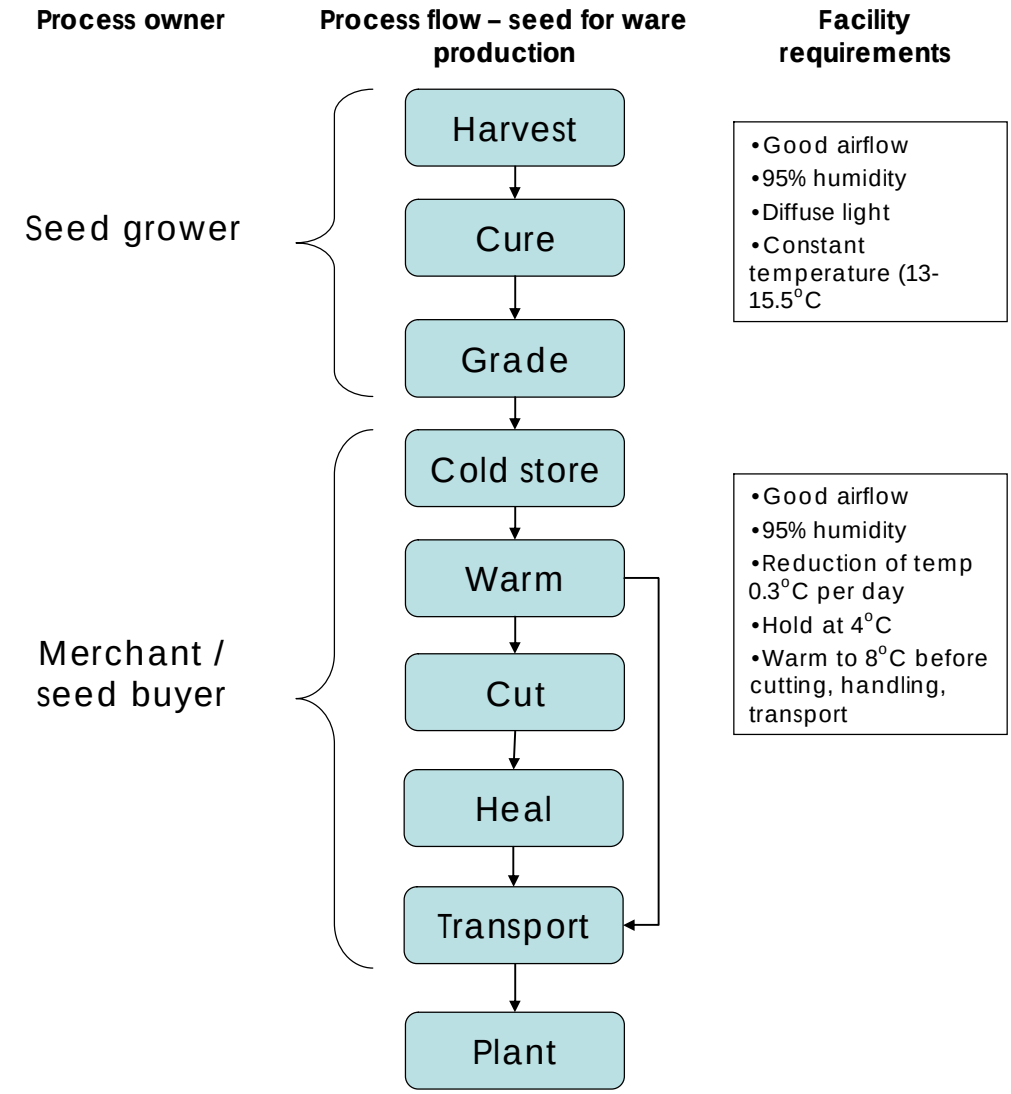
- emerge more rapidly;
- have more sprouts;
- have more stems per plant;
- yield more highly in a short season;
- produce a slightly lower yield in a long season;
- produce smaller tubers at harvest (Bohl *et al*, 2000).

This can be either a good thing or a bad thing depending on the intended use of the seed tubers. For example, growers of process potatoes may be seeking large tubers and have a long growing season available. By using young seed they will be more likely to meet this aim and produce a high yield of large tubers. On the other hand a

ware grower seeking many smaller tubers should use physiologically aged seed rather than young seed.

It should be noted that aging is a gradual process and there is no clear distinction between the stages of this process. A great deal of research has been carried out in an attempt to develop a scale of ageing and ways to measure this, but results are highly variable even within varieties. Sprout tests can be used to gauge approximate age, and publications such as Struik & Wiersema (1999) provide diagrams and descriptions of the characteristics of various ages of seed. Information on the conditions under which seed has been produced and stored can also assist ware growers to estimate the physiological age of seed.

Figure 1. Process flow for seed potato storage and handling – seed destined for ware production



3.2. What are the stress factors that age seed?

Physiological aging can be caused by anything that places stress on the plant during tuber development (such as drought, disease, frost) and during storage and

handling (high or very low harvest temperature, bruising, storage temperature, humidity, cutting, and disease).

4. Recommended practices for storage, cutting and transport

4.1. Storage

There are three main factors affecting the condition of tubers following storage – storage temperature, humidity, and airflow. The different phases of storage also need to be considered – the curing period after harvest and longer term storage have different storage requirements.

After harvest the tubers require a period for wound healing and curing before they are cooled for longer term storage. During this time the temperature should be held at about 13-15.5°C with good airflow and 95% humidity.

If the tubers have been harvested in very warm (>20°C pulp temperature) or very cold temperatures (<7°C) their temperature will need to be adjusted as soon as possible. Field heat is difficult to remove, so it is recommended that tubers are not harvested over 20°C pulp temperature. In New Zealand this process generally occurs at ambient temperature in the growers shed. Average air temperatures in Canterbury are in the ideal range during March and April, however during February-May humidity is lower at 80-85%. Humidifiers can be used to increase humidity in the shed.

Tubers should be held at 13-15.5°C for a period of 4-5 weeks in diffused light and with good air circulation until the tubers have stabilised and become dormant**.** After this they may be slowly cooled (avoid rapid cooling) at a rate of 0.3°C per day until they reach the ideal storage temperature of 4°C (this can vary with variety and varietal recommendations should be followed) and should be held at that temperature with good airflow and with humidity between 90- 95%. It is very important that tubers are dormant before they are coldstored.

High humidity can help minimise moisture loss in storage, especially when air is being forced around the tubers. Humidifiers can be used to increase humidity in the coolstore. Good airflow is also essential to reduce CO_2 build-up in storage, as excess CO_2 levels can lead to sprout development. Continuous aeration is not necessary, and can lead to excess moisture loss - aeration for a few hours a day can be sufficient.

4.2. Grading

Very cold tubers should not be graded, as cold tubers are more susceptible to bruising damage. If the tubers have been coldstored before grading they need to be slowly warmed to at least 8°C to reduce bruise injury (10 °C for bruise susceptible varieties). Grading machinery should be set up to minimise the length of drop of tubers from conveyers and into bags or bins to no more than 15cm. An excellent review of bruise prevention has been written by Thornton and Bohl (2006).

4.3. Cutting

The temperature at which tubers are cut is very important. Very cold seed should not be cut. It should be slowly warmed to the age-appropriate cutting temperature – around 10°C for young seed and no more than 8°C for old seed. Johnson (2006)

provides an excellent review of the inter-relationship between age, pre-cutting, and cutting temperature.

The period of time before planting at which seed can be cut varies with the physiological age of the seed. Cutting ages the seed. Generally the older the seed the shorter the time before planting that it should be cut. Young seed can be pre-cut and cured up to two weeks before planting. This is an advantage in that cut surfaces can be healed before transport and planting. In contrast, very old seed can be cut only a few days before planting.

A further consideration is sharpness of cutting blades - ensure the blades are very sharp, as clean cuts will heal faster and cause less bruising than blades that are not sharp. Cutting equipment should also be sterilised between seedlines to prevent spread of disease and virus.

In New Zealand almost all cut seed is produced in the South Island and is transported to the grower after cutting. Such seed needs to be allowed to cure for a period before shipping. During curing good ventilation and temperature control is required. In the USA, Johnson (2006) recommends curing cut seed for 6-10 days at 85-95% humidity before transport and planting. In New Zealand, merchants recommend a minimum curing period of 24-36 hours before transport, or immediate transportation (<24 hours) to its destination. Fungicidal seed treatments are generally applied after cutting to prevent disease, and tubers are coated with bark powder or cement to aid wound healing.

4.4. Transportation

Long distance transportation of whole and cut seed is a stage of the production chain that can have a major impact on seed potato quality. As noted above, bruising, lack of ventilation and temperature fluctuations can lead to ageing of the seed and disease development.

Seed should not be transported directly out of cold store, as cold seed bruises more easily than seed that is at least 8^{o}C. It is also important that seed does not overheat during transport. As most seed is transported in bins on tarpaulin covered trucks with no refrigeration, overheating, temperature fluctuations, and ventilation can all cause problems.

Some measures that can be taken to protect quality are:

- Ensure cut seed is transported to its destination as quickly as possible (<24 hours)
- Ensure drivers don't walk on the tubers while covering the load
- Leave a small part of the load uncovered (rear of tarp) to improve airflow
- Remove covers when parked for any length of time (e.g., on ferry crossing)
- Don't remove covers when parked if raining – park under cover and in the shade

Many seed companies have developed codes of practice with their transport suppliers – growers can ask for details of the assurances seed companies can provide in addition to seed certification.

On receipt of seed tubers growers should check the temperature and condition of the tubers and move bins to a well ventilated store.

5. Summary of best practice to manage seed quality during storage and handling

Temperature

- × don't harvest too hot or too cold
- ✓ allow wound healing to occur at 13-15.5°C
- ✓ ensure cooling (0.3°C per day) or warming is gradual
- ✓ don't handle cold tubers
- ✓ don't allow temperatures to fluctuate widely
- ✓ ensure forced ventilation air is slightly cooler (as little as ½ a degree) than the tubers to prevent condensation
- ✓ check temperatures in storage – infrared thermometers can detect hotspots, which may indicate a disease or ventilation problem
- ✓ ensure cut seed is cured before transport

Humidity

- ✓ use humidifiers to increase humidity to 95% in storage
- ✓ always humidify air that is forced through stacks of seed tubers

Ventilation

- ✓ ventilate storage facilities
- ✓ ventilate consignments being transported
- ✓ in transport leave a small part of the load uncovered (rear of tarp) to improve airflow
- ✓ remove covers when parked for any length of time (e.g., on ferry crossing)
- × don't remove covers when parked if raining – park under cover and in the shade

Bruise prevention

- × don't handle potatoes below 8°C
- × don't allow tubers to drop more than 15cm
- ✓ use cushioning material , such as foam, in drop areas (bins, trucks)
- ✓ ensure drivers don't walk on the tubers while covering the load

Light

- ✓ cure in diffuse light to induce dormancy

6. References and further reading

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