SPECIAL FEATURE: SEED POTATOES

As every vegetable grower understands, all good crops start with good seed, and potatoes are no exception. However, potato tubers, unlike many other seeds, need a considerable care and attention to optimise results. Seed potatoes, themselves a perishable input, power the young plants for their first 40 days and account for about 30% of the total cost of production. Understanding what they need, and why, is of great value.

By Paulette Baumgartl

EXPLORE A TOPIC FURTHER

Our special extended feature on seed includes information on age, diseases, storage, cutting, treatment, and certification. Some topics have been extensively covered in previous editions of this magazine or elsewhere; look for this symbol for links to articles, webinars, and fact sheets.

SEED AGE

At any one time the seed tuber has two ages: its chronological age and its physiological age. Chronological age is, as the name suggests, a time marker, usually from harvest. Physiological age reflects the life the tuber has led since harvest.

The physiological age of seed will influence how a potato crop will perform (Table 1). Growers can effectively manipulate the physiological age of seed potatoes according to growing conditions and desired outcome. For example, seed growers may prefer older seed that yields many smaller tubers, whereas growers producing processing potatoes may favour younger seed so as to produce larger tubers.

Young seed	Old seed
Slow emergence	Rapid emergence
Fewer stems / hill	More stems / hill
Low tuber set	Higher tuber set
Longer tuber bulking period	Shorter tuber bulking period
Long tuberisation period	Uniform tuber set
Larger tubers at harvest	Smaller tubers at harvest
More foliar growth	Less foliar growth

Table 1. Characteristics of old tubers versus young tubers (Adapted from Bohl, Nolte, Kleinkopf and Thorton; Struik (2007))

Many factors effect physiological age, including:

- Depending on cultivar, seed **dormancy** may vary from a few weeks to several months.
- **Growing conditions** of the seed. Crop stress due to high temperatures, low moisture, poor nutrition, frost, or disease pressure increase ageing.
- **Mechanical damage and bruising** of the tubers increases seed respiration rate and accelerates ageing.
- **Cold storage temperatures** reduce respiration rate and therefore ageing. Avoid fluctuating temperatures due to low ventilation rates.
- **Respiration rates of cut seed** rise during healing, increasing physiological age. Providing optimal conditions for rapid curing after seed cutting minimises ageing and disease risk.

EXPLORE FURTHER

For a deeper dive into the topic of seed age, read more in Issue 1 of PotatoLink Magazine:
http://bitly.ws/BFzD

To read more about diseases, access the fact sheets here:
https://potatolink.com.au/factsheets

To watch webinars about diseases, access here:
https://potatolink.com.au/webinars

DISEASES AND DEFECTS OF SEEDS

Potato seed tubers can be an important source of disease inoculum, and, when present, can cause substantial reductions in yield or quality in the subsequent crop under the right environmental conditions.

Some diseases are more likely to cause significant losses than others.

Diseases, such as ring rot, late blight, and leafroll (net necrosis) (Figure 1), are carried on or in the seed, and have the potential to spread very quickly through the crop. Tubers infected with such diseases need to be safely discarded. Other diseases, including rhizoctonia black scurf and pythium leak, have limited secondary spread from the tuber (other sources of inoculum are usually more concerning) and are less serious.

Importantly, the absolute losses resulting from specific tuber problems will depend upon environmental conditions and disease management practices. The most important aspect of disease management in potato production is the use of certified seed potatoes (see break out box on page 12).

Table 2 provides a useful summary of typical tuber diseases, physical symptoms and risks.

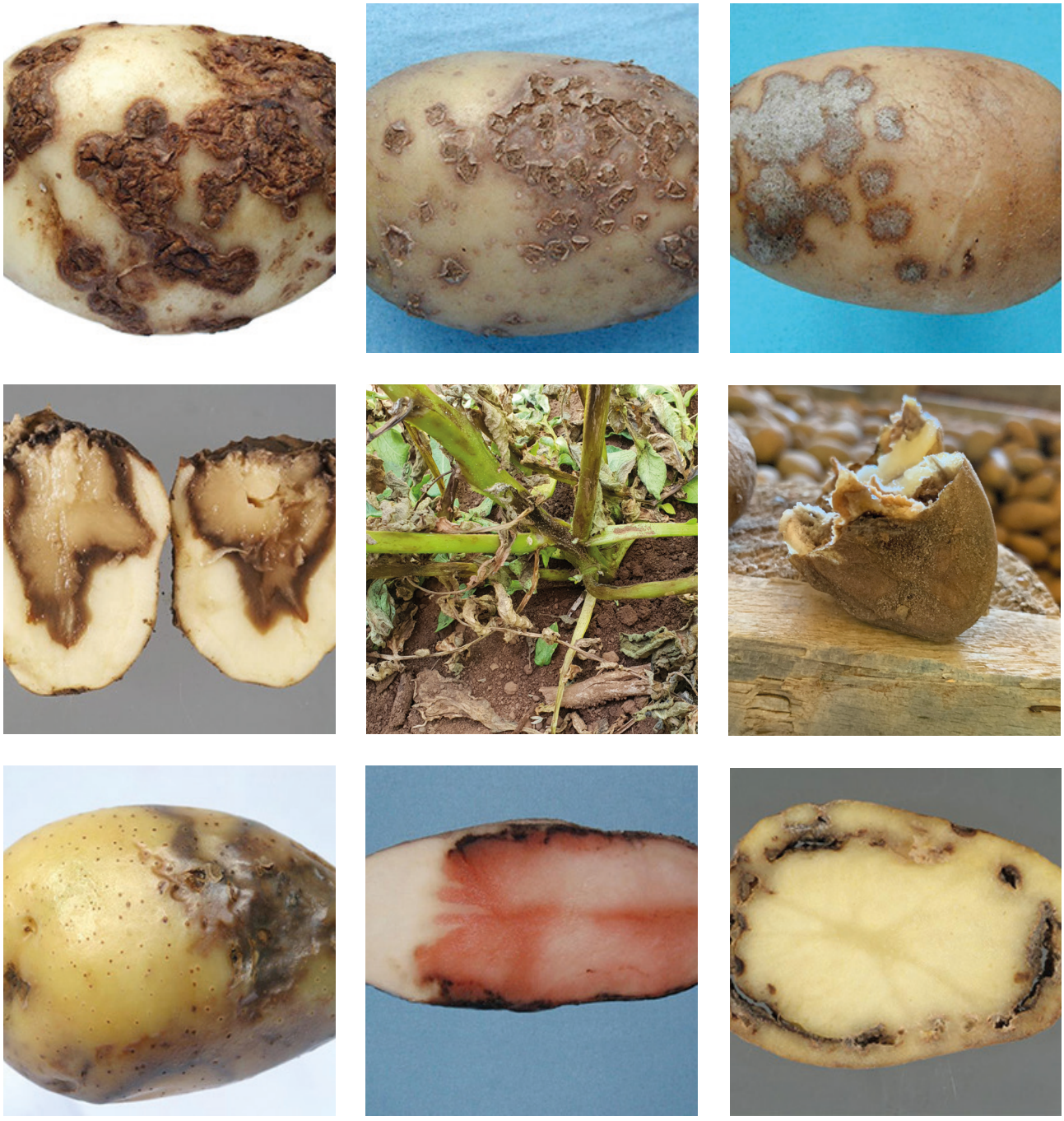

Figure 1. From top, left to right: common scab, powdery scab, silver scurf, soft rot, blackleg, fusarium rot, late blight, pink rot, ring rot (Source: Agriculture and Horticulture Development Board (AHDB) potatoes archives website).

Disease or defect	Source of pathogen or disorder			Diagnosis & location on/ in tuber	Spread within storage[1]	Other comments
	Soil	Seed	Other			
Common scab	✓	✓		External, general	No	
Powdery scab[2]	✓	✓		External, general		See footnote 2
Rhizoctonia	✓	✓		External, general, must wash	No	
Silver scurf[3]	✓	✓		External, general, must wash		See footnote 3
Bacterial soft rot	✓	✓	✓	External general; internal general	Yes	Other sources are from cull piles and irrigation water
Blackleg	✓	✓		External, stem end; cut internal stem end and longitudinal	No	
Early blight	✓	✓		External, general; internal, make shallow cuts through lesions	Yes	
Freezing and chilling			✓	External, general; internal, stem end and cross section	No	
Fusarium rot	✓	✓		External, general; internal, cut through lesions	No	
Late blight		✓	✓	External, general; internal, cut through lesions	Yes	Other sources include cull piles and volunteers
Mechanical injury			✓	External, general; internal, cut through damaged area	No	
Pink rot	✓			External, stem end, eyes, lenticels; cut internal, turns pink	Yes	
Ring rot*		✓	✓	External skin cracks; cut internal, near stem end	No	Other sources of inoculum include volunteers, equipment, and containers
Root knot nematode	✓	✓		External, general; internal, cut tangential	No	
Black heart	✓	✓		Cut internal, longitudinal	No	Caused by lack of oxygen under certain field conditions, in storage, and in transit.
Black spot			✓	Cut internal, stem end half or on shoulder	No	Deep piles contribute to problem
Fusarium wilt	✓	✓		Cut internal, through stem end, only in xylem	No	
Leaf roll virus		✓	✓	Cut internal, cross section	No	Insect transmission from infected plants in cull piles and volunteers
Verticillium wilt	✓	✓		Cut internal, extends through vascular ring	No	

Table 2. Summary of important potato tuber disease and defects (Source: Cornell College of Agriculture and Life Sciences https://www.vegetables.cornell.edu/pest-management/disease-factsheets/detection-of-potato-tuber-diseases-defects/summary-of-important-aspects-of-20-potato-diseases-and-defects/)

[1]Refers to tuber-to-tuber spread. Some of the diseases and disorders will progress within affected tubers in storage but will not spread to healthy tubers.

[2]Powdery scab is caused by the pathogen *Spongospora subterranea*. It is not directly spread by tuber to tuber contact in the store. Spore balls, also called cystori, are produced by the powdery scab pathogen and can survive in soil for lengthy periods and the inoculum load can carried on the surface of tubers in infested soil or shed dust. Powdery scab is primarily a soilborne disease and does not develop in the potato storage.

[3]Silver scurf of potatoes is caused by the fungal pathogen *Helminthosporium solani*. The disease occurrence can be promoted in store with free moisture on the tuber surface. In the store, spores of *H. solani* can be spread in air. In addition, the spores of the fungus can be spread in contaminated shed dust coating tubers with inoculum load.

* Not recorded in Australia, and listed as a zero-tolerance disease in seed certification scheme conditions.

SEED STORAGE

Potato tubers are living, breathing, organisms. Keeping this in mind, the particulars around how to keep them happy during storage make a lot more sense.

Potato seeds respire, 'sweat' and convert starch to sugars to use as energy. How much they do any of these things depends on the environment in which they are stored. Are they a little high maintenance? Perhaps. But the correct storage conditions are not complicated. Maintaining them ensures that money invested into quality seed is not wasted.

TEMPERATURE AND RELATIVE HUMIDITY

Note the following key considerations:

1. Maintain uniform temperatures and high (85% to 95%) relative humidity (RH) during storage. **WHY:** Low RH leads to dehydration and shrinkage.
2. Avoid temperature fluctuations by setting maximum and minimum points close together. **WHY:** Fluctuations can reduce the RH in the room and result in condensation on the tubers. The fungi and bacteria that cause breakdown in storage flourish under wet conditions, so seed must be kept dry.
3. Minimise spatial variation within the room to keep humidity high and temperature uniform. Replace leaky insulation and avoid frequent door opening.
4. Ensure potatoes are stacked in a manner that allows air to circulate. **WHY:** Even at 4°C, seed potatoes are still respiring and producing heat. This heat needs to be removed by the cold room air; if the air cannot circulate over and under the bins, hot spots will develop.
5. When warming up or cooling down, change temperatures gradually over several days.
6. Temperature management is most important as the tubers reach the end of their natural dormancy. For example, trials in the Netherlands found that yield was reduced if seed stored at 4°C was warmed to 16°C for more than six weeks before planting. Yield was less affected if seed were stored at 16°C for the same period before cooling to 4°C (Struik et al., 2006). However, the best results were achieved when tubers were kept continually at 4°C throughout storage.

OXYGEN

Seed potatoes are, like humans, sensitive to the concentrations of O_2 and CO_2. If CO_2 levels are too high, potatoes are unable to respire normally. As little as 4,000ppm CO_2 (0.4%) can reduce seed vigour after planting. In severe cases, lack of air inside the centre of the tuber leads to black heart.

EXPLORE FURTHER

Watch more: Dr Jenny Ekman, Maarten van Delden, and Dr Nigel Crump discuss the importance of correct seed potato storage, optimal storage conditions and management of physiological age.
http://bitly.ws/BFAk

Read more: Click here for the seed storage and physiological age factsheet.
http://bitly.ws/BFAy

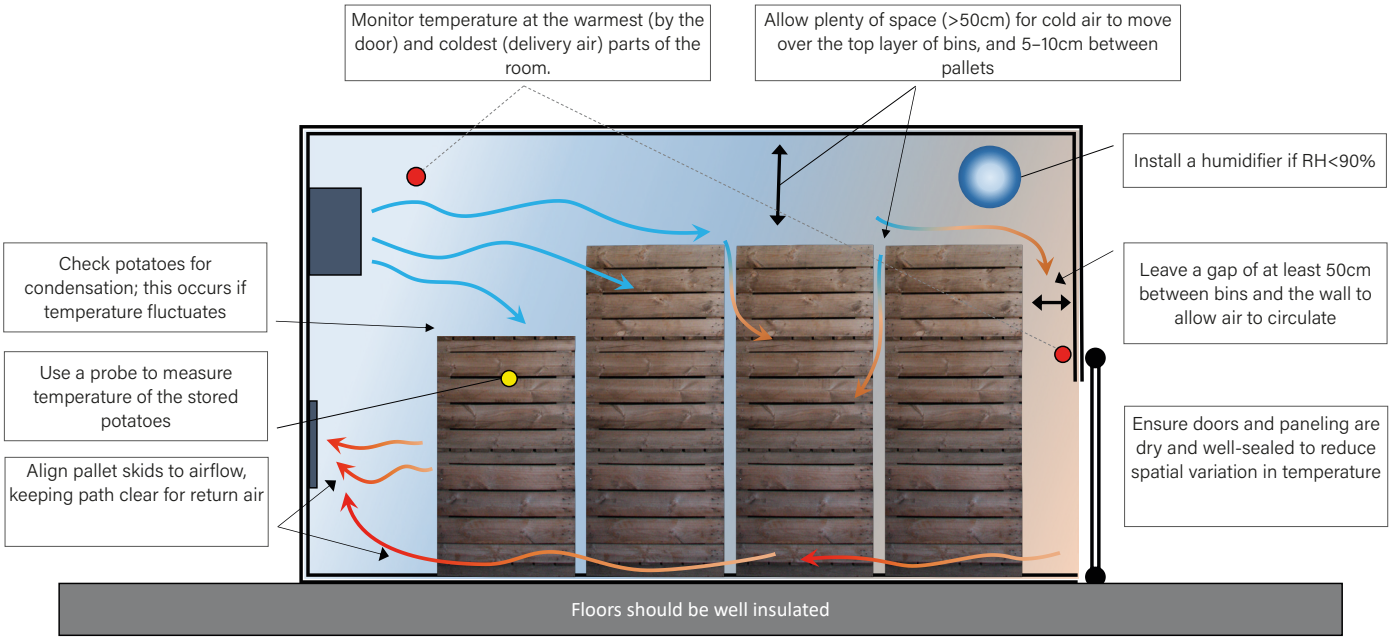

Figure 2. Cold storage rooms should be set up to allow the cold air to circulate around the bins; leave gaps between pallet stacks and the walls, align pallet skids to airflow; leave clear space for the return air intake. Temperature should be monitored and condensation checked in different parts of the room as well as in the stored seed (Source: J. Ekman)

TREATMENT AND HANDLING OF SEED

SEED CUTTING

With seed costing up to 30% of the total cost of potato production in Australia, seed cutting is a common practice.

As well as cost savings, cutting offers several advantages. Properly cut and cured seed, if held for three or four weeks, will overcome dormancy for some varieties. Careful cutting that results in uniform sized pieces with consistent numbers of eyes can improve uniformity of emergence. Cutting is particularly useful for varieties that have slow seed curing ability, such as Atlantic and Kennebec.

Seed cutting: age and temperature

1. Young or middle-aged (physiologically) seed is best suited to cutting, as cutting will further age the seed as it heals.
2. Young seed can be cut up to one month before planting. However, if the seed has already sprouted, this time should be reduced to 2 weeks.
3. Middle-aged seed that has not sprouted can be cut up to two weeks ahead of planting. Middle-aged seed that has sprouted and been de-sprouted is considered old and therefore not suitable for cutting.
4. The temperatures at which to cut and then hold seed varies with physiological age and sprouting.
   - Potatoes shouuld be warmed prior to cutting over approximately 10 days.
   - The younger the seed, the higher the cutting and holding temperatures.
   - Young seed can be cut and held at about 10°C.
   - Older seed should not be warmed or held above 7°C.
   - If the seed has already sprouted, warm to 10°C and cut as soon as the temperature is reached.
5. Carefully consider the effects of temperature and timing on physiological age. Keep in mind that warming, cutting, and holding will all advance physiological age.
6. Remember, pre-cutting is not for all seed.

Cut potatoes will be particularly sensitive to the soil into which they are planted. Delayed emergence, slow, uneven establishment and reduced plant stands are all symptoms of planting seed in soil that may have been either too cold, too wet or too dry. Recently cut seed will be particularly vulnerable to infection and dehydration if planted into an unfavourable environment.

Seed cutting: size

The clear objective is to create pieces that fit into the planter and provide uniform stands. Mechanical cutters may not always be perfect, but can handle large volumes of seed, cutting the tubers into two or four pieces.

The size of a potato seed piece affects early plant vigour a great deal. Larger seed pieces usually emerge faster than smaller ones.

Ideally, cut seed tubers into blocky pieces about 50g in size. Discard poorly cut seed pieces, such as slivers or slabs (Figure 3). Remove seed pieces ripped or torn by dull knives.

Each seed piece should have at least one eye. For varieties with poor eye distribution, such as Atlantic and Shepody, consider cutting seed pieces closer to 55g each.

Also use larger seed pieces (55 – 70g) for Russet Burbank and similar varieties. Adjust planting distances for

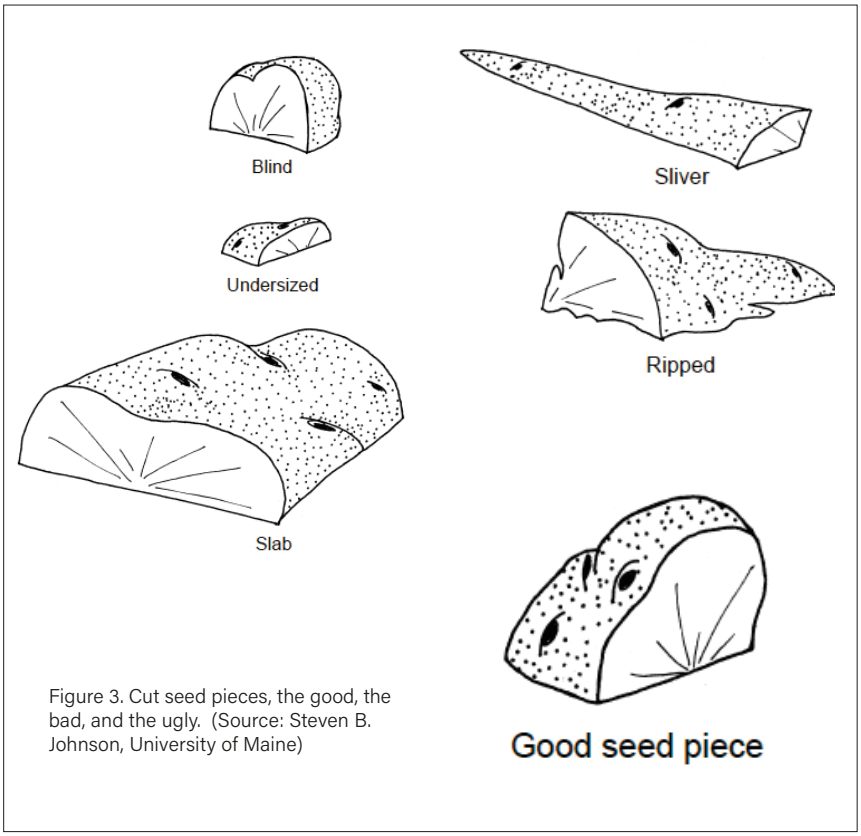

Figure 3. Cut seed pieces, the good, the bad, and the ugly. (Source: Steven B. Johnson, University of Maine)

such large pieces, allowing each extra space to grow.

Higher total yields are generally associated with larger seed pieces, but at some point, the seed piece size will not result in increased yield.

Bruise problems are more likely with very large seed pieces, especially at warmer temepratures. Excess bruising increases the risk of seed decay and accelerates ageing.

If cutting very large seed, also note that each piece will have a relatively large cut surface area. More stored energy will be used for wound healing, leaving less to support new plant growth. Emergence will likely be slowed, and plants will be less vigorous. A good rule is to keep the number of cut surfaces per tuber to a minimum.

Undersized seed pieces can contribute greatly to the number of doubles or triples planted. Oversized seed pieces can cause skips and are also prone to fall out of the planter.

To assess the seed cutting operation, count out 100 seed pieces and weigh them. If aiming for 50g per piece, no more than 10 pieces should be less than 30g or more than 70g. For most planters to run smoothly, at least 70 percent of the seed should be in the 43 – 85g range.

Other key points

1. Seed tubers should not be washed.
2. Do not try to salvage diseased potatoes or those that are breaking down.
3. Grade out bent or very rough tubers for hand cutting.
4. Size seed potatoes before cutting:
   - Less than 50g should not be planted
   - Between 50-100g should be planted whole
   - Between 100-150g should be cut into two pieces
   - Between 150 – 300g should be cut into three pieces
   - Greater that 300g should be cut by hand or not used at all
5. Keep the number of cut surfaces to a minimum to reduce bruising during handling and planting.
6. Seed pieces should have 2-3 eyes.
7. Disinfect all equipment before each seed cutting session and between seed lots.
8. Calibrate the seed cutter daily and between lots.
9. Keep the seed cutter knives sharp and straight to prevent ripping the potato surface. Ripping provides an ideal area for disease organisms to attack the seed.

CURING AND HANDLING CUT POTATO SEED - STEP BY STEP

The curing process takes between six to 10 days when the following steps are followed:

1. Cure cut seed optimally around 15 degrees and with high humidity and good ventilation.
2. Do not pile more than 1.8m deep - good air circulation will keep the temperature uniform and prevent build up of carbon dioxide and ethylene, which interferes with wound healing.
3. Relative humidity levels of 85 – 95% promote healing and prevent dehydration.
4. If there is too much air flow and not enough humidity, a thin skin may form on the cut surfaces. This thin layer is not enough to provide wound protection and can be easily sloughed during handling.

Care in handling cut potato seed is perhaps the most underrated aspect of commercial potato production. Cut potato seed is much more easily bruised than whole potatoes of similar weights. The most vulnerable areas of the seed pieces are the edges of the cut surfaces. Very small impacts can damage cells on the edges of the cut seed. These damaged areas make it easy for pathogens to infect the seed piece. Damaged cells may not heal.

As already noted, there is increasing recognition that optimising emergence and growth means minimising bruising to both seed-tubers and seed pieces. These are effectively baby plants; they need to be handled gently.

TREATING THE SEED: FUNGICIDES AND OTHER ACTIVE INGREDIENTS

Sourcing high quality, certified seed is an investment worth protecting. Seed treatments are therefore an important component of the overall disease management program.

Properly treated seed will provide a better, more uniform plant stand. However, more is not always better, as high concentrations of some products can be phytotoxic. Conversely, inadequate coverage may not provide good control.

Dust formulations are preferred for cut seed. If using a liquid, remove any diseased tubers before treatment to avoid spreading pathogens. As liquid formulations can inhibit wound healing, cut seed should ideally be fully cured before treatment.

Treatment will not be effective on seeds already diseased.

Determining which product to use will depend on a number of factors, including site history and other testing data that is supplied with the certified seeds. It is always a good idea to discuss requirements with a local agronomist.

THE VALUE OF CERTIFIED SEED

The adage 'rubbish in, rubbish out', succintly summarises the importance of buying good seed.

In 2013, The Australian Seed Potato Council (ASPC) was established to provide a collaborative framework involving the four respective State-based seed potato Certification Authorities, which includes the Department of Agriculture and Food Western Australia (DDLS Seed Testing and Certification), Australian Seed Potato Certification Authority (AuSPICA), Crookwell Seed Potato Growers and the Tasmanian Institute of Agriculture (TIA).

Certified seed potatoes underpin the security of the national potato industry. Seed certification provides some certainty that the investment made on seed is a good one, ensuringe that the seed potatoes meet quality standards set by the authority.

The benefits of potato seed certification are numerous and include:

- Avoiding spread of disease and maintaining tuber quality.
- Ensuring the genetic purity of potato varieties.
- Upholding common terminology.
- Creating uniform national labeling for both domestic and export certified seed potatoes, and uniform guidelines for seed production.

SOURCES

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