Chapter 7
Seed and Planting Management

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Introduction

Proper seed management can significantly impact subsequent crop growth. Selecting high-quality seed is an essential first step for growing a quality potato crop. Planting certified seed will minimize seed-related problems, but growers also need to cut seed pieces to the correct size and plant them accurately and efficiently. This chapter will discuss seed selection, seed piece preparation, and effective planting protocols.

Guidelines for Selecting Seed

The purchase of certified seed is the first step in ensuring suitable vigor and yield potential in a crop. For a seed grower purchasing seed for recertification, it also provides assurance that the seed is within tolerance for economically important diseases. However, just because seed is certified does not guarantee it is equal to all other certified seed, nor that it is free from disease. Certification provides evidence that the seed lot has been inspected, tested, and is within tolerance to the grade standard. This section provides some ideas on how to obtain high-quality potato seed (Fig. 7.1).

Selection of High-Quality Seed

Much information can be obtained about the quality of a prospective seed lot by visiting the seed grower's farm. Visits should be made during the growing season to visually check seed fields. After harvest, equipment, storages, and the seed lot itself can be inspected. Growers should do the following:

Fig. 7.1 A quality crop of potatoes starts out with high-quality seed. (Photo credit: Nora Olsen)

Inspection of Equipment and Storage Facility

Seed handling equipment should be in good repair and clean. Clean equipment is especially important to minimize the spread of diseases, such as bacterial ring rot. Likewise, the storage facility should be in good working order to protect the seed potatoes from temperature fluctuations and light. The area around the storage facility should be free of cull piles and other potato debris, which are sources of disease.

Many seed producers have temperature-recording devices to keep accurate records of storage conditions. These records can be reviewed to determine that storage temperature has been managed properly. Adequate ventilation and humidity are also important. Large fluctuations in storage conditions may lead to increased physiological aging (discussed later in this chapter) and decreased seed performance.

Inspection for Sprouting or Mechanical Damage

Sprouted seed potatoes may suffer performance problems. Broken sprouts often produce excessive and weaker stems, which, in turn, produce more tubers per plant with reduced tuber size at harvest. Bruised or damaged seed is an indication of rough handling during harvest and transport and is associated with physiological aging and increased levels of disease.

Inspection for Diseases

The presence of several important diseases can be detected by visual inspection or with a simple test. It is important to plant and maintain healthy seed because the seed piece contributes to the establishment of the plant. A study with Russet Burbank showed the importance of maintaining seed health and that seed remaining attached to the plant contributes to U.S. No. 1 yield beyond the time plants reached about 8 in tall. Although in this study the seed pieces were physically removed, the study provides evidence that the longer seed pieces remained intact, the higher the yield may be at harvest. This study was with only one cultivar, but it offers insight that other cultivars may possibly react the same way. Pictures and descriptions of disease symptoms discussed here are presented in Chap. 9.

Late Blight Tolerances for late blight in seed are typically included in the same category with other tuber rots. This is a result of the difficulty of detection and identification rather than a reflection of its potentially destructive impact on the subsequent crop. Also, secondary tuber-rotting organisms often invade late blight-infected tubers and mask the late blight symptoms. Consequently, low levels of late blight decay may not be noticeable nor will these levels prevent the seed from being certified.

A careful visual inspection of any seed produced in an area where reports of late blight have occurred during the previous growing season must be completed.

Fusarium Dry Rot Symptoms of severe infestations of *Fusarium* dry rot can be visually detected, but seed will not be certified if it contains more than 2% serious damage by dry- or moist-type *Fusarium* dry rot. Seed lots without severe visual symptoms may still have the potential to develop this disease. Dry rot potential can be determined by conducting a simple "bag test." See the Sidebar 7.1.

Sidebar 7.1: Testing for *Fusarium* Dry Rot Potential in Seed

Randomly select 40–60 tubers from the seed lot in question. Using a sterilized knife, cut 20–30 of the tubers into seed pieces the same size as those produced by your seed cutter. Place the cut seed pieces in a large paper bag (like the bags from a grocery store), fold the top over, and shake vigorously for 1 min.

Place the paper bag inside a large plastic trash bag and fold the top over, but do not seal it because some air must be able to enter the bag. Keep the bag at approximately 70 °F for 3–4 weeks.

Cut the other 20–30 tubers in the same manner, but after placing them in another paper bag, add the seed piece treatment intended for use on the seed. Once again, shake the bag vigorously for 1 min, place the paper bag in the plastic trash bag, and store as described above.

At the end of the 3-week incubation period, examine the seed for *Fusarium* dry rot decay. If the untreated seed pieces have *Fusarium* decay, check to see if the seed piece treatment prevented the growth of *Fusarium* on the treated seed pieces.

Remember, a seed piece treatment will not stop the growth of a preexisting *Fusarium* infection. It will only prevent the development of new infections on healthy seed pieces.

Use proper protective equipment when working with the seed piece treatment.

Soft Rot Some soft rot will be found in most seed lots, but the level of infestation should not exceed 1%. More than this amount could be an indication of potential problems for seed piece decay. Seed tubers coated with dried "slime" that resulted from earlier rot problems in storage will be more prone to soft rot infection after cutting. A test performed by a qualified laboratory can determine soft rot potential.

Rhizoctonia Canker and Black Scurf A simple visual inspection at the seed grower's storage can detect potential problems with Rhizoctonia. On seed potatoes, *Rhizoctonia* sclerotia (black scurf) should not cover more than 20% of the tuber surface.

Sclerotia are seldom responsible for more than cosmetic damage to the infected tuber but are the source of inoculum for the more damaging canker form of Rhizoctonia, which has the potential to cause losses in the field. Rhizoctonia cankers may girdle underground sprouts, thereby stunting or killing stems. The result is a poor stand, lower than expected stem numbers, or both. Developing stolons can also be infected, which can lead to a lower number of tubers per plant.

Bacterial Ring Rot Seed certification programs implement a zero tolerance for this pathogen. Sampling strategies that maximize the probability of detecting the organism in conjunction with sensitive DNA-based testing, such as polymerase chain reaction assays, are commonly used to determine eligibility of a seed lot for certification. Serological testing, such as enzyme-linked immunosorbent assays or immunofluorescent staining assays, have also been used, but validated DNA-based tests are generally considered to be more sensitive and specific.

Silver Scurf Silver scurf does not usually cause yield losses, but its presence may result in cosmetic defects and elevated weight loss, leading to reduced quality in fresh-packed potatoes. Transmission of the disease can occur through seed; therefore, examination for silver scurf symptoms is recommended to decrease the likelihood of the disease becoming a problem in a commercial potato crop.

Scab In general, seed displaying excessive levels of either common scab or powdery scab should be avoided.

Virus Certification standards for allowable virus content vary by state. Tolerance levels for potato leafroll virus (PLRV) are generally below 0.25%. Tolerances for potato virus Y (PVY) are higher but also vary by state. Seed containing in access of 10% PVY should be avoided.

Examination of Certification Records

Before making a final decision on a seed lot purchase, growers should examine seed certification records. Growers can obtain seed certification records from the seed certification agency in their state. Seed buyers should examine the summer field-inspection reports, the storage-inspection reports (available in January), and, if available, results of a winter grow-out test conducted in an area with warm winter weather favorable for potato growth (available in early March). This information is obtained from the North American Certified Seed Potato Health Certification. See Chap. 4, Fig. 4.11). These certificates are available by request from the agency in the state or province where the seed was certified.

All seed potatoes should have passed a shipping-point inspection and must be sealed and properly tagged by a federal-state inspector. All transport trucks must be sealed with a metal seal by a shipping-point inspector. Growers must verify the certification number before accepting a shipment to be certain the potatoes being delivered are the same ones purchased.

Seed Tuber and Seed Piece Size

Seed performance is affected by seed piece size, and the size of seed pieces is highly dependent on the size of the uncut tubers. Because of this, growers should consider the proportion of large tubers when selecting a seed lot.

Seed Tuber Size

Tubers used for cutting into seed pieces should be 3.5–10 oz. This size range is used for cutting because of limitations in the number and nature of cuts that can be made by a mechanical seed cutter. A 3-oz tuber cut exactly in half would yield two seed pieces in the acceptable size range (1.5–2.5 oz); however, it is not likely that a seed cutter would cut these tubers exactly in half, so it is recommended that growers set cutting equipment to leave tubers that are 1.5–3 oz. in size uncut, and plant them as single-drop seed potatoes.

Utilizing tubers larger than 10 oz. increases the likelihood of producing "blind" seed pieces—those with no lateral buds or "eyes." This happens because the number of eyes on a seed tuber increases only slightly as tuber size increases.

The number of eyes per seed piece influences the number of stems per plant. Every eye on a seed piece or whole tuber has the potential of producing at least one stem, although there are physiological factors that can prevent all eyes from producing a stem. Seed pieces cut from large tubers—those more than 10 oz—may not contain enough eyes to produce the desired number of stems per plant. Large tubers also tend to produce seed pieces that may be too large for some planters to accurately plant, which causes skips during planting (Fig. 7.2).

Average Seed Piece Size and Distribution

Two important aspects of cutting seed are to: (1) obtain the appropriate average seed piece size and (2) achieve the proper seed piece size distribution. All cutting operation managers should know both the average seed piece size and the seed piece size distribution of each seed lot being cut. The seed cutter needs to be adjusted, as needed, to optimize average seed piece size and distribution (Fig. 7.3).

Fig. 7.2 Seed pieces need to be uniform in size to avoid planter skips. (Photo credit: Phillip Nolte)

Fig. 7.3 Careful attention to seed cutting and planting practices will result in a uniform stand of healthy, vigorous plants. (Photo credit: Nora Olsen)

Average Seed Piece Size

Emergence, seedling vigor, subsequent plant growth, and final yield are all related to seed piece size. Research has shown that larger seed pieces result in higher total yield than smaller seed pieces. However, the benefit of larger-sized seed pieces diminishes as the seed piece size increases above approximately 2.5 oz. The optimum seed piece size depends on factors such as cultivar, seed availability, cost of seed, in-row spacing, and market incentives.

For most cultivars, planting seed pieces averaging 1.5–2.5 oz. in size will provide optimum agronomic and economic returns. Growers are advised to eliminate tubers and seed pieces smaller than 1.5 oz. during sorting and cutting. Seed pieces less than 1.5 oz. are less productive, resulting in lower yields than larger seed pieces, because of a lower amount of reserves available for sprout growth. Researchers at Washington State University calculated that if only 10% of the total weight of seed pieces was less than 1 oz., it would result in approximately 20% of the planted area having seed pieces with limited yield potential. Several research studies have conclusively shown that seed pieces smaller than 1.5 oz. will produce significantly less yield than larger-sized seed pieces. Generally, growers should avoid planting seed pieces weighing more than 3 oz. because of increased seed costs and reduced planter accuracy.

Planting seed pieces averaging 1.5–2.5 oz. is acceptable for most cultivars, but acceptability of this size range for individual cultivars depends on the number of eyes per seed tuber as discussed above. Cultivars that produce an adequate number of eyes per tuber should produce seed pieces with at least one eye per tuber when cut into seed pieces weighing 1.5–2.5 oz. Cultivars with a low number of eyes per tuber will need to be cut into seed pieces weighing closer to 3 oz. to avoid having blind seed pieces. The seed cutter operator needs to carefully check each cultivar being cut to ensure there are no blind seed pieces.

When determining the amount of seed to purchase, growers need to consider average seed piece size, row width, and seed piece spacing to be certain enough seed is purchased. Table 7.1 shows the amount of seed needed on a per-acre basis when planted in rows spaced 36 in apart. For seed pieces being planted in rows spaced closer or further apart than 36 in, the quantity of seed purchased will need to be increased or decreased proportionally. Alternatively, for rows spaced closer or further apart than 36 in., the spacing between the seed pieces within the row can be increased or decreased such that an equal number of seed pieces per acre is planted, resulting in the same quantity of required seed per acre. The effect of seed piece size on yield and grade is presented in Table 7.2. The effect of seed piece size on stem numbers per acre is presented in Table 7.3.

Table 7.1 Amount of seed needed to plant 1 ac of potatoes at within-row spacings from 8 to 13 in and average seed piece sizes from 1.5 to 3.5 oz. in rows spaced 36-in apart[a]

	Within-row spacing in 36-in rows					
	8	9	10	11	12	13
Seed piece size (oz)	(cwt per acre)					
1.5	20.4	18.2	16.3	14.8	13.6	12.6
2.0	27.2	24.2	21.8	19.8	18.2	16.8
2.5	34.0	30.3	27.2	24.7	22.7	20.9
3.0	40.8	36.3	32.7	29.7	27.2	25.1
3.5	47.6	42.4	38.1	34.6	31.8	29.3

[a]Amount should increase by 10% to account for cutting losses

Table 7.2 Effect of different seed sizes on yield and size profile of Russet Burbank potatoes

	% U.S. No. 1		% U.S. No. 2			
Treatment	>10 oz.	4–10 oz.	>10 oz.	4–10 oz	% undersize	cwt/acre
2 oz	39	36	7	11	7	462
3 oz	33	38	7	13	9	479

Adapted from Kleinkopf and Thornton (1989)

Table 7.3 Effect of different seed piece sizes on number of stems per plant and stems per acre at 3-in row spacings in 36-in wide rows

Treatment	Spacing (in)	Seed (cwt/ac)	Stems/plants	Stems/ac
2 oz	9	24	3.1	60,016
3 oz	12	27	3.9	56,628
4 oz	12	36	4.2	60,980

Adapted from Kleinkopf and Barta (1991)

Seed quantities presented in Table 7.1 are for post-cut seed, so the actual amount of seed that growers will purchase should be increased by about 10% to account for cutting waste and occasions when seed pieces too small for planting are eliminated. Note that even a small increase in average seed piece size results in a fairly large increase in the amount of seed needed. For example, with an average seed piece size of 2.0 oz., it takes 18.2 cwt to plant 1 ac at in-row spacing of 12 in. in rows spaced 36 in, but it takes 22.7 cwt to plant 1 ac with an average seed piece size of 2.5 oz., an increase of 4.5 cwt per acre (Table 7.1). This increase in seed quantity can significantly increase seed costs for a grower, so it is essential growers pay close attention to the average cut seed piece size.

Determining Average Seed Piece Size

Average seed piece size should be frequently checked during the cutting operation. To do this, collect and weigh a sample of approximately 12–15 lbs. (192–240 oz) of cut seed pieces, count the number collected, and then divide the weight of the seed pieces in oz. by the number of seed pieces to determine the average size.

Seed Piece Size Distribution

Not only is it important to have the correct average seed piece size, but it is also important to have a minimum of at least 72% of the seed pieces within the desired size range, which for most cultivars is 1.5–2.5 oz. It is possible to cut tubers into seed pieces that have an acceptable average seed piece size but do not have an acceptable size distribution. (Fig. 7.4a, b).

A seed lot could, in theory, contain equal numbers of only 1 and 3-oz seed pieces, which is an average seed piece size of 2 oz. However, the size distribution of this cut seed would be unacceptable because seed pieces would be either smaller than 1.5 oz. or larger than 2.5 oz.

Seed Cutting and Seed Piece Treatments

The correct average seed piece size and distribution, as discussed earlier, cannot be obtained unless the seed cutter is properly adjusted and maintained. In addition to properly cutting the seed, a seed piece treatment should be used that minimizes

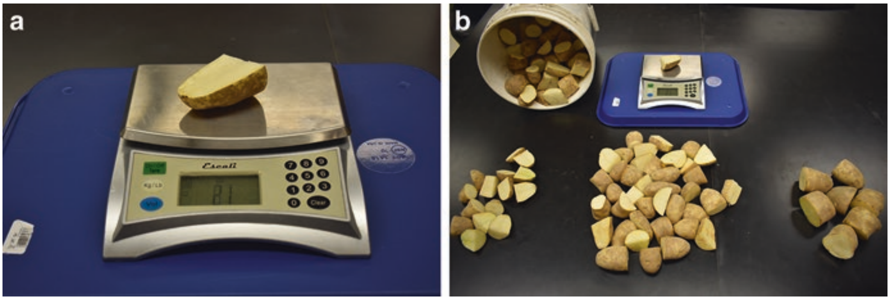

Fig. 7.4 Determination of seed piece size distribution requires weighing (**a**) and categorizing (**b**) individual seed pieces. (Photo credit: Phillip Nolte)

disease spread. Seed piece treatments are also available that will protect the crop against some insects, such as Colorado potato beetle (CPB), and fungal pathogens, such as *Fusarium* dry rot.

Seed Cutter Maintenance and Adjustments

The seed cutter must be maintained, properly adjusted, and continually monitored during cutting to produce quality seed pieces for planting.

Cutter Knives

Sharp cutter knives will produce smooth cuts on all seed pieces. A dull knife leaves an uneven cut surface, much like "fish scales," that will not heal as rapidly as a smoothly cut surface. If fungi, such as *Fusarium* dry rot, are present, there is a greater possibility for the pathogen to infect a seed piece. Also, disease pathogens under these ragged surfaces are less likely to be controlled by a seed piece treatment.

Cutter Adjustments

Initial alignment of the sponge drum, cross knife, and cutting discs should be made before cutting any seed tubers. The seed cutter owner's manual will provide proper settings and procedures. Cutting discs should be set according to the owner's manual and then adjustments made to cut the desired seed piece size. These adjustments will likely need to be changed when changing seed lots because of different tuber sizes. A seed cutter operator should continually monitor the average seed piece size and profile and make adjustments, as necessary.

Fig. 7.5 The frequent cleaning and disinfecting of seed cutting and handling equipment is an excellent way to avoid disease problems in the subsequent crop. (Photo credit: Nora Olsen)

Cleaning and Sanitation

Potato diseases can readily spread during the cutting operation. Of particular concern are bacterial ring rot, *Fusarium* dry rot, and soft rot. The frequency at which a seed cutter needs to be cleaned and disinfected is not easily determined. However, the more often it is cleaned, the less likely a disease pathogen will be spread via the cutter.

A good practice is to thoroughly clean and disinfect the cutter at least once a day and certainly when changing seed lots (Fig. 7.5). Also, if a tuber is found that has bacterial ring rot, it is critical to immediately stop the cutting operation to clean and disinfect the cutter and associated equipment.

The cutter and equipment can be thoroughly cleaned with a power washer that contains an industrial detergent and warm to hot water. This will remove dirt, dried plant sap, and bacterial slime that may be on the cutter and equipment. After completely cleaning, an approved disinfectant should be applied.

All seed cutter surfaces to be disinfected must remain moistened with the disinfectant solution for a minimum of 10 min. The disinfectant solution must contact the bacteria or fungi to kill them. If the solution cannot contact the disease organism, then the disinfecting process is of little or no value.

Several disinfectants are labeled for use on cutting equipment, but because labeled products change, obtain a list of the latest available labeled products from a reputable dealer or from your state Department of Agriculture. Some products can

Fig. 7.6 Application of a seed piece treatment can help reduce or eliminate many seed-related problems in the field. (Photo credit: Nora Olsen)

be used only on non-porous surfaces, so growers must consider this when selecting a disinfecting product. Also, before selecting a disinfectant, growers must consider its activity when diluted in hard water or effects of organic matter, corrosiveness to metal, and worker safety.

Seed Piece Treatments

Because several days are required for cut seed pieces to heal, researchers often recommend seed piece treatment fungicides to protect cut seed until the wound barriers can be established. Several products are on the market, each having advantages and disadvantages. Some seed piece treatments may also contain an insecticide for control of certain insect pests.

A seed piece treatment should be selected that is effective against the problem that is of most concern. It may be necessary to use different seed piece treatment products for different seed lots or for seed planted in different fields.

Regardless of which seed piece treatment is selected, some general guidelines need to be followed to make the most efficient use of the product. Complete coverage of the seed piece is likely the most essential factor. Adequate coverage ensures the most protection (Fig. 7.6).

Regardless of coverage, it is important to realize that a seed piece treatment will not stop an infection that has already occurred from spreading. Treatment will only protect healthy seed pieces from becoming infected.

Cutting and Healing Seed Before Planting (Pre-Cutting Seed)

Potato planting season can be difficult to coordinate and plan when growers want to get the crop planted within a certain time frame. Wet weather can delay planting, which will leave even less time for planting within the desired time frame. Part of the planting operation involves cutting seed tubers into seed pieces, and delays in the cutting operation can delay planting. For that and other reasons, some producers may prefer to "pre-cut" the seed. Pre-cutting has some advantages, but growers also need to recognize its challenges.

Advantages

The big advantage to pre-cutting is that it allows growers time to focus on the cutting operation without being concerned about planting. Growers can take more time to ensure tubers are being cut into properly sized seed pieces and size profile. If soft rot has been a problem in the field, then pre-cutting offers an advantage because the seed pieces can heal (see discussion of wound healing under *Challenges*, below, and in the Sidebar 7.2), which will stop soft rot from invading the seed pieces. Soft rot may be more of a problem when seed pieces are trying to heal a cut surface while in the soil in a field.

Sidebar 7.2: Wound Healing Process

Understanding the wound-healing process after cutting seed tubers into seed pieces will help growers have a better understanding of how planting conditions can affect emergence and plant population.

An early event in the wound-healing process is "suberization," which consists of several steps. Within the outer two or three layers of intact cells just beneath the cut surface, a complex fat-based compound called "suberin" is deposited. The chemical structure of suberin—common bottle cork is 70% suberin—has not yet been fully determined, but it is the origin of the term suberization. A suberin layer protects a seed piece from bacterial pathogens, such as soft rot, and the cut surface loses less moisture than before the healing process began.

The wound-healing process is finished after a new wound cork layer, called the "phellem" layer is developed. Cells beneath the suberin layer divide several times, which results in 4–6 layers of flattened, brick-shaped cells. After the phellem layer is complete, these cells also become suberized in the same manner as the first suberin layer.

The previously formed suberin layer dies and collapses because the cells are cut off from the moisture supply within the seed piece. The seed piece has now developed a new wound barrier similar to the original tuber skin or periderm that appears like the original skin, and better yet, protects the seed piece like the original skin.

Suberization is completed in 2–4 days. The remainder of the process may be completed in a week under ideal conditions, but usually takes longer. Ideal conditions are a temperature of 50–55 °F, plenty of oxygen, and high relative humidity.

Planting in cool, wet soils will delay the wound-healing process, which allows more time for seed-decaying organisms to invade the freshly cut seed piece.

Using an effective seed piece treatment is recommended for both cut-and-plant and pre-cut seed.

Challenges

Just as a seed piece can decay in a field, it can also decay in a pile after cutting. The biggest challenge to pre-cutting is to provide the necessary conditions for wound healing. Seed should never be piled higher than approximately 6 ft. It is also important to supply adequate amounts of moist air, because seed pieces will not heal properly in lower relative humidity, and wound healing requires oxygen. The temperature of the pile needs to be carefully regulated, keeping it at 50–55 °F. Application of a seed piece treatment to combat *Fusarium* seed piece decay is also highly recommended.

Seed pieces can be safely handled and planted 3–4 days after cutting if the proper storage conditions have been met. About 5–14 days after cutting, the healing surfaces of the seed pieces become extremely vulnerable to damage when seed is handled. For this reason, seed that cannot be planted within 3–4 days after cutting may need to be held until 14–18 days after cutting to ensure that the entire wound healing process is complete.

Seed Age

Chronological and physiological are two terms that may be used to describe seed tuber “age.” Seed age has a direct impact on crop response.

Chronological Age

Chronological seed age is the duration of time from seed tuber harvest the previous fall to planting the following spring. A chronologically older seed tuber—14 months, for example—will exhibit different performance characteristics compared with a younger seed tuber of only 7 months. This is because the chronologically older seed tuber will also be physiologically older.

Physiological Age

While chronological age is easy to determine, physiological age is not. Physiological age of a tuber involves a complex interaction of environmental and cultural conditions that occurs during the seed growing season and storage, in conjunction with chronological age. Physiological age can be broadly defined as the physiological status of the tuber as it affects productivity.

In general, the most influential factor affecting physiological aging is the accumulation of heat units or exposure to warmer temperatures. Typically, the greater the heat unit accumulation, such as warmer growing temperatures surrounding the seed crop or storage conditions, the physiologically older the seed will be. Fluctuating seed storage temperature can also cause earlier dormancy break and advanced physiological age. Unfortunately, exact relationships between occurrence, type, and duration of temperature exposure and physiological age, and thus impact on crop performance, are difficult to assess and predict.

Although physiological age has been extensively researched, no indicator or test exists to accurately predict it. Researchers have analyzed specific biochemicals in seed tubers, but no direct correlation between these biochemicals and a particular age or performance capacity has been established.

However, four general visual sprout development patterns are associated with distinct stages of physiological age. The youngest and first of these stages is the single sprout, where there is typically one sprout per eye. The second stage is the development of multiple sprouts per eye and loss of apical dominance. Branching of individual sprouts marks the beginning of the third stage. The fourth and oldest stage occurs when the formation of sprouts stops, and small tubers are formed at the eyes. These visual stages will vary with cultivar.

Performance of Physiologically Aged Seed

Some performance characteristics of physiologically older seed include earlier emergence, multiple stems, an increased number of tubers per plant, and earlier senescence. Several characteristics of physiologically younger and older seed are listed in Table 7.4.

Extremely young seed exhibits slower emergence and early season plant development but higher overall yield potential. Planting older seed will result in a reduction in plant stand, season-long vigor, and yield potential.

Table 7.4 Characteristics of physiologically younger vs. older seed

Younger seed	Older seed
Slower emergence	Faster emergence
Fewer stems (sprouts/eye)	Multiple stems (sprouts/eye)
Fewer tubers per plant	More tubers per plant
Later tuber initiation	Earlier tuber initiation (at lower leaf area index)
More foliar production	Less foliar production
Later plant senescence	Earlier plant senescence
Larger-sized tubers	Smaller-sized tubers

Adapted from Iritani et al. (1972)

Factors Influencing Physiological Age of Seed

Growing Conditions of the Seed Crop

Many environmental and cultural conditions during the growing season may influence seed physiological age; unfortunately, solid relationships have yet to be established. Some research has indicated sub-optimal fertility and irrigation, early plant senescence caused by disease, insects, and frost or any other plant stress may all contribute to physiological aging of seed. Weather conditions during the growing season, especially soil and air temperatures, have the potential to age seed tubers. In general, the warmer the growing season, the greater the potential there is for aged seed.

Handling of Seed Tubers

Generally, as seed tubers are handled the physiological age of the tuber increases. Rough handling that promotes bruising, wounding, or stress on the tuber can impact seed age.

Temperature During Seed Storage

Typically, seed potatoes are stored at approximately 38 °F to minimize sprouting, decrease transpiration (water losses), and minimize physiological aging (Fig. 7.7).

Warmer storage temperatures will increase physiological age. Depending on the year and cultivar, small differences in storage temperatures may or may not significantly impact seed performance. Warming the seed at the end of the storage season will promote advanced sprouting and physiological aging. Warmer temperatures

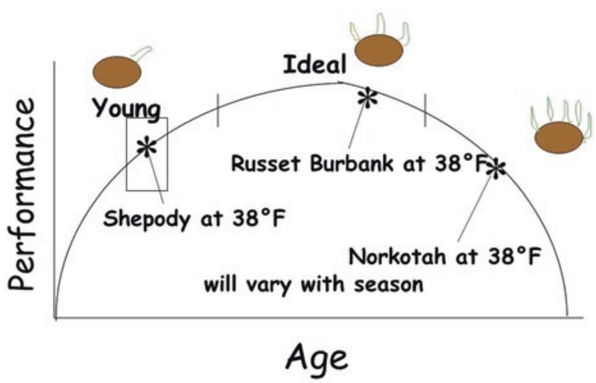

Fig. 7.7 Potential seed age and performance as influenced by seed storage temperature. (Image credit: Nora Olsen)

during early seed storage can also impact physiological age and performance. The best practice to avoid both aging and handling damage is to warm seed to at least 45 °F just before handling, cutting, and planting.

Cutting and Transporting

When seed potatoes are cut, the internal apical (bud end of the tuber) dominance within the seed piece diminishes, thereby allowing sprouting of eyes on other areas of the tuber. When transporting seed, handlers should minimize extremes and fluctuations in temperatures and limit the amount of time in trucks. Temperature variations and excessive time in transport can contribute to advancing physiological age of the seed, and lack of ventilation can increase the potential for pathogen infection.

Minimizing Physiological Age of Seed

Because a predictable method for measuring the physiological age of seed has yet to be developed, it is difficult to know how any particular lot of seed will perform. Thus, using physiological age of seed in an attempt to control crop performance is unpredictable. Therefore, the best strategy for assuring predictable seed performance is to adopt practices that keep seed physiologically young. This includes purchasing seed from growers that utilize optimal seed production practices and store seed at consistently low temperatures, minimizing bruising and tuber damage during transport and seed-piece cutting, and providing holding conditions prior to planting that minimize sprouting.

Planting

Optimizing yield requires using clean, correctly adjusted equipment; planting fields under proper conditions; and precisely planting the seed pieces (Fig. 7.8).

Establishing a Uniform Plant Stand

Several factors must be considered when establishing a uniform plant stand.

Time of Planting

Planting date should be a function of soil temperature rather than calendar date. Soil temperature should be above 45 °F to minimize seed piece decay and encourage rapid emergence. For example, Russet Burbank seed pieces planted with a soil

Fig. 7.8 Optimizing yield requires using clean and correctly adjusted equipment, planting fields under proper conditions, and precisely planting the seed pieces. (Photo credit: Nora Olsen)

temperature of 45 °F may take nearly 6 weeks to emerge, but will emerge in about 4 weeks from the same depth when planted in soil with a temperature of 50 °F.

Planting in cool soil will not likely get the crop out of the ground sooner than waiting for warmer soil temperatures. However, the initial planting date should be scheduled to get all potatoes planted in a timely manner.

Soil should be moist before the crop is planted. If necessary, producers could irrigate fields before planting. Be aware that water applied too soon after planting seed pieces will likely enhance seed piece decay.

Seed Piece Spacing

The ideal seed piece spacing depends on cultivar and end use. For example, potato processing companies that purchase potatoes to be made into french fries usually stipulate a lower size limit and desire larger potatoes. Conversely, the market for red cultivars favors smaller-sized tubers. Growers need to know the end use and the most desirable size category of the harvested crop.

The seed piece spacing that provides the desired harvested tuber size may be different for the same cultivar produced in multiple growing regions in the U.S. Grower experience becomes critical in determining optimum spacing in situations of variable growing conditions, changing market specifications, and differing cultivar requirements. Historical records of past planting practices may be very useful in planning optimum spacing protocols, and keeping such records is very important.

There is also a relationship between seed piece size and in-row seed piece spacing. Research has been reported indicating that, at least for some cultivars, equal quantities of seed planted per acre will produce equal total and U.S. No. 1 yields.

That is, smaller seed pieces planted at narrower in-row spacing will produce the same yields as larger seed pieces planted at wider in-row spacing.

Planting Depth

A common planting depth for many cultivars is 6 in. In general, that is 3 in below the soil line with an additional 3 in formed in a hill above the seed piece. It may be tempting to plant seed pieces deeper than this to reduce the amount of field-green tubers. Tubers exposed to the sun will turn green, which is considered a grading defect. However, research has shown that planting deeper may not reduce the amount of field-greening and may cause a yield reduction in some cultivars. Also, planting deeper than recommended may delay the time it takes for plants to emerge.

Growers will generally form a hill after planting, which will place the seed piece deeper in the soil when measured from the top of the hill to the top of the seed piece. Hilling practices may be marginally effective for controlling field-greening of tubers.

Planting Seed Pieces Accurately

Seed piece size distribution and planting speed are the two main factors that contribute to planting accuracy. Other minor factors influence how accurately a planter places seed pieces, but paying particular attention to these main factors will help optimize seed piece placement. See Sidebar 7.3.

Sidebar 7.3: Importance of Seed Piece Spacing

The seed piece spacing interval that will produce tubers in the desired size range at harvest depends on the cultivar grown and end use. For example, a cultivar that will be used for fresh pack may need to be planted at narrower spacing than if it is intended to be processed into frozen fries. Consequently, a grower needs to know the preferred seed piece spacing interval for each cultivar.

More importantly, however, is making certain the planter is placing the seed pieces at the intended interval. To accurately determine seed piece spacing, it is essential to uncover the seed pieces in at least 25 ft of row behind each planter unit and measure the seed piece intervals.

Generally, as the seed piece spacing within the row is increased, the average size of the harvested tubers will increase. However, extending the seed piece spacing beyond that which is ideal for a particular cultivar will likely not produce a higher percentage of large-sized tubers. Factors affecting harvested tuber size include cultivar, length of growing season, and production area.

Seed Size Distribution

Potato planters will generally place seed pieces more evenly when the seed pieces are of uniform size.

Planting Speed

No single planting speed is “best” for all planters, but generally as planting speed increases, planting accuracy decreases. Planting speeds may vary from about 2–5 mph. However, adjusting planting speed will likely solve many planter performance problems. Planters that are properly adjusted and operated correctly should place 75% or more of the seed pieces within the desired spacing.

Seed pieces placed in the row within 3 in of the desired spacing are considered accurately planted. Planting too fast causes more skips because seed pieces may roll after they are dispensed or seed pieces are not picked up by the cup or pick.

Other Planter Adjustments

A number of minor planter adjustments can be made to achieve higher planting accuracy. When using cup planters, the seed level in the bowl should be even with the conveyor delivering the seed. Chain and idler spring tension can also influence seed piece placement. Air cup and belt-type planters may also require fine tuning to produce the proper results.

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