

SEED HANDLING AND PHYSIOLOGICAL AGE - IMPACTS ON SEED PERFORMANCE^{1/}

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The potential yield and quality of any commercial potato crop is determined to a large extent by the quality of the seed that is planted. However, research in Idaho has shown that yield potential of seed decreased by an average of 7% during handling from seed grower to commercial grower, and another 14% loss in productivity occurred during the cutting operation (Table 1).

Table 1. Effect of seed handling on yield of four seed lots planted at Kimberly, Idaho in 1990.

Sample Site	Seed Lot			
	A	B	C	D
	-----Yield (cwt/acre)-----			
Seed Storage	492	464	455	483
Commercial Storage	465	461	478	477
Seed Cutter	430	441	455	415

Source: Kleinkopf and Barta, 1991 (5).

Part of this handling related yield reduction may have been due to seed cutter management. However, bruising that occurs during these handling operations is also undoubtedly one of the factors in this loss of productivity. Bruising reduces seed productivity by increasing seed decay and physiological aging.

Seed Decay

The relationship between bruising and seed decay has been shown very clearly in research conducted at North Dakota State University (2). Seed tubers that had a high inoculum level of soft rot bacteria were planted in a field trial. Seed that had been bruised prior to planting had 65% decay, while unbruised seed of the same lot had only 6% decay. Bruises provide an entry site for both dry rot and soft rot to infect the tuber. An evaluation of 11 seed lots that were shipped to western Idaho in 1992 showed that most averaged more than 2 severe bruises per seed tuber

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at the time of receipt by the commercial grower. Many of these severe bruises were infected with dry rot, with almost all seed lots having more than 20% of tubers with at least one infection site. These initial infections are important because they provide disease spores that are spread during the cutting operation. These infections are also not controlled by the seed treatment fungicides that are applied during the cutting operation. Seed decay organisms like dry rot do not have to reduce emergence to have an impact on yield. Any infection that leads to decay of a significant proportion of the seed piece during sprouting and emergence is going to reduce the amount of reserves available for sprout growth. The resulting competition for limited seed piece reserves can lead to reduced early season plant vigor and lower yield at harvest. Dry rot infection of seed pieces may limit yields of some varieties more than others (Table 2).

Table 2. Effect of dry rot inoculation of seed pieces at planting on yield of four potato varieties.

Variety	Inoculated	Non-Inoculated	% Yield Reduction
----- Yield (cwt/acre) -----			
Shepody	212	288	26
Superior	233	302	23
Russet Burbank	346	393	12
Yukon Gold	241	254	5

Source : Platt, 1987 (7).

Physiological Age

Physiological age affects seed performance by influencing a number of plant characteristics. In general, physiologically "old" seed will emerge earlier, have more stems and higher tuber set, senesce earlier, and have smaller average tuber size than physiologically "young" seed. Several factors may account for the generally reduced yields provided by physiologically aged seed. First, as potato tubers age they lose some of their capacity to heal wounds. With lower wound healing rate a higher level of seed decay would be expected, especially under adverse conditions (i.e. cool-wet soil conditions at planting). Secondly, the seed piece provides a limited amount of reserves for sprout growth. These reserves must be adequate to provide energy for plant growth until the plant begins producing its own energy through photosynthesis. Increased stem numbers due to physiological aging results in more competition for these limited reserves. For Russet Burbank in the Columbia Basin, yield potential increases as the amount of seed piece reserves available per stem increase (4). The increased stem production of old seed also leads to higher tuber set and an overall increase in total tuber growth rate early in the season. This higher tuber growth rate results in a higher tuber nutrient requirement. If the demand for nutrients by the tubers is not met by root uptake, the tubers begin to draw nutrients out of the vines. This leads to early leaf senescence and plant death before maximum yield is obtained.

For any given production region there is an optimum stem number that produces the highest yield of marketable tubers. The optimum stem number will depend in large part on the variety grown, the incentives for producing certain size classes of tubers, and the length of the growing season. For commercial production of Russet Burbank in Idaho, seed pieces with two to three stems generally produce the desired tuber set and result in optimum yield potential. Any factor that increases stem number above the optimum can negatively impact yields. Seed potatoes bruised during handling will have high respiration rates which result in physiological aging. Research at Washington State University (3) showed that severely bruised seed pieces can produce almost 2 more stems than unbruised seed (4.7 vs 2.9). However, seed handling is only one of many factors that can influence physiological age of seed. Environmental conditions during seed production, harvest, storage, and after planting have a very large affect on physiological age.

Bruise Susceptibility

There are two reasons why seed tubers tend to sustain a lot of damage. First, seed is generally harvested, stored and handled cold. Tubers handled at 35°F sustain about twice as much bruising as those handled at 45°F. Scheduling harvesting operations to avoid cold tubers, and warming tubers to 45°F prior to handling can significantly reduce the level of shatter bruise present on seed. Second, seed is usually handled numerous times between harvest and planting the following spring. Much of the machinery used in harvesting, sorting, transporting, cutting and planting seed is designed for moving large volumes, not for gentle handling. Concepts that can be used with any seed handling equipment to reduce bruising include: run belts, chains and conveyors full, lower drops, and use padding on all hard surfaces.

Management Practices

Certain management practices can help reduce some of the negative effects of rough handling and excessive physiological aging on seed performance. Poor sanitation can eliminate any benefits of purchasing high quality seed. Thoroughly clean and disinfect the seed storage, handling and cutting equipment before any seed arrives. Unless the seed is to be cut or planted directly off the truck it should be placed into a storage equipped with a ventilation system. The seed should be kept under constant temperature and high humidity to help heal any new bruises. Warm seed to 50°F prior to cutting to initiate sprouting and reduce bruising. Warming seed also helps reduce the tendency for seed to shatter when it goes through the cutter knives. Keep cutter knives sharp to prevent "feather edges" that allow entry dry rot and soft rot into areas that fungicides cannot contact. Adjust the cutter to minimize the proportion of seed pieces less than 1.5 ounces in size. Small seed pieces must expend a lot of energy on wound healing and have less energy available to produce a vigorous plant. Use an effective fungicide to help protect the cut surface of seed during the wound healing process that occurs after cutting.

At planting, soil temperature becomes important. Soil temperatures below 48°F prevent healing of cut surfaces and delay emergence. There is no advantage to planting early into a cold soil. For example, at 45°F Russet Burbank does not emerge for 40-45 days, while at 50°F it emerges in 20-25 days (1). Shepody is even more sensitive to cold soil temperatures than Russet Burbank. This extended time before emergence increases the chance that seed will decay before a vigorous plant is established. Planting depth also impacts emergence rate. If possible plant

shallow to encourage rapid emergence (3-4 inches below original soil level for Russet Burbank).

Management of both seed size and spacing can be used to compensate for increased stem production by physiologically old seed. At a comparable stem population, physiologically aged seed produced yields that were as high as physiologically young seed (Table 3).

Table 3. Effect of seed size, spacing and physiological age on stem production and yield of Russet Burbank.

Treatment	Spacing (in.)	Stems Per Hill	Stems Per Acre	Total Yield (cwt/acre)
2 oz	9	3.1	60,000	522
2 oz aged	12	4.1	59,500	503
3 oz	12	3.9	56,699	524
3 oz aged	15	3.1	59,000	523
4 oz	12	4.2	61,000	514
4 oz aged	18	6.2	60,000	501

Source: Kleinkopf and Thornton, 1989 (6).

Unfortunately, it is not very easy to obtain an estimate of physiological age prior to planting. Information on growing season, harvest, storage and handling give some clues about the physiological age of seed. If aged seed is suspected based on these factors, seed size and spacing can be adjusted accordingly. However, stem production after emergence is really the most measurable indicator of physiological condition of the seed. If seed produces more stems than expected nutrient applications can be adjusted to account for the higher tuber uptake. For example, at a tuber growth rate of 6 cwt per acre per day, tubers will require 2 pounds of nitrogen per acre per day. If tuber growth rate increased to 8 cwt per acre per day due to high stem number and resulting high tuber set, the nitrogen requirement would increase to 2.7 pounds per acre per day, a 33% increase. Tuber uptake of other nutrients would increase to a similar extent. Monitoring of plant nutrient uptake through petiole analysis would help growers identify potential nutrient deficiencies associated with this increase in tuber requirements.

Summary

Seed handling practices can affect seed performance in several ways. Rough handling increases decay potential and increases physiological aging. The results can be reduced stand, increased stem production and lower yield. Because of the cold handling temperatures and number of operations associated with seed transport, careful handling by both seed and commercial growers is essential in reducing the level of bruise damage on seed.

Bruising is only one of many factors that affect physiological age of seed. Any factor that "stresses" the seed during production, harvesting, storage, cutting

and planting will increase physiological aging and result in higher stem production. Physiologically aged seed can be managed to produce yields that are as high as physiologically young seed. Seed size, spacing and nutrient management can be adjusted to compensate for the higher stem number and tuber set associated with aged seed. The optimum stem number is dependent on the variety grown, growing season length and market incentives.

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