SEED POTATO QUALITY AS IT AFFECTS COMMERCIAL PRODUCTION PERFORMANCE

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Selecting and buying seed potatoes are known to be important management decisions. Seed costs can account for 10-20% of the variable cost per acre, therefore buying high quality seed can substantially impact your production efficiency. The quality of seed potatoes can have an effect on stand establishment, tolerance to stressful conditions, and a multitude of other factors that impact total yield, tuber size profile and both external and internal qualities of harvested tubers. Early establishment of a uniform stand will generally equate to higher yield and higher tuber dry matter. Establishment of a uniform stand makes management practices easier and more efficient resulting in a crop that produces greater productivity and profitability. If emergence is rapid, young sprouts will spend less time in the soil and therefore be less exposed to attacks by blackleg and rhizoctonia organisms. Rapid stand establishment also lessens the impact of seed piece decay. Tolerance to stressful conditions is an important seed quality issue especially if planting into cold soils.

Seed Quality

Seed quality encompasses many factors that should be considered when selecting seed sources. High quality seed lots are those with the least amount of disease present and with the desired seed tuber size and shape. Seed lots consisting of larger tubers may not have good eye distribution of the tubers resulting in a high number of blind seed pieces. There is increasing interest in the purchase of single drop seed. Single drop seed offers the advantages of less time and money spent due to the elimination of the need to cut the seed. It is however unlikely that the seed potato industry has the ability to produce large volumes of single drop seed. If single drop seed use becomes a reality it is unlikely it can be made available in the quantities needed at the price commercial producers are accustomed to paying now. It should be recognized that plants from single drop seed tubers may emerge later and more sporadically due to strong apical dominance of the single drop seed. Other management practices such as increasing seed spacing for the desired stem density per acre may need to be implemented when planting single drop seed. Along with seed tuber disease content and seed tuber size and shape, a common factor focused on when buying seed is historical performance of seed from a given grower. Other less identifiable seed quality issues that affect plant establishment and yield include physiological age, seed vigor, and the nutrient and energy reserves of the seed tubers.

This Presentation is part of the Proceedings of the 1997 Washington State Potato Conference and Trade Show.

Physiological Age

Seed tuber physiological age is vaguely defined as the "physiological status of the tuber as it affects productivity." It is a function of both the environment and management experienced in the field during the seed growing season, and during storage of the seed. Physiological age is also influenced by chronological age. Physiologically aged seed tubers typically exhibit the following characteristics: low growth vigor, earlier emergence, emergence of multiple stems per eye, earlier tuber initiation, decreased foliage production, earlier senescence, and compromised yields. Some of these characteristics are desirable and some are not depending upon the production system in which the seed tubers are used. Unfortunately there is no test that can identify the physiological age of seed tubers. It would be beneficial to know the physiological age of any given seed lot, enabling that particular seed lot to be used in the appropriate management system.

Vigor and Energy Reserves

Another quality factor that would be beneficial to identify prior to planting would be seed tuber vigor. Vigorous seed exhibits rapid, uniform emergence with strong sprout and leaf development and would therefore be less impacted when exposed to stressful conditions following planting. Seed lots with high vigor would perform better when planted into adverse conditions such as cold, wet soils, and still obtain strong emergence. Factors reported to influence seed vigor are: seed growing location and cultural practices, storage conditions, and genetics. All of these factors can affect the chemical composition of seed tubers and may affect vigor.

Growthroom Study

There are some field observations that indicate seed potatoes produced at more northern latitudes produce plants that exhibit greater vigor than plants from seed tubers produced at more southern latitudes when subsequently planted out in the same location. This concept is termed "Northern vigor" and has been to promote seed potatoes produced in Alaska, Canada and North Dakota. There is controversy over whether or not these observations are true. Unfortunately little research has been performed to look at it directly.

One of the major differences between northern and southern latitudes is the hours of daylight or photoperiod during the summer. There are longer days at northern latitudes. To ascertain if this difference in daylength impacts vigor of harvested tubers, the following growth chamber experiment was performed. Certified seed of 'Dark Red Norland' were planted into two growth chambers. Conditions in one chamber were patterned after longer daylengths observed at 60 °N latitude and the other after daylengths observed at 45 °N latitude (Fig. 1). Day/night temperatures were 70/60 °F. Plants were grown for 100 days, tubers were harvested, cured and stored for 7 months at 38 °F.

Due to the importance of carbohydrates in seed potatoes as a source of energy reserves for emerging sprouts, the harvested tubers from longer and shorter day plants were analyzed for starch and sugar content. Tubers harvested from plants grown under the longer daylength had higher specific gravity (Fig. 2A). Specific gravity is an indicator of dry matter and thus starch since the majority of tuber dry matter is composed of starch.

The starch content of these tubers was also directly measured showing a trend for more starch in the tubers harvested from longer day grown plants (Fig. 2B).

Potato tuber starch is made up of two forms of starch: amylose and amylopectin. There was significantly more starch in the form of amylopectin in tubers harvested from plants grown under longer days. Therefore the form of starch may be an important factor for rapidly supplying energy for early sprout production. Sugars were fairly similar in tubers grown under both daylengths although there was a trend for more glucose and fructose in tubers harvested from shorter day grown plants (Fig. 2B).

Tuber proteins are an important food source for early sprout and leaf development since they are a source of amino acids and nitrogen and thus may affect vigor. Although total protein was similar between the harvested tubers (Fig. 3), there was a higher percentage of the protein in the soluble form from tubers harvested from plants grown under longer days. Since a higher percentage of the proteins is in a more soluble form they are more readily available for early sprout growth and may influence early sprout vigor.

To test if the harvested tubers from one photoperiod regime were more vigorous than the other, the harvested tubers were subjected to a vigor test. Tubers from plants grown under long day conditions were identified as 'longer day seed' and those grown under short days as 'shorter day seed.' The stored tubers were used as seed tubers and planted in three growth chambers used to stimulate different after planting field conditions. One chamber was held at 55 °F, another at a cold temperature of 45 °F, and the third at a warm temperature of 65 °F. The later two were considered to be stressful conditions. The seed piece and emerging plants were harvested at 14, 30 and 45 days after planting (DAP).

At 45 °F plant emergence was earlier and more rapid from longer day seed than from shorter day seed (Fig.4). Emergence was fairly similar for the seed held at 55 and 65 °F, although duration to 100% emergence was shorter at the higher temperatures (data not shown). At 45 °F by 30 DAP leaf area and sprout length were significantly greater from plants emerging from longer day seed than shorter day seed (Fig.5). Shorter day and longer day seed acted fairly similarly at 55 and 65 °F (data not shown). Sprout fresh weight per plant was greater from longer day seed than shorter day seed at 45 and 65 °F by 30 DAP (Fig.6). By 45 DAP, the plants began to form tubers at all three planting temperatures. There was greater tuber fresh weight per plant produced from longer day seed than shorter day seed at 45 °F (Fig.7). Shorter day and longer day seed acted similarly at 55 °F (Fig. 7) and 65 °F (data not shown). Longer day seed appeared to be more tolerant of the 45 °F treatment as demonstrated by strong sprout and leaf development. This tolerance may have been affected by the energy reserve composition of the seed tuber (Fig. 2B, Fig. 3).

Based upon this growthroom study and the relationship between energy reserve factors and vigor characteristics in general, carbohydrate and protein content may give some indication of vigor. Starch and sugars are both carbohydrates necessary for sprout growth and leaf development. Therefore how quickly and vigorously a plant emerges may be dependent upon the seed tuber's carbohydrate reserves and how easily and readily it can be used for that early sprout growth. The amount and form of starch may be an indicator of greater energy reserves readily accessible for early sprout growth.

Greater protein content, especially in the soluble form, may be advantageous in early sprout development.

Seed Lot Trial

The variability between how different seed lots perform makes the selection of seed sources a challenge. In an attempt to see if differences in performance of seed tubers from different seed sources were associated with production location and seed tuber specific gravity, 'Shepody' seed lots supplied to the Washington Commercial Seed Lot Trial in Othello, WA were sampled. Data on percentage of the stand emerged at 40 DAP and average aboveground stem numbers were obtained. Tubers were harvested 100 DAP, and tuber specific gravity, and yield data were obtained. Specific gravity and tuber number per plant showed considerable variability (Fig. 8). Although the seed lots were subjected to the same cultural practices and environmental conditions, they differed in yield and specific gravity. The difference in yield and tuber specific gravity were not obviously associated with seed tuber specific gravity, percent emergence or stem number. Therefore the question arises, could these differences be attributable to an influence by some other variable(s) associated with the seed source?

Seed Tuber Nutrient Reserves

Adequate nutrition is an extremely important factor in potato production with substantial attention paid to soil testing, pre-plant fertilization, and in-season fertigation. Could the nutrient status of the seed tuber also be important in plant establishment and vigor of the crop? In the true-seed industry, nitrogen, sulfur, phosphorus, potassium and calcium are considered important components of vigorous seeds. Nitrogen and sulfur are very important in protein structure and vital in supplying energy reserves for early sprout growth. Phosphorus and potassium are important in breaking down reserves, such as carbohydrates, for early growth and calcium is important in membrane stability and integrity. Previous research at Washington State University has indicated that calcium concentration in the soil solution, and possibly also in the seed tuber, may influence IBS occurrence. Dr. Jiwan Palta reported at the 35th Annual Washington Potato Conference that greater seed tuber Ca concentration decreased susceptibility to seed piece decay from bacterial soft rot. There can be great variability in the nutrient content of purchased seed tubers as indicated in Figure 9 for 'Russet Burbank' seed. How or if this variability in seed tuber nutrient status affects production performance is yet to be established.

High quality seed potatoes are those with the least amount of disease, desired size and shape, physiological age, vigor, nutrient and energy content. It is important to identify and purchase high-quality seed along with selecting seed lots that fit best into a given management system. This would include systems such as producing smaller potatoes or planting into cold soil temperatures. A uniform and vigorous plant establishment make management more efficient with higher yield and quality potential and thus better economic returns. In the future, is it possible there will be a vigor or productivity test for seed potatoes? Tests are used quite extensively in the true-seed industry that aids in identifying seed lot potential. It would be extremely beneficial for the commercial production of potatoes to have the ability to evaluate a seed lot prior to planting and determine the appropriate uses of that seed.

References

Harris, P. 1978. The Potato Crop. Chapman and Hall, London.

Rowe, R. C.1993. Potato Health Management. Amer. Phytopath. Soc. Press, St. Paul, MN.

Figure 1. Photoperiod Regimes

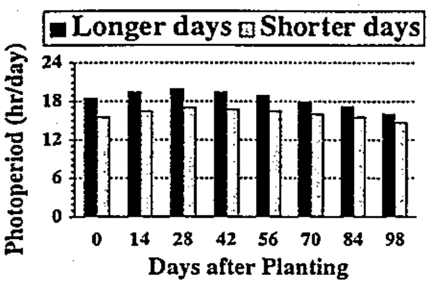
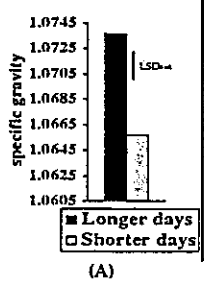


Figure 2. Specific Gravity (A) and Sugar (mg/g dwt) and Starch Content (µg/mg dwt) of Harvested Tubers (B)



(A)

	Longer days	Shorter days	Sig.(LSD)
Sugars:			
sucrose	16.29	15.91	ns
glucose	13.69	17.00	ns
fructose	7.28	10.60	ns
total sugars	37.26	43.52	ns
Starch:			
amylose	136.90	124.49	ns
amylopectin	509.25	464.98	*(44.10)
total starch	646.15	589.47	ns

(B)

Figure 3. Protein Content of Harvested Tubers

	Longer days	Shorter days	Sig.(LSD)
total protein (µg/mg dwt)	28.7	33.1	ns
soluble protein (% of total)	73.7	47.9	*(19.8)

Figure 4. Emergence at 45 °F

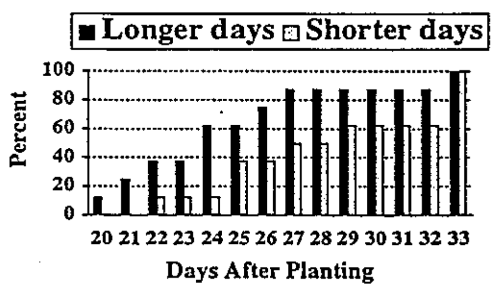


Figure 5. Early Growth Vigor at 45 °F

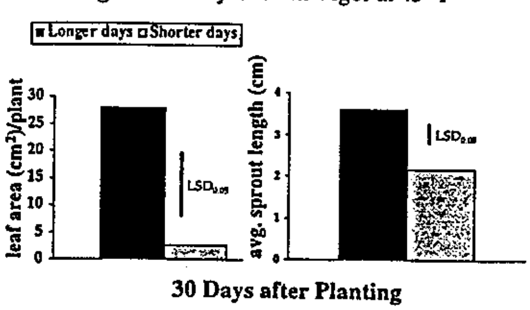


Figure 6. Sprout Growth Under 'Stressful' Growing Temperatures

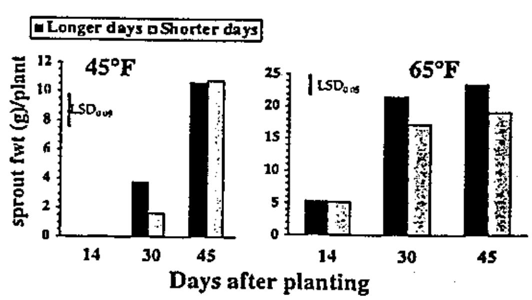


Figure 7. Total Tuber Yields per Plant

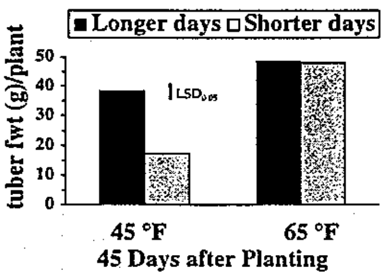


Figure 8. 1996 Washington Commercial Seed Lot Trials - 'Shepody'

Source	Seed s.g	% Emg	Stem #	Tuber s.g	Tuber #/plant
1	1.0718	48	3.4	1.0849	4.4
2	1.0805	60	4.0	1.0879	6.4
3	1.0964	41	3.8	1.0922	4.7
4	1.0651	14	2.6	1.0863	4.8
5	1.0677	55	3.6	1.0864	5.2
6	1.0791	44	2.8	1.0910	4.3

Figure 9. 1996 Washington Commercial Seed Lot Trial - 'Russet Burbank'. DTE = days to emergence.

Source	% S	% P	% K	% Ca	DTE
1	0.15	0.27	1.9	0.03	33
2	0.16	0.17	2.5	0.07	33
3	0.17	0.19	2.2	0.05	32
4	0.16	0.14	2.1	0.06	33
5	0.20	0.37	2.4	0.07	29
6	0.17	0.19	1.9	0.03	29