EARLY SEASON PLANT STAND VARIABILITY AND UNDERLYING FACTORS RELATED TO ENVIRONMENT AND SEED CONDITION

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Initial plant stand obtained after emergence in Spring forms the basis for growth, development, and ultimate performance of the potato crop. In this paper, data extracted from growth chamber, greenhouse, and field studies will be used to discuss factors that play an important role in early season plant stand of different cultivars. The following factors will be addressed:

- Storage related factors, i.e., time in storage, storage conditions, and storage temperature.
- Seed condition, as determined by Rhizoctonia solani, as a seed borne disease, and physiological age of seed.
- Circumstances after planting, i.e., planting depth and soil temperature after planting.

Storage

Time in storage

The results of two growth chamber experiments were compared to address the effect of storage time following the break of dormancy on plant emergence. The experiments involved seed with different storage histories:

1986 - Dormancy of seed broken immediately after Fall harvest and subsequently stored at 38°F until Spring planting.

1988/89 - Seed stored at 38°F after Fall harvest and dormancy was broken in Spring before planting.

In both experiments seed pieces were planted in cone shaped pots and placed in a growth chamber where they were kept at 45°F for a prolonged period of time ($1\frac{1}{2}$ months in 1986, $2\frac{1}{2}$ months in 1988/89). The temperature in the growth chamber was eventually elevated to 60°F to speed up emergence.

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The results in percent emerged plants of the two different experiments is shown in Table 1. Several cultivars were included in these experiments and all exhibited a reduced percentage of plants emerged for the 1986 experiment where there was a long storage period between break of dormancy and actual planting. In the 1988/89 experiment, where there was a short period of storage after break of dormancy until planting, virtually all plants of all cultivars emerged. Of interest are the differences among cultivars and how they responded to the prolonged time in storage after dormancy was broken in the 1986 experiment. HiLite and Shepody had more emerged plants than Russet Burbank, while A7411-2 and Norgold had considerably fewer emerged plants. These latter two cultivars also had missing plants in the 1988/89 experiment. 'Kinder tubers' were found for non-emerged plants of Norkotah, Norgold, and A7411-2, while other cultivars did not show this phenomenon. Non-emerged plants of Russet Burbank and HiLite exhibited frequently small spindly sprouts.

Storage Conditions

To explore the effect of storage conditions and prolonged storage on performance of seed in terms of plant emergence, a study was conducted in which seed was stored in storage and seed was stored by planting it in soil. The study was intended to address the often heard belief that it does not matter if potato seed is planted in cold soil because it is 'in storage' until the temperature rises and allows growth. The seed pieces were held in storage or soil for 2 and 4 months after break of dormancy in early Spring. Temperature during these periods was 40°F for both conditions, which inhibited or greatly retarded sprout growth. After 2 and 4 months, seed pieces that were held in storage were planted and, at the same time, the temperature of the soil that stored seed was raised to allow emergence.

Table 2 lists the results in percent emerged plants. Two contrasting cultivars were included, i.e., Russet Burbank, a late maturing cultivar with a long period of dormancy in storage, and Norgold, a rapidly developing, early cultivar with a short dormancy. Russet Burbank showed 100 percent emergence after two months in soil or storage. A reduced number of plants emerged after 4 months of storage, while seed in soil exhibited a lower percentage plants emerged than seed in storage. A similar but more dramatic effect on percent plants emerged was observed for Norgold. After 4 months in cold soil, no plants of Norgold were able to emerge. Non-emerged plants of Norgold and Russet Burbank showed in most cases Kinder Tuber formation.

Seed Condition

Rhizoctonia solani as a seed borne disease

In the 1987 growth chamber experiment, seed tubers of all participating cultivars were visibly infected with Rhizoctonia solani, or 'black scab'. The presence of this fungus had an effect on final percent plants emerged (Table 3).

Most plants of Shepody, Russet Burbank, and HiLite were, although severely damaged, able to eventually emerge. Norkotah and, in particular, A7411-2 and Norgold exhibited greater losses (up to 50% for Norgold).

Non-emerged plants of Norgold, A7411-2, and Norkotah frequently formed Kinder tubers in association with killed sprouts. This symptom can perhaps be interpreted as a consequence of low vigor resulting in the inability to produce a plant. This caused a little tuber to be produced to guarantee survival. No Kinder tubers were observed for Russet Burbank, instead it produced and branched several sprouts until one of the sprouts was able to emerge and form a plant.

Physiological Age

In studying the effect of physiological age on plant emergence, young and old seed was planted in a growth chamber held at a constant 50°F (Table 4). Old seed for both cultivars, in particular Norgold, produced fewer plants than young seed.

Similar young and old seed was planted in a field experiment at an early (early April) and a late (late April) planting date (Table 4). Fewer plants were established from old seed than young seed at the early planting date when the average soil temperature for the first 3 weeks after planting was 53°F. At the late planting, however, when the average soil temperature was higher, old seed performed as good as the young seed and no effect of physiological age was found on final plants emerged.

Circumstances after Planting

Soil Temperature after Planting

Seed pieces of several cultivars were planted at different depths in cone shaped pots and held at different low temperatures in growth chambers for prolonged periods of time (up to $2\frac{1}{2}$ months). Figure 1 shows that lowering soil temperature from 50°F to 45°F significantly delayed emergence. Lower soil temperatures also increased the variability in days from planting to emergence (Figure 2). The expressed variability is the spread of time over which plants emerge (standard deviation). Data shown in Figure 1 and 2 is an average across planting depth 1 and 3 inch.

Planting Depth

The effect of planting depth on days to emergence is illustrated in Figure 3. Note that the effect of depth is very similar for all cultivars, meaning that there was no significant interaction observed between depth and cultivar on days to emergence. Planting depth also influenced the variability in time to emergence (Figure 4). Planting at a depth of 6 inch increased emergence variability considerably for particular clones such as A7411-2, Shepody, and HiLite. These cultivars had a relatively small emergence variability at the 1 and 3 inch depth.

In Summary

Inferior plant stand can be caused by:

* Physiologically aged seed, as a result of:
  - elevated temperatures in storage
  - Prolonged period of time in storage or soil at low sprout inhibiting temperatures.

* Seed or soil borne diseases, such as Rhizoctonia solani.

* Conditions after planting:
  - low soil temperatures
  - planting depth.

The final effect on plant stand of the above factors depends on cultivar.

Russet Burbank tends to be a stronger, hardier cultivar than several other cultivars, exhibiting less detrimental effects on plant stand.

Table 1. STORAGE: Time
Growth Chamber 1986 and 1988/89, 45°F

	Percent Emerged	
	1986	1988/89
HILITE	75	100
SHEPODY	50	100
R. BURBANK	38	100
NORKOTAH	38	100
A7411-2	13	95
NORGOLD	13	92

Norkotah, A7411-2, Norgold: "Kinder Tubers"
R. Burbank, HiLite: spindly sprouts

Table 2. STORAGE: Time
Growth Chamber 1988

Keeping seed in STORAGE versus SOIL at 40 F, emergence at elevated temperature

	Percent Emerged Plants	
	R. BURBANK	NORGOLD
STORAGE - 2 MONTHS	100	100
SOIL - 2 MONTHS	100	88
STORAGE - 4 MONTHS	88	56
SOIL - 4 MONTHS	50	0

Table 3. SEED CONDITION: Seed borne Rhizoctonia solani infection
Growth Chamber 1987

	Percent Emerged
	1987
SHEPODY	100
R. BURBANK	92
HILITE	83
NORKOTAH	67
A7411-2	58
NORGOLD	50

Table 4. SEED CONDITION: Physiological Age

YOUNG: stored at 38°F, 'peeping' at time of planting
OLD: stored at 56°F for 8 weeks, desprouted at time of planting.

Growth Chamber 1989, 50 °F

	Percent Emerged
R. BURBANK - Young	100
R. BURBANK - Old	88
NORGOLD - Young	100
NORGOLD - Old	43

Field Plot, 1989

	Percent Emerged
Early Planting: 53 °F	
R.BURBANK - Young	96
R.BURBANK - Old	79
Late Planting: 59 °F	
R.BURBANK - Young	95
R.BURBANK - Old	93

Figure 1. Days from planting to emergence for six potato cultivars at 45°F and 50°F. Plotted values are averages across planting depths 1 and 3 inch.

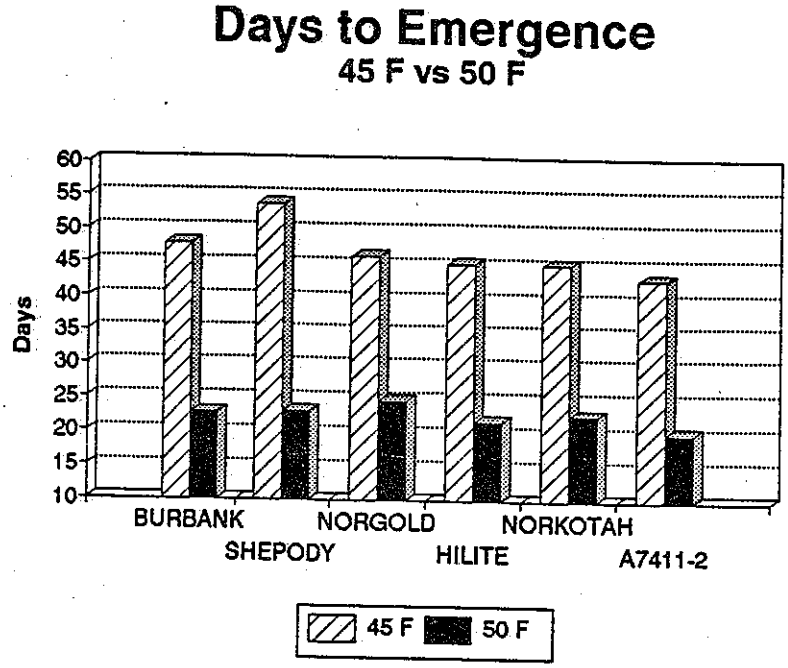

Figure 2. Emergence variability (standard deviation) for six potato cultivars at 45°F and 50°F. Plotted values are averages across planting depths 1 and 3 inch.

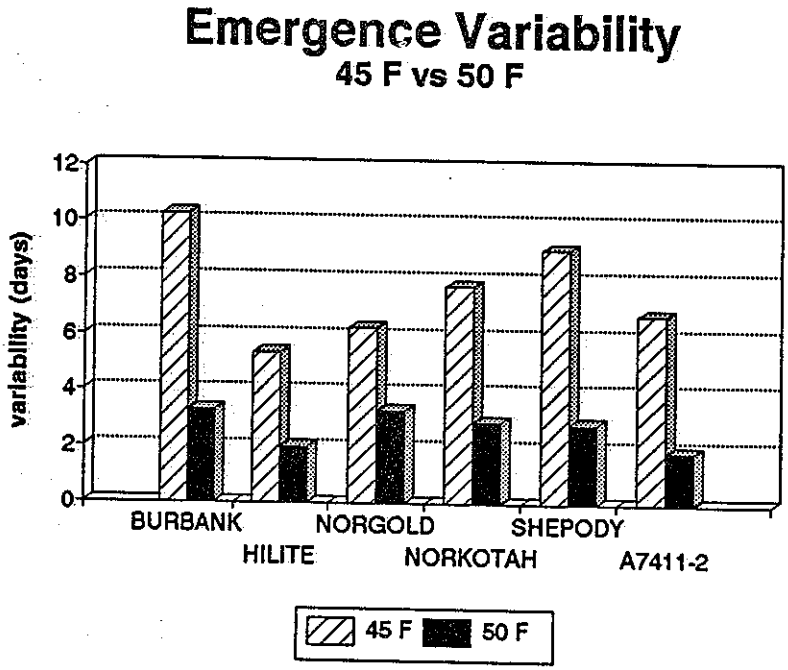

Figure 3. Days from planting to emergence for six potato cultivars at 1, 3, and 6 inch planting depth.

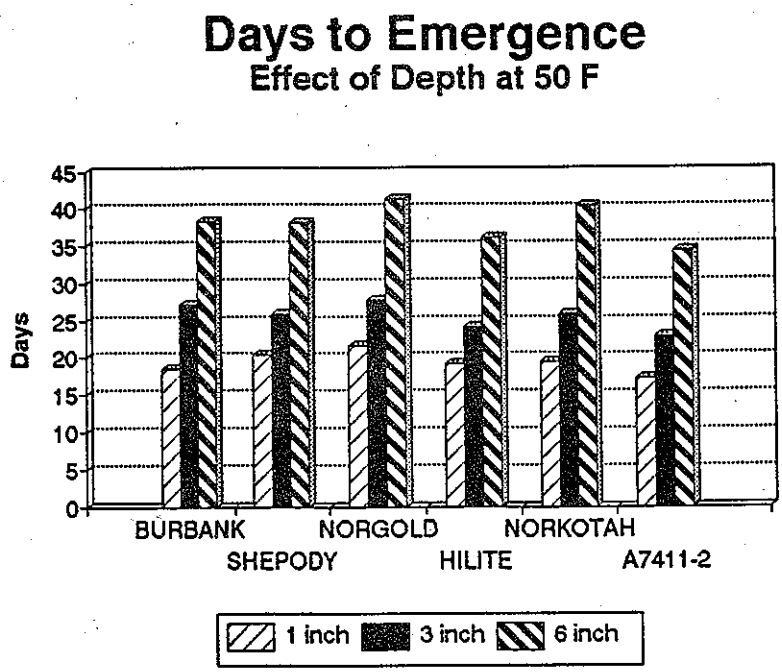

Figure 4. Emergence variability (standard deviation) for six potato cultivars at 1, 3, and 6 inch planting depth.