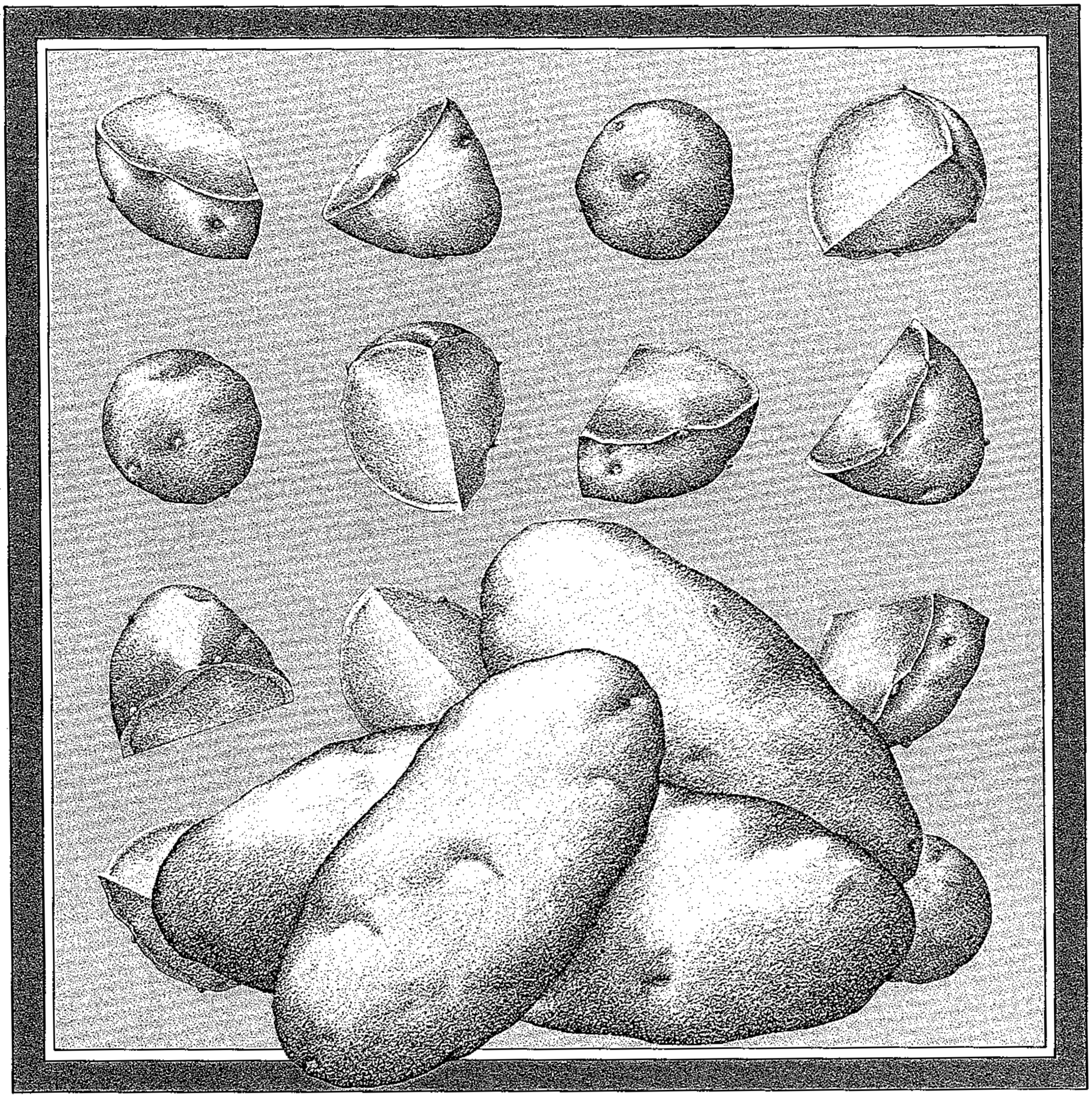
POTATOES

INFLUENCING SEED TUBER BEHAVIOR



A Pacific Northwest Extension Publication

Washington Oregon Idaho

PNW 248

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WHY SEED TUBER BEHAVIOR IS IMPORTANT

■ Productive capacity of seed tubers is influenced by growing conditions of the seed, storage conditions, and environmental conditions after planting.

■ A short growing season with relatively cool temperatures and a low aphid population is desirable for seed production.

■ Seed tubers age physiologically with both time and high storage temperatures.

■ Physiological aging generally means loss in productive capacity, especially in long growing season areas.

■ As seed tubers age, the tendency is:

- more rapid emergence
- increased stem production
- higher tuber set
- early vine senescence
- lower harvest yield

■ For seed production, where a high yield of small tubers is desirable, aging the seed by exposure to 50–55°F temperatures is recommended.

■ For high yields of large tubers, physiologically young seed is desirable. Seed should be stored at constant temperatures of approximately 40°F with minimum exposure to high temperatures.

■ Generally, as the size of mother tubers from which seed tubers are cut increases, productive capacity decreases. Tubers 10 ounces (280 grams) or larger are not recommended for use as seed.

■ In the seed cutting operation, small sizes 1 ounce (28 grams) or less and slivers should be eliminated. Small seed is not an economically productive unit.

SUMMARY

For the potato grower it is important to understand and to be able to influence the numbers of stems arising from a seed piece. The number of stems or density of stems in a field is determined not only by seed size and spacing, but also by physiological condition or seed age.

Although the conditions under which seed is grown influence its behavior, the more influential and controllable factors are storage conditions and subsequent handling.

Russet Burbank seed stored at lower temperatures (38–40°F) produce an average of 2.5 stems per seed piece. At higher storage temperatures, over 4.0 stems per seed piece can be produced with an 11 ton yield reduction of U.S. No. 1 potatoes per acre. With a value of $80 per ton this would mean a loss of $880 per acre. On the other hand, with the higher stem populations, an increase of 5.5 tons of undersize tubers per acre could be obtained, but which have little value on the commercial market. For a seed grower it would be desirable to obtain smaller tuber sizes (less than 8 ounces) and manipulate storage temperatures for higher stem (3–4 stem) and tuber populations in seed fields.

Planting date should also be considered in obtaining desired stem populations along with physiological age, seed size, and spacing. As germination temperature increases with later planting dates, the tendency is for increased stem numbers. To overcome this the seed should be kept at a low temperature (40°F) until planting. Warming seed at this time should only be to reduce bruising during handling. Slightly wider spacing from 10–12 inches would also be advantageous to increase tuber size at harvest.

Understanding seed behavior is essential for manipulation and control of stem number and tuber set. Cultivars respond differently to environmental conditions. Seed management practices should be worked out for each cultivar and growing environment. With present knowledge, complete control of seed behavior can not be obtained because of unpredictable growing conditions. However, growers can improve their chances of obtaining profitable yields by making knowledgeable decisions on seed management practices.

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INTRODUCTION

As production costs continue to increase faster than prices received by growers, it becomes evident that potato producers must continue to improve not only yields but also potato quality. Tuber size is one aspect of quality. Many processors pay a bonus for quality; growers who produce tubers with undesirable characteristics, such as small size, are penalized.

Greater control of seed behavior is needed. Seed behavior influences the number and vigor of stems arising from a seed piece, and time and number of tubers set. These in turn affect rate of tuber development and maturation, size, grade and ultimate crop yield. Greater control of seed behavior would enable the grower to manipulate tuber development for market requirements.

Manipulation of seed behavior can be of significant economic importance to potato growers. Figure 1 shows yield and grade distribution as influenced by average stem number per seed piece. Fewer stem numbers can result in higher yields. An increase in stem number from 2.5 to 4.5 per seed piece reduced U.S. No. 1 yield approximately 11 tons per acre and increased undersize tubers by 5.5 tons per acre.

Another important factor in manipulating seed behavior is to reduce variability among seed pieces within a planting lot. From a genetic point of view, the potato is inherently quite variable due to its heterozygosity. Physiologically, seed tubers can vary due to differences in time of initiation, amount of starch accumulated during growth, and rate of tuber enlargement.

The major emphasis of potato seed certification programs in the United States has been elimination of seed borne diseases such as viruses. This emphasis has been properly placed because diseases have been a major hinderance to economic yields in many areas. However, with the advent of meristem culture and stem cutting programs, viruses and bacterial diseases are being controlled. This means that greater emphasis can be directed toward physiological and biochemical seed condition in relation to productivity.

The objective of this publication is to provide potato growers with an understanding of seed potato physiology which should make it possible for them to manipulate environmental and physiological conditions to increase marketable potato yield. Considerable differences exist among cultivars in their response to environmental conditions. The information in this publication is based primarily on the study of Russet Burbank which is the predominant cultivar grown in the United States, (comprising 38 percent of the total seed produced). In the northwest states of Idaho, Washington and Oregon, Russet Burbank accounts for 90 percent of the 475,000 acre annual production.

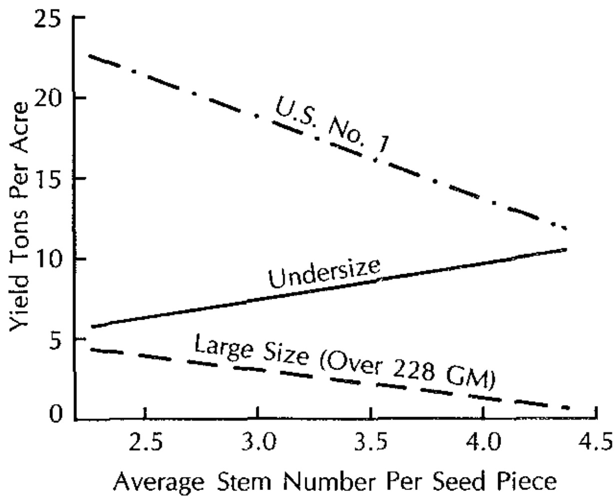


Fig. 1. The influence of stem number per seed piece on yield of Russet Burbank potatoes of different sizes.

STEM DENSITY

THE CONCEPT

The number of main stems arising from a seed piece is important because it influences the number and size of tubers at harvest. It also can be used as an indicator of physiological condition of the seed, which has an influence on plant vigor (Fig. 2) and yielding ability. While the number of stems is important, equally important is how stems are derived: from alteration of spacing, seed piece size, and/or physiological age.

CONTROL OF STEM DENSITY

There are basically four factors which influence stem density per unit area:

- cultivar
- seed size
- spacing
- physiological condition of the seed.

The grower has some control over all of these factors, but physiological condition is the most difficult to manipulate. A plant with five stems (Fig. 3) will set 16–20 tubers. This is considered too many in most areas, producing many small tubers at harvest. A physiologically younger seed piece with three stems and 12 tubers has a better chance of developing sufficient tuber size and would bring greater economic returns.

Desired tuber sizes are determined by market requirements which can vary according to whether the tubers are to be used for chips, French fries, fresh market or seed. The grade and yield ultimately obtained is influenced by growing season length, temperature level, water, fertility, soil conditions, seed quality, and the grower's management ability. Although growers do not have complete control of many of these factors, they have some control, and the degree and manner in which this control is exercised will influence yield levels.

CONTROL OF STEM AND TUBER NUMBER

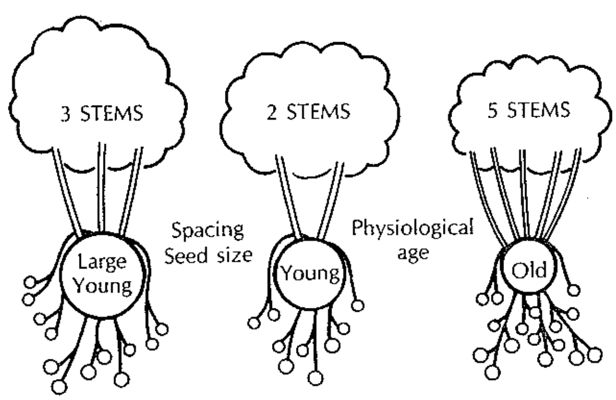


Fig. 3. Illustration of seed size, spacing and physiological age which influence stem and tuber numbers per unit growing area.

Fig. 2. Extreme differences in vigor of plants of Russet Burbank due to physiological age of seed 5 and 12 months old.

FACTORS INFLUENCING PHYSIOLOGICAL AGE

Seed tubers are living organisms. They age physiologically with time. The aging rate depends upon the growing environment of the seed, storage environment, and field conditions during germination or sprouting of the suceeding commercial crop (Fig. 4). The most influential environmental factor is temperature.

Control of physiological age through manipulation of chronological age is difficult in many cases. The economic benefits are questionable when logistics and costs are considered. Of more practical significance is manipulation and control of other factors known to influence physiological age.

INFLUENCE OF SEED GROWING ENVIRONMENT

Temperature. As seed tubers are exposed to high temperatures during growth, the physiological aging process is accelerated and tubers will be more mature at harvest. This is one of the reasons why seed tuber production is generally located at high altitude and in cooler areas of the country. Harvesting seed tubers in an immature condition when the vines are still green can offset, to a degree, the effect of growing under high temperature.

Moisture. Not much is known of the direct influence of moisture on physiological age. However, indirectly it can have considerable influence on relative maturity of the tuber. Generally, tubers exposed to moisture stress tend to age faster and sprout sooner than tubers not stressed.

Maturity. The term maturity is not well defined. It most often refers to degree of thickening and setting of the skin. It is generally preferable to harvest seed tubers slightly on the immature side when some skinning takes place. The maturation process can continue in storage if temperature and humidity are adequate. The foliage should be alive and somewhat green at the time of vine kill. Tubers from vines which died prematurely from disease or lack of fertilizer are generally physiologically older and often do not store well.

Fertility. Fertility level and management affect size, yield, and tuber maturity. Low levels of fertility can result in premature plant death, which results in seed tubers aging physiologically. High fertility levels result in immature tubers because of delayed plant maturity which also may be undesirable.

Growing Season. Shorter growing seasons are more desirable for seed tuber production because there are

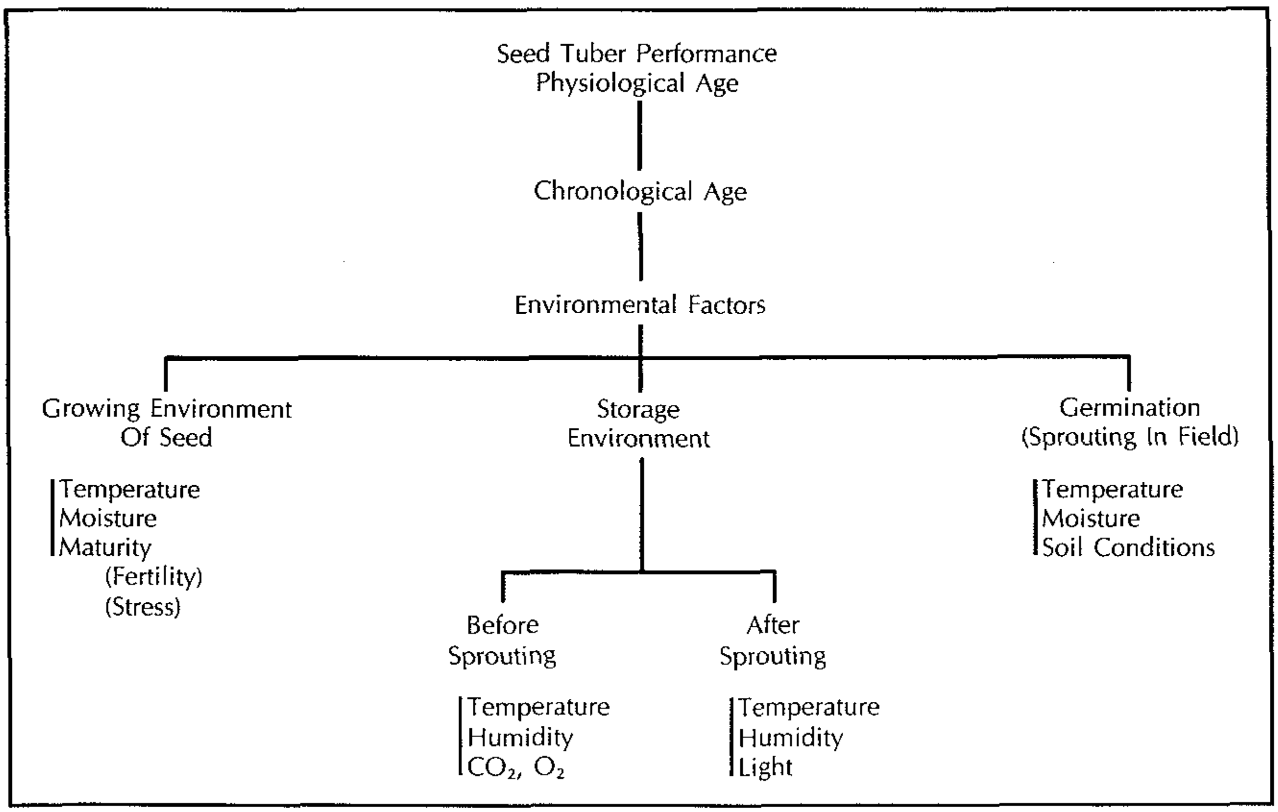


Fig. 4. Diagramatic presentation of the important factors influencing physiological age of seed tubers.

fewer opportunitities for physiological aging and virus infection. In most areas, populations of leafroll virus spreading green peach aphids increase in late summer. With a shorter growing season, the chances of virus infection are greatly reduced and the tubers can be harvested in a physiologically younger condition. The tubers will also be smaller, which is generally desirable for seed.

Harvest Conditions. Bruising seed tubers during harvest increases chances of decay, ultimately resulting in weak plants. Bruises also increase the variability of stem numbers in the succeeding crop. To reduce the amount of bruises and clods in storage, the soil should be moist and mellow at the time of harvest, with harvesters adjusted for minimum damage. Seed tubers should not be left undug in the field for long periods after vines are killed, especially under high soil temperatures. Harvest should be completed before cold weather and chance of chilling in the field.

INFLUENCE OF STORAGE CONDITIONS

Storage conditions can have a greater influence on physiological age and sprouting behavior of seed than the growing conditions of the previous season.

Temperature. Temperatures of around 40°F (4.4°C) are optimum for long term storage of most cultivars. At this temperature respiration rate is close to a minimum. Temperature manipulation can be used to influence seed behavior. High temperatures (above 60°F) during the time of dormancy break tend to induce apical dominance in most cultivars. As high temperature treatments are given later, apical dominance is reduced. Low storage temperatures (40°F) can greatly prolong the dormancy period of most cultivars. On the other hand, alternating high and low temperatures in storage generally shortens the dormancy period. Temperatures near freezing (32–34°F) followed by high temperatures may cause complete loss of apical dominance. Seed tubers should not be allowed to sprout in storage. Breaking off of sprouts during planting tends to cause more and weaker stems to develop.

Humidity and Gases in Storage. Excessively high humidity has been reported to shorten dormancy. On the other hand, low humidity which causes excessive dehydration can result in tuber aging. Exposure of tubers to high concentrations of carbon dioxide or to ethylene in storage can also result in dormancy breaking, although the continued presence of high carbon dioxide inhibits sprout growth.

INFLUENCE OF GERMINATING CONDITIONS OF THE COMMERCIAL CROP

Temperature. Germinating conditions can be important especially where planting dates are spread over a long time period, as in the Columbia Basin of Washington and Oregon. In these areas soil temperature during germination can be below 45°F during the early planting period and warm up rapidly (60°F) at later planting dates. Cooler temperatures during germination such, as in the seed areas of Idaho or Oregon, tend to produce slow emerging plants with few stems. These plants develop larger, more vigorous vine and root systems, characteristic of physiologically young seed. This can be overcome somewhat by warming the seed before planting. With higher germinating temperatures, emergence is more rapid and more stems develop per seed piece. Seed tubers planted in light, sandy soils which warm up rapidly tend to have higher stem populations than those planted in heavier soils.

Moisture and Fertility. Dry soil conditions at planting result in slow, uneven germination with many weak sprouts. Where possible, fields should be irrigated before planting. It has been observed that high rates of fertilizer applied close to the seed piece can cause burning of the roots and a significant decrease in stem population, especially under dry soil conditions.

IMPLICATIONS OF PHYSIOLOGICAL AGE

A greater understanding of the effects of seed potato physiological age should make it possible to attain better control of field performance and would be of economic advantage to potato growers. Research in the Netherlands and France and preliminary data from England indicate considerable differences in cultivar response to age. Some generally accepted characteristics of physiologically young and old seed are listed in Table 1. The degree and type of response to aging can vary with cultivar and growing conditions.

LENGTH OF GROWING SEASON

Generally, physiologically young seed is more desirable for use under conditions of a long growing season because plants from young seed tend to stay green longer and mature later. On the other hand, physiologically older seed would be advantageous where rapid, early growth is desired for an early market, where spring germination temperatures are low and emergence is slow, and where large tubers are undesirable as in the case of seed production. The terms young and old are relative terms and performance depends upon the particular stages in which comparisons are made and on the production area.

CHRONOLOGICAL AGE (LENGTH OF STORAGE)

The relationship between chronological age and yield is shown in Figure 5. The optimum age for seed suggested is approximately five months from harvest of seed to planting for commercial production. Seed younger than this showed signs of juvenility where emergence was very slow and uneven resulting in decreased yields. The manipulation of chronological age is not logistically and economically feasible in many potato production areas. Of more practical significance would be control of physiological age through control of temperature exposure, particularly storage temperatures, as suggested in England.

HEAT UNIT ACCUMULATION

The yield response to heat unit accumulation from time of tuber initiation in seed fields, through growth and storage, until planting the next spring is shown in Figure 6. The Dutch cultivar Desiree was used in these studies. The relationship indicates there is an optimum physiological age for yield in terms of heat unit accumulation.

STEM NUMBER AND YIELD

Russet Burbank seed produced fewer stems per seed piece and higher total yield under lower storage temperatures than under higher temperatures (Table 2 and Fig. 7). As storage temperatures increased, average stem numbers per seed piece increased and yield decreased. In the shorter growing season areas such as southeastern Idaho, somewhat older seed (exposured to higher temperatures) would produce yields com-

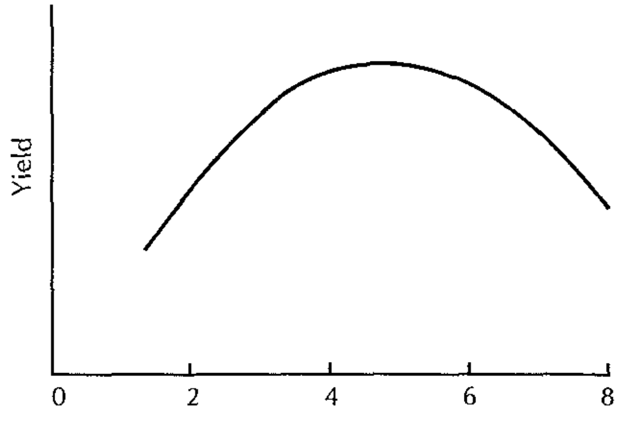


Fig. 5. The relationship between chronological age of potato seed tubers and yield (Kawakami, 1953).

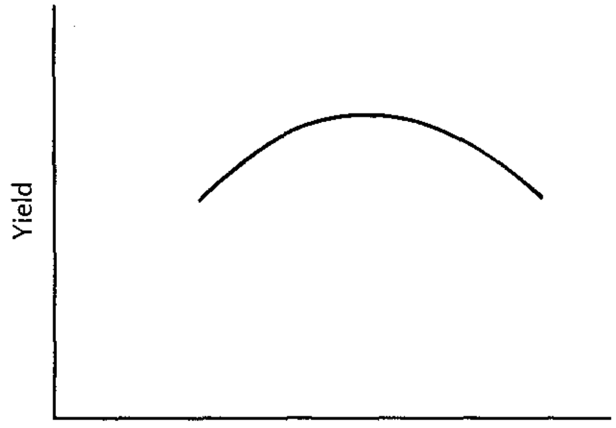


Fig. 6. Relationship between yield (cv. Desiree) and temperature accumulated by the seed tuber from initiation to planting (Wurr, 1978).

Table 1. Characteristic behavior of psysiologically young and old seed tubers.

Young Seed	Old Seed
Slow emergence	Rapid emergence
Apical dominance	Multiple main stems
Few main stems	Increased stem branching
Vigorous, large plants and root systems	Smaller, weaker plants and root systems
Fewer tubers set per hill	Relatively many tubers per hill
Long bulking period	Rapid bulking
Long tuberization period	Relatively uniform tuber set
Large tubers at harvest	Smaller average size tubers
High yields	Early senescence, and lower yields
Delayed senescence	

parable to young seed, although the average size would be smaller. The relationship between stem number per seed piece and tuber number has been shown to be curvilinear (Fig. 8) although the total number may vary from year to year. Tuber set with the Russet Burbank cultivar is influenced primarily by temperature and fertility level, particularly during the early stages of growth, although in many cultivars it is basically a day length reaction. Environmental conditions which tend to limit vegetative growth usually favor tuber formation.

The relationship between higher yields and fewer average stem numbers per seed piece could be due to two factors. First, the seed stored at low temperatures accumulated less heat units and therefore was physiologically younger, more vigorous, and able to keep photosynthetically active young leaves over a longer period of time. Second, the amount of food reserve in the seed piece was greater per stem in the young seed because of less stems for a given size seed. Figure 9 shows the relationship between seed weight per stem and yield. These results were obtained using Russet Burbank seed grown and stored under identical conditions but cut to different sizes.

CULTIVAR RESPONSE

Cultivars respond differently to seed size. The benefits are largely dependent upon the cultivar propensity to produce stems. Cultivars with high stem production are less responsive to influence of seed size than those with inherently low stem production.

EFFECT OF PLANTING DATE

Planting date also has a significant influence on stem production per seed piece (Table 2) with later plantings generally producing a higher stem population. This is contrary to the ideal. The goal with later plantings is limited stem numbers, and subsequently fewer tubers set, so that each tuber has a better chance of developing marketable size, except in the case of seed production. This can be attained to a certain degree by storing seed at lower temperatures (Table 2). On the other hand, if a higher tuber set is desired for the early plantings, then exposure to higher storage temperatures (50–55°F for two weeks) prior to planting is required. Total yield was significantly less for the last planting date. The difference in yield between the first and second planting dates depends to a large extent upon how fast the early spring temperatures warm up and therefore varies from year to year. The differences in stem numbers due to planting dates is attributed primarily to germination temperature, although it is recognized that there is some influence of chronological age.

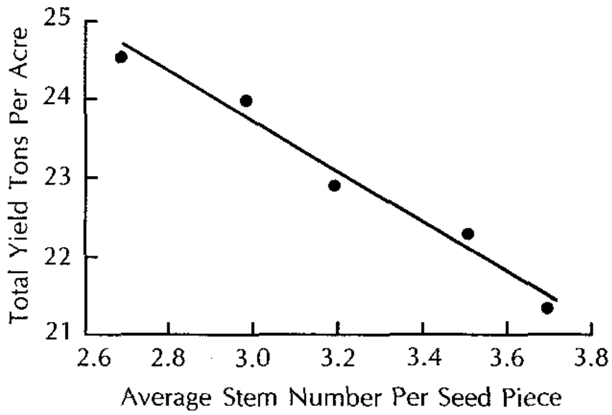


Fig. 7. Relationship between stem number per seed piece (obtained by storage at different temperature, Table 2) and total yield for the Russet Burbank cultivar (average of three years and three planting dates).

Table 2. Influence of planting date and storage temperature on average stem numbers per seed piece and yield. (Columbia Basin)

Storage Temperature °F	Planting date March 31	April 20	May 12
38°F (3.3°C)	2.4	2.7	2.9
42°F (5.6°C)	2.5	3.4	3.3
48°F (8.9°C)	2.8	3.6	3.4
42–60°F*	2.9	3.3	3.5
60–42°F**	3.2	3.8	4.2
Av. for planting date	2.8	3.4	3.5
Av. Total Yield Tons/Acre	25.0	24.0	21.0

*Storage temperatures of 42°F all winter and 60°F one month before planting.
**Storage temperature of 60°F for two months initially and 42°F remainder of the storage period.

Figure 10 shows the effect of germinating temperatures on average stem numbers per seed piece. Higher germination temperature results in an increase in stem numbers within the range of 50–60°F. The degree of influence depends to a large extent upon the physiological age of tubers at planting time. If the seed is physiologically old before planting then germinating temperatures have much less influence. Generally, it is undesirable to plant when soil temperatures are below 48°F, especially in the shorter growing season areas. Cold soils can result in slow, uneven, and poor germination. This can be overcome somewhat by warming seed before planting.

VARIABILITY OF STEM NUMBERS

Variability of stem numbers per seed piece in a potato field is equally as important in influencing yields as average stem numbers per seed piece. Although complete control of this factor may never be attained, it is possible to reduce variability. The data (Fig. 1) indicates that between two and three stems per seed piece would be optimum for high yields. This number of stems would set 8–14 tubers per hill. (The actual number varies from year to year.) Figure 11 shows that the percentage of seed tubers giving the desired stem numbers is much greater for seed stored at 38°F when compared to seed stored at 48°F. Storage at the higher temperature not only gave a lower percentage of desired stem numbers, but also increased the variability of stem numbers. High stem populations per seed piece are most undesirable for producing high yields of large tubers.

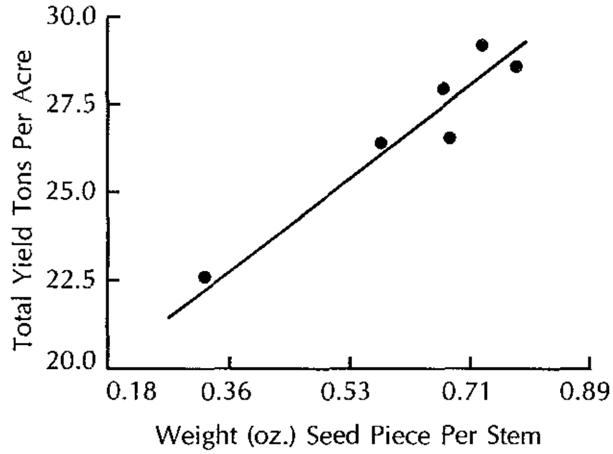


Fig. 9. Relationship of weight of seed piece per stem and yield of Russet Burbank potatoes (average of 1971 and 1972 data).

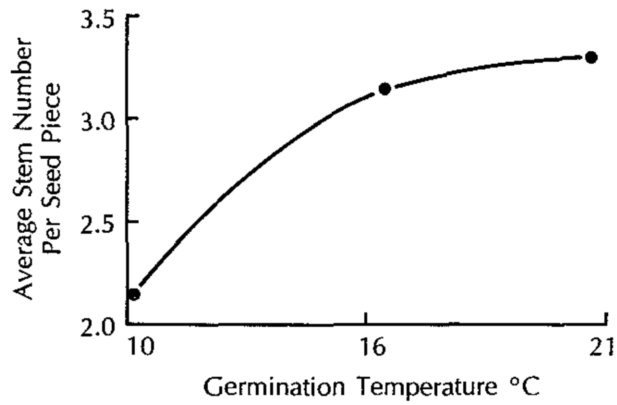


Fig. 10. The influence of germinating temperatures on stem numbers per seed piece of Russet Burbank (Greenhouse data, 1981).

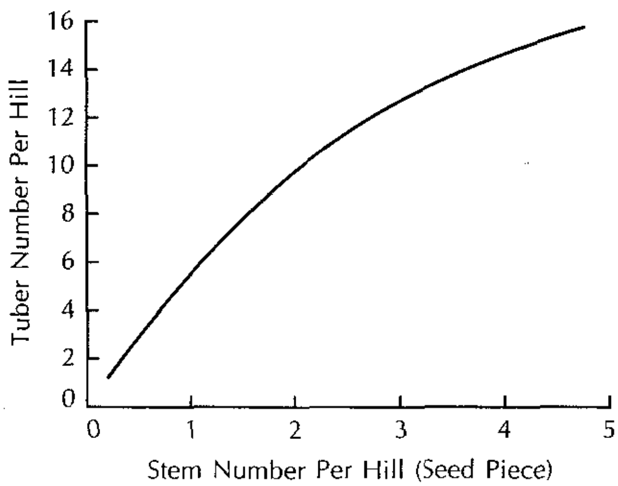


Fig. 8. A general relationship between stem numbers per (seed piece) and tuber numbers of the Russet Burbank cultivar.

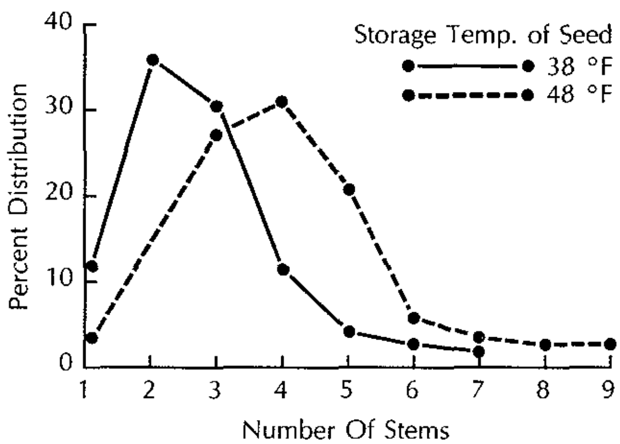


Fig. 11. The effect of seed storage temperatures on percent distribution of stem numbers per seed piece in a field of Russet Burbank potatoes.

SEED HANDLING

WARMING UP

The primary purpose of warming seed (50–55°F) should be to prevent bruising during handling in the cutting operation. Warming seed excessively can increase stem numbers, physiological aging, early plant senescence, and reduce yields. For rapid emergence of early planted potatoes for seed production and increased tuber production for the early market, seed warming is advantageous. Warming seed helps reduce the effect of cool germinating temperatures in the early spring, which tend to cause slow emergence.

CUTTING

Mechanical seed cutting results in variable sizes of seed pieces. To improve seed size uniformity, tubers should be presized, and the seed cutter knives adjusted accordingly. Cut seed pieces which are less than 1 ounce (28 grams) should be discarded since they produce less productive plants. Small seed will also result in undesirable stands in the field by causing either multiple seed pieces in a hill or missing hills.

SIZE OF SEED

Two size factors are important: size of the mother tuber from which seed is cut, and the size of the resulting seed piece. Generally, the larger the mother tuber from which the seed is cut, the less productive the resulting seed will be. A maximum desirable size for Russet Burbank is around 8 ounces (224 grams). On the other hand, yields tend to increase with size of seed piece planted (Fig. 12). The difference in plant size due to differences in seed size is shown in Figure 13. Yield increase with seed size increase follows the law of diminishing returns. Seed pieces much larger than 2–2½ ounces could result in poor stands because most planters are not designed to handle excessively large seed. Stem numbers increase as seed size increases, but the increase is not proportional (Fig. 14). This may be the reason why large seed produces higher yields than small seed. The food reserves per stem increase as seed size increases, resulting in increased yields (Fig. 9).

SPACING

Seed spacing within a row should be on the basis of stem density per unit area. The governing factors are:

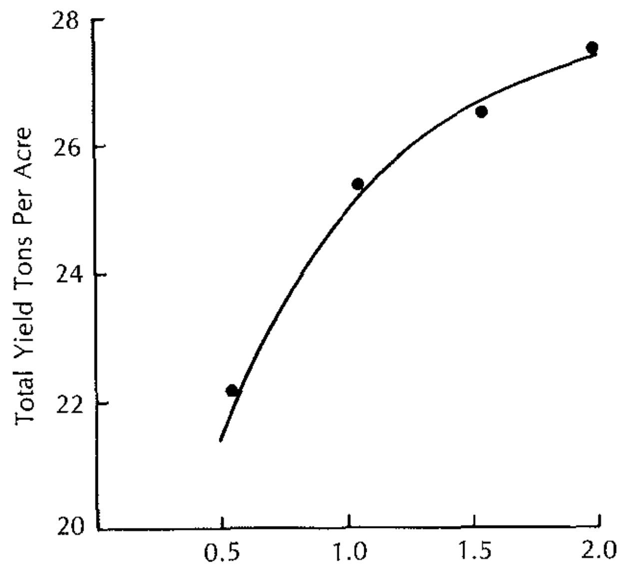
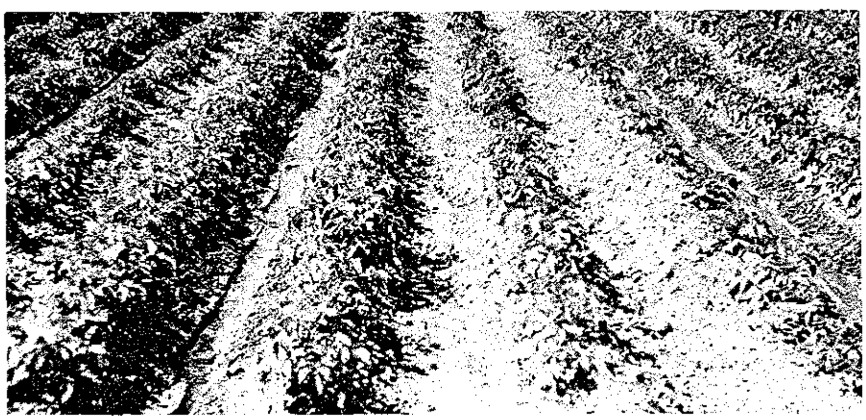


Fig. 12. Total yield of Russet Burbank as influenced by seed size.



2 1½ 1 ½

Seed size (oz.)

Fig. 13. The influence of seed size on plant size 40 days after planting.

cultivar, market demands for size, season length, fertility level, moisture availability, and soil type. Spacing between rows is determined by the same criteria, with additional consideration of equipment size and type, and digging ease.

Cultivars which set a low number of tubers, such as Kennebec or Nooksack, should be spaced closer, 8–10 inches (17.5–22.5 centimeters) within the row, unlike cultivars which produce heavy sets such as Norchip, or where the market prefers large tubers, such as Russet Burbank used for French fry production. In some cases, close spacing within a row has been reported to reduce losses from hollow heart and growth cracks, and thereby improve grade and appearance.

SEED TREATMENT

The need for a seed treatment varies from one area to another depending to a large extent upon the cultural practices used and planting conditions. A fungicide treatment is recommended when seed pieces are planted in dry soil or where cut seed may be held several days prior to planting. For insurance against poor stand and unpredictable weather conditions, seed tubers are generally treated before planting.

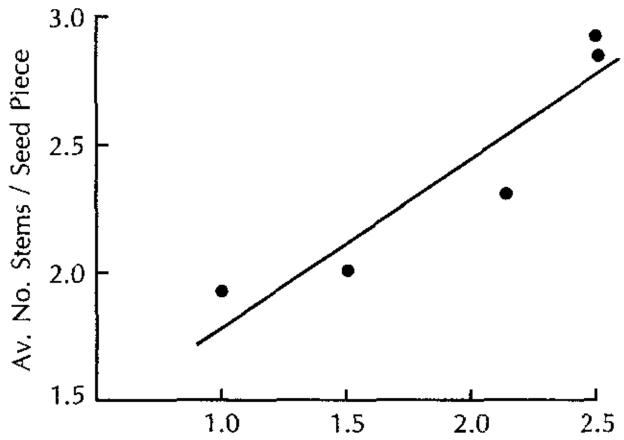


Fig. 14. The relationship between seed size and stem number per seed piece of Russet Burbank potatoes.

SEED TUBER PHYSIOLOGY

CONCEPT OF DORMANCY

Many plant materials, such as flower and fruit buds, seeds, and tubers undergo a period of dormancy or suspended growth during which time no growth takes place under favorable growing conditions. In the potato, this period is generally measured from the time of harvest, although it should probably be measured from the time of tuber initiation. Dormancy is a mechanism which helps insure the survival of a plant species. It can be due to unfavorable environment such as low temperatures, or unfavorable conditions within the tuber such as a hormonal imbalance. This latter condition is generally referred to as a rest period, considered by some as a separate state of dormancy. In this publication dormancy will be considered as a lack of bud growth due to conditions within the tuber.

Dormant periods of different potato cultivars can vary from none to more than four months. The Russet Burbank has a dormant period of approximately two months. However, this can be modified by exposure of tubers to high or low temperatures, moisture stress, premature death of the plant, disease, etc. Storage conditions such as exposure to temperature extremes, low humidity, rot, or oxygen tension can also influence dormancy length.

METHODS OF BREAKING DORMANCY

Normally, it is not necessary to break dormancy. However, in some cases, dormancy has to be broken artificially. This can be done in a number of different ways. The degree of effectiveness varies with type and concentration of chemical used, stage of dormancy, and temperature. Cultivars respond differently to treatments for breaking dormancy. Generally, a method for breaking dormancy should be worked out for each cultivar.

Temperature treatments. High and low temperatures as well as alternating high and low temperatures can hasten breaking dormancy. Low temperatures of 32–34°F are known to release tubers from apical dominance and result in earlier sprouting.

Chemical methods. Many chemicals can break tuber dormancy, but some are more effective than others. The concentrations, length of exposure, and effectiveness varies with cultivar, dormancy stage, application method, temperature during and after treatment, and whether seed is cut or whole. One commonly used chemical is gibberellic acid (GA_3). The tubers are dipped in a solution of approximately one part per million and placed in a controlled temperature room for five days at 60–70°F with high humidity. This method retains apical dominance to a certain degree.

CONCEPT OF APICAL DOMINANCE

Apical means apex or tip. On the potato tuber the eyes are arranged spirally from the tip of the apical end to the basal end. When sprouting starts, the apical bud at the very tip which was initiated last starts to grow first (Fig. 15). This bud produces auxin (IAA), which diffuses to the lower buds inhibiting their growth. If the apical bud is broken off, then the source of auxin is removed and the lower buds start to grow. The degree of apical dominance varies considerably among cultivars. For instance the Nooksack cultivar has a very strong apical dominance. Many single stem plants can be found in a field of Nooksack potatoes.

Some cultivars have no apical dominance. Apical dominance exists not only in the tuber as a whole but also within each eye. Generally there is a potential of three or more sprouts developing out of one eye. Among the bud clusters in a single eye, apical dominance is present. Apical dominance also exists within a bud or sprout within each eye. That is, the terminal shoot inhibits growth of the lateral branches of a single sprout or stem. As tubers get physiologically older, apical dominance is gradually lost. It is possible for a physiologically old seed tuber to have most of its eyes sprouting, multiple sprouts from each eye, and considerable amount of lateral branching on each of the sprouts or stems. Apical dominance can be influenced by storage temperature, chemicals used for breaking dormancy, breaking the apical sprout, or aging the seed.

CONCEPT OF PHYSIOLOGICAL AGE

The influence and significance of physiological age is not well understood. It has been described as "The physiological state of a tuber at any given time." The confusion about physiological age can be attributed primarily to the lack of a precise definition and criteria for its measurement. Cultivars respond differently to the aging process, and the response and performance to seed age can be influenced by the environment in which the commercial crop is grown.

As far back as 1924, the suggestion was made to use sprouting capability as a means of characterizing seed potential. It was observed that seed with a single, thick sprout produced more vigorous plants. A Dutch scientist has shown the following sequence of events with age: (1) one sprout stage, (2) the multiple sprout stage, (3) the branching stage and (4) the small tuber formation stage.

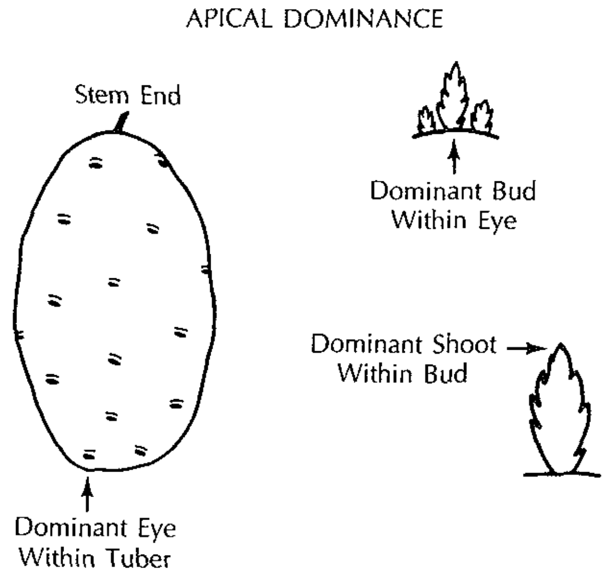


Fig. 15. Illustration of the concept of apical dominance and the regulation of stem numbers emerging from a seed piece.

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