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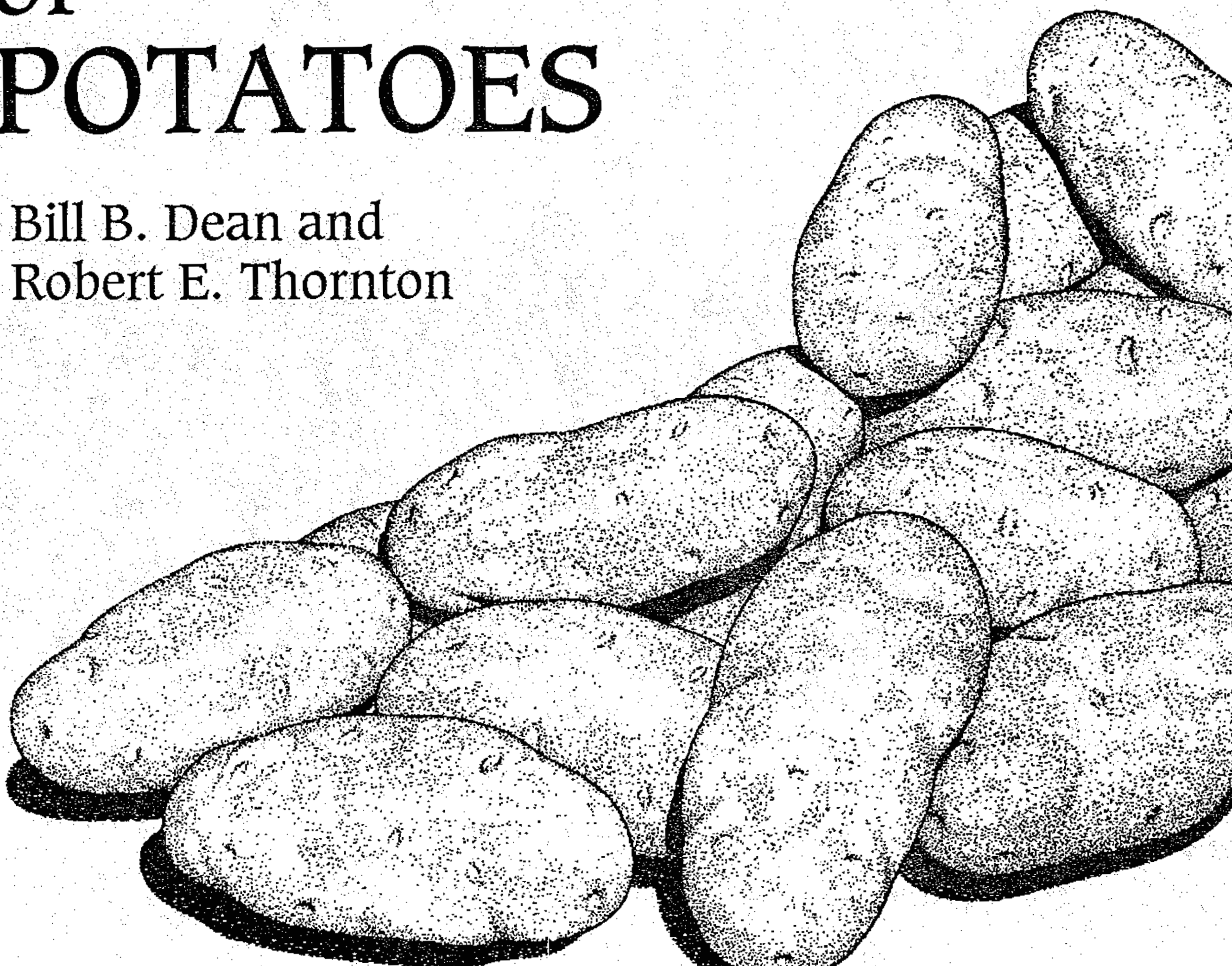
the SPECIFIC GRAVITY of POTATOES

Bill B. Dean and
Robert E. Thornton



Cooperative Extension • College of Agriculture and Home Economics • Washington State University, Pullman

About the Authors

Bill B. Dean, Ph.D., is an Associate Horticulturist at the WSU Irrigated Agricultural Research and Extension Center, Prosser, Washington, and Robert E. Thornton, Ph.D., an Extension/Research Horticulturist at Washington State University, Pullman.

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INTRODUCTION

The potato processing industry uses the measurement of tuber specific gravity to judge the quality of potatoes. Many factors affect the specific gravity of potato tubers and some factors affect the measurement of specific gravity. This publication is designed to help processors, fieldmen and potato growers understand potato tuber specific gravity and how it is measured. We have provided references and citations so you may obtain the original research reports if you need them.

WHAT IS SPECIFIC GRAVITY?

Specific gravity is the density of any object relative to the density of water at a given temperature. At 50°F (10°C) the specific gravity of water is 1.000 and when a potato tuber is placed in a container of water it will sink because it has a specific gravity greater than 1.000. Potato tubers contain 75-80% water, 17-23% carbohydrates and about 2% protein, vitamins and minerals (Table 1). The major dry matter components of the potato tuber are starch (80-85%), cellulose (10-15%), and soluble sugars (1-5%). Therefore, the specific gravity of the tuber is influenced by the amount of those materials present.

The primary factor in specific gravity, however, is starch content. Starch is a polysaccharide made up of repetitive units of sugar molecules linked together to form either amylose or amylopectin, which are major components of potato starch. Starch is formed in potato cells. The concentration of starch is highest in tuber tissue next to the vascular ring near the outside of the tuber, lowest in the pith cells located in the tuber's center and intermediate in the region (perimedulary tissue) between these two areas (Figure 1).

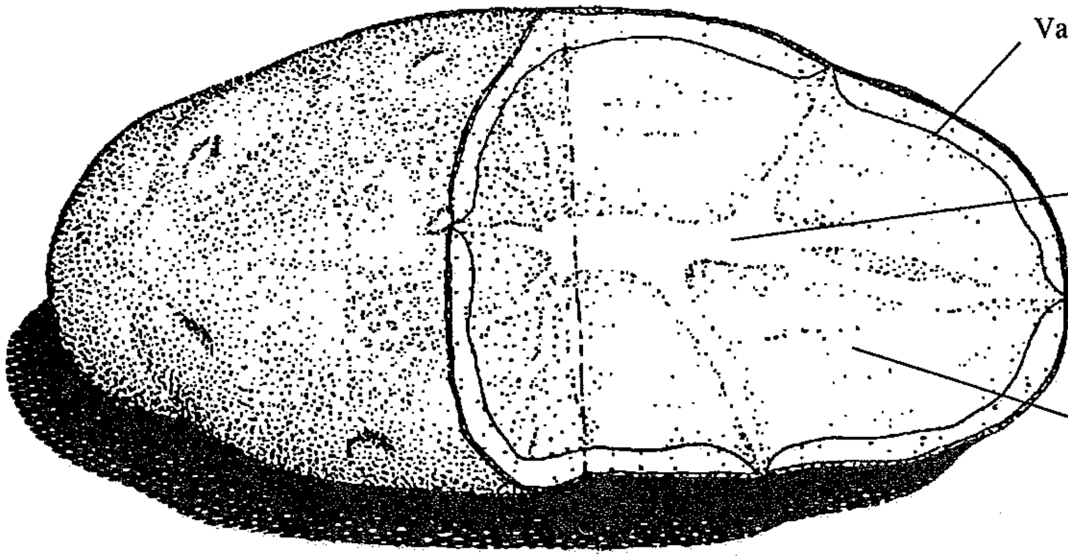


Figure 1.

Starch concentration also varies from one end of the tuber to the other in many potato cultivars (Table 2). Potato tubers from the same field and from individual plants within the same field also exhibit variability in starch content. Much of this variability is due to differences in tuber size. The highest starch level that tubers can reach appears to be inherited, as seen by the difference between cultivars (Table 3).

POTATO GROWTH AND SPECIFIC GRAVITY

The potato plant uses light, water, carbon dioxide and mineral nutrients for growth. Green leaves possess the ability to convert light energy into chemical energy through the process called photosynthesis. Using energy from the sun, water from the soil and carbon dioxide from the air, this process manufactures sugars in the leaves. The sugar is transported to the tubers and converted into cell walls and starch. The greater the plant's ability to photosynthesize effectively, the greater will be the specific gravity potential.

Since the production of starch through photosynthesis is the key to achieving high specific gravity, an understanding of how the plant grows and develops relative to this process is important. Growth and development of the potato plant is divided into four distinct phases. Each of these phases requires a specific set of conditions for optimum development.

PHASE I—Sprouting and Emergence

Sprouting and emergence occur slowly below 53°F (11.5°C) and increase linearly between 55°F (12.7°C) and 68°F (20°C). This

TABLE 1. Composition of Raw Potato Tubers.

Water (%)	79.8
Food energy (calories)	76.0
Protein (gm)	2.1
Fat (gm)	0.1
Carbohydrate	
total (gm)	17.1
fiber (gm)	0.5
Ash (gm)	0.9
Calcium (mg)	7.0
Phosphorus (mg)	53.0
Iron (mg)	0.6
Sodium (mg)	3.0
Potassium (mg)	407.0
Vitamin A value (IU)	Trace
Thiamine (mg)	0.1
Riboflavin (mg)	0.04
Niacin (mg)	1.5
Ascorbic Acid (mg)	20.0

Source: Nutritive Values of Fruits and Vegetables. United Fresh Fruit and Vegetable Association. Alexandria, Va.

TABLE 2. Solids Content (%) in Three Parts of Tubers of Six Potato Cultivars.

Tuber portion	White Rose	Red La Soda	Kennebec	Russet Burbank	Lenape	Norchip
Bud	16.1 b^{z}	18.8 b^{xy}	18.3 b^{xy}	17.5 b^{yz}	25.6 b^{w}	19.7 b^{x}
Pith	14.3 c^{x}	13.6 c^{x}	14.0 c^{x}	15.0 c^{x}	20.5 c^{y}	15.0 c^{x}
Stem	21.2a^{y}	23.5 a^{x}	23.4 a^{x}	22.1 a^{xy}	29.6 a^{w}	23.4 a^{x}

Source: Weaver, et al. 1978. Potato Composition I: Tissue selection and its effects on solids content and amylose/amylopectin ratios. *Am. Pot. J.* 55:73-82.

TABLE 3. Varietal Differences and Range in Specific Gravity within Varieties of Potatoes Grown under the Same Conditions, as Shown by the Number of Tubers at Various Readings.

	Number of Tubers												
Variety / Specific Gravity	1.058	1.062	1.066	1.070	1.074	1.078	1.082	1.086	1.090	1.094	1.098	1.102	Average Specific Gravity
Green Mountain	--	--	--	--	--	--	1	4	7	6	3	1	1.092
Mohawk	--	--	1	2	2	1	9	9	17	8	7	10	1.090
Russet Rural	--	--	--	--	1	2	5	4	6	4	2	2	1.088
Sequoia	--	--	--	2	1	4	1	5	3	--	--	--	1.082
Pioneer Royal	--	--	--	1	6	6	7	8	1	1	--	--	1.081
Houma	--	--	--	2	3	9	6	4	--	--	--	--	1.079
Katahdin	--	2	1	11	10	10	16	14	2	2	--	--	1.079
Chippewa	--	--	2	15	22	12	21	5	1	--	--	--	1.077
Irish Cobbler	--	--	1	2	4	6	1	2	--	--	--	--	1.077
Warba	--	--	--	1	8	4	4	--	--	--	--	--	1.077
Sebago	2	3	1	--	4	3	3	3	1	--	--	--	1.075
Pontiac	6	6	8	20	6	8	2	7	--	--	--	--	1.071
Earlaine No. 2	3	2	3	2	1	1	--	--	--	--	--	--	1.066

From: *Potato Chipper*, October 1948

rate does not change substantially between 68°F (20°C) and 78°F (25.6°C) (Table 4). Using optimum-sized seed pieces and spacing will increase the total dry matter produced from a given field.

TABLE 4. The Effect of Temperature on Emergence of Russet Burbank Potatoes.

Temperature °C	°F	Days to 50% Emergence
5.3	41.5	*
8.0	46.4	*
10.6	51.1	*
11.8	53.2	14.5
13.8	56.8	11.5
15.7	60.3	9.0
17.5	63.5	9.5
19.6	67.3	8.0
20.9	69.6	7.0
22.3	72.1	6.0
24.2	75.6	6.0
25.8	78.4	6.0

*Did not emerge after being in the gradient block for 21 days.

PHASE II—Emergence to Tuber Initiation

Photosynthesizing leaves produce and accumulate carbohydrates during the day which are moved to roots, immature developing leaves and tubers as needed. Therefore, the specific gravity attained depends on the number of days the optimum number of leaves are photosynthetically effective.

The production of carbohydrates and their division into various plant parts (partitioning) results in tubers that contain either high or low starch levels. The optimum temperature for production and accumulation of carbohydrates (sugars and starch) by photosynthesis and, therefore plant and tuber growth, is between 68°F (20°C) and 78°F (26°C) (Dwelle, et al. 1981, Ku, et al. 1977). The longer that leaves are present to intercept the sun's energy, the more the plants will produce. When leaves are damaged or killed by disease, insects, cold, heat or wind, photosynthesis is reduced. Damaged leaves produce less carbohydrates than healthy leaves, and the carbohydrates produced by the remaining leaves are used to replace the damaged ones at the expense of tuber growth. This allocation of dry matter reduces the total available carbohydrates to the tuber and therefore reduces yield and tuber specific gravity.

Two measurements are used. Leaf Area Index (LAI) indicates how much leaf surface is present and Leaf Area Duration (LAD) indicates how long it is functional. Leaf Area Index (LAI) represents the amount of leaf surface relative to the soil surface covered. An LAI of 1 indicates that there is one acre of leaf surface for one acre of ground covered. An LAI of 4 would have 4 acres of leaf surface covering one acre of ground. An LAI between 3 and 5 is considered to be optimum for potatoes. Conditions that interrupt or delay achieving the desired LAI can result in tubers with low specific gravity.

The length of time leaves remain on plants is referred to as Leaf Area Duration (LAD). The longer that leaves remain photosynthetically active the higher the potential tuber yield and specific gravity. There is a common belief that planting a crop early will result in a longer LAD resulting in a higher tuber yield and specific gravity. However, supposed beneficial effects of early planting may be offset by spring frosts, cool soil and air temperatures, increased seed piece decay and moisture stress. The amount of time between planting and when tubers are initiated is controlled genetically, modified by plant hormones, and influenced by cultural practices, climate and photoperiod. The presence of initiated tubers may stimulate the plant to produce additional carbohydrates (Dwelle, et al. 1981, Nosberger and Humphries 1965, Sale 1973).

PHASE III—Tuber Development and Growth

Once tubers are initiated, carbohydrates produced by the leaves are no longer used only for foliage and root growth. Some of the carbohydrates are moved in the form of sugars to developing tubers where they are changed into starch. How this is controlled is not well understood but it is known to be influenced by a number of factors.

Temperatures above and below the optimum (68-78°F) influence the production of carbohydrates by the leaves of the plant and can reduce the amount of carbohydrates available for movement to the tubers. Water stress reduces the ability of leaves to obtain carbon dioxide from the air and therefore reduces carbohydrate production. Water stress may also cause starch in tubers to be converted to sugar and moved back to the leaves (Iritani and Weller 1980). This results in lower tuber starch content and thus, lower tuber specific gravity. In this phase, tuber quality, yield and specific gravity are influenced by irrigation, fertilization, plant spacing, seed piece size, and the presence or absence of insects, diseases and weeds.

PHASE IV—Plant Decline and Tuber Maturity

During this phase the rate of plant growth is reduced and the LAI declines. Specific gravity of tubers may increase, decrease or remain the same. Tuber specific gravity is influenced by a number of factors, some of which are not controllable by the grower.

As leaves begin to mature or are damaged by disease, their photosynthetic ability declines, they begin to die and tuber growth slows down or ceases. As tuber growth rate slows, the stimulatory effect they had on carbohydrate production by the leaves is reduced. This can result in renewed foliage growth. Fields can pass through a "casting off" and then "regreening" phase. This regreening may appear advantageous but it can actually result in a reduction in tuber specific gravity.

The specific gravity of tubers generally increases during tuber development, levels off during the maturity phase, and may actually decline before harvest (Figure 2).

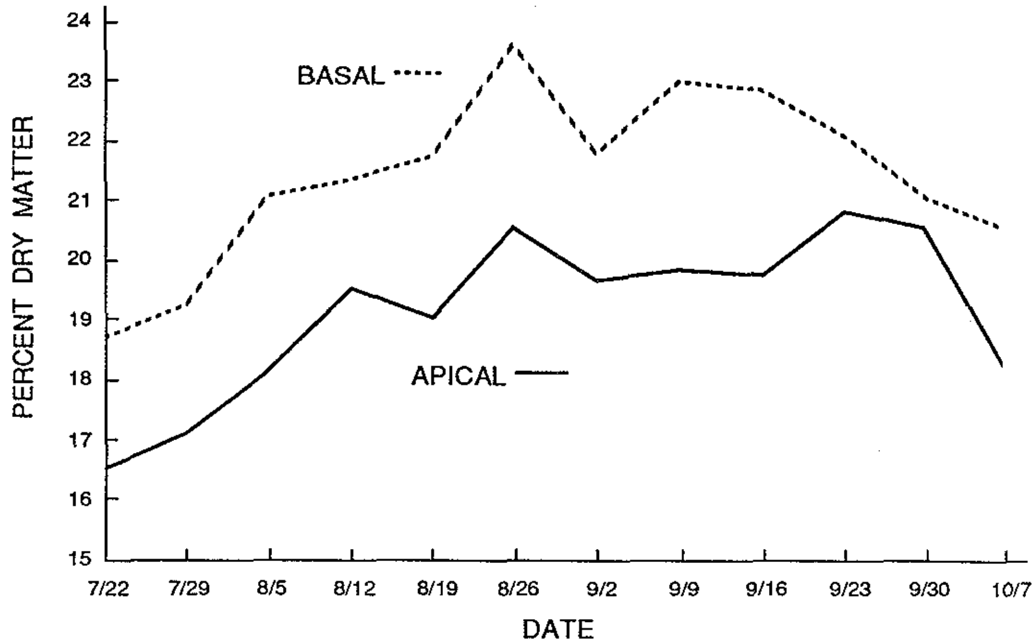


Figure 2. Dry matter content of two potato varieties at given dates before harvest (redrawn from Iritani, W. M. and L. Weller, *Am. Potato J.* 50:389-397).

A decline in specific gravity can result because starch in tubers is converted back to sugars and used for foliage growth (regreening). When this occurs, the tuber functions as if it were a seed piece and supplies the materials needed for foliage growth. Tubers harvested during this time will have lower specific gravity than when harvested earlier. After the new foliage growth is established and is producing carbohydrates in excess of its own needs, carbohydrates can again be moved to the tubers, resulting in an increase in tuber specific gravity.

FACTORS THAT INFLUENCE SPECIFIC GRAVITY LEVELS

Some conditions that influence specific gravity levels are plant nutrition, soil moisture and cultural practices. Nutrient levels higher or lower than the optimum level at any given growth stage may hinder crop growth, and tuber yield and quality, including specific gravity.

Nitrogen

Soil nitrogen strongly influences plant and tuber growth and tuber quality. Levels that are too high result in a decrease in tuber specific gravity. Nitrogen levels above the deficient level increase specific gravity. Depending on the method and efficiency of application, soil type and irrigation management, the actual amounts of fertilizer nitrogen required will vary. Approximately 80% of the crop's nitrogen needs must be met during the tuber initiation and bulking phase. To accomplish this, 200-280 pounds of nitrogen should be available during these periods.

High levels of nitrogen will result in excessive foliage growth and a delay in tuber initiation and early tuber growth. Conversely, a deficiency of nitrogen results in formation of tubers before the plant has developed leaves. This results in a limited production potential. Inadequate plant development also occurs in areas of potato fields that do not get adequate water. Plants whose growth is limited set tubers and develop large tubers early in the season compared to tubers from plants well-supplied with water and nutrients. However, by the end of the season well-watered and fertilized plants produce a substantially higher yield. Careful monitoring and timely management decisions are required to achieve the needed nitrogen level at the appropriate time.

Inconsistencies found in the literature regarding nitrogen levels and timing to achieve optimum yield and quality are probably due to a large number of variables other than applied nitrogen. Some of these variables are the level and availability of soil nitrogen, the interaction of nitrogen level with levels of other nutrients, the presence or absence of disease and the influence of soil moisture.

Phosphorus

Phosphorus fertilization also influences specific gravity. One hundred to 300 pounds of available phosphorus in the soil is usually sufficient for good plant and tuber growth. Applications of phosphorus throughout the growing season have some benefit. However, the techniques and management strategies need to be developed further.

Potassium

The effect of potassium on yield and specific gravity of tubers has been studied extensively. Although there is some disagreement on the effect of potassium, it is clear that applying high levels of potassium fertilizer can lower tuber specific gravity (Kunkel 1969). High potassium levels can reduce specific gravity by delaying vine and tuber maturity; therefore, the amount of fertilizer potassium applied should be based on knowledge of soil potassium levels. The amount of potassium available to the crop should be between 375-525 pounds per acre.

The chloride form of potassium fertilizer (KCl) may affect specific gravity levels by influencing carbohydrate production (Gausman 1962). An adequate potassium level reduces the amount of blackspot bruising that occurs during harvest and handling of tubers.

Other Nutrients

Scientific studies have not shown the minor elements to have an effect on tuber specific gravity (Harrison, et al. 1982). Articles in trade journals often mention possible beneficial effects of some of these minor elements.

Soil Moisture

The amount of water applied to a potato crop (within reasonable limits) does not appear to affect tuber specific gravity. However, variation in soil moisture level can significantly influence distribution and level of both specific gravity and sugars in tubers. Moisture stress may result in tubers with so-called sugar, jelly, or translucent ends (Iritani and Weller 1980). As with plant nutrients, a constant adequate amount of soil moisture is needed to maximize the general health of the plant and produce a crop of tubers with high specific gravity.

Miscellaneous Factors

Many cultural practices such as cultivation, vine killing, and pest control have an impact on tuber specific gravity. Soil fumigation may affect specific gravity by reducing the effect of soilborne pests. Any factor that limits the LAI, LAD or the photosynthetic rate of the crop will reduce tuber specific gravity.

Postharvest Changes

The amount of starch and therefore the specific gravity in potato tubers does not change significantly during storage if proper storage conditions are maintained. Storage temperatures above 48°F increase respiration rates, reducing the tuber's starch content and resulting in lower tuber specific gravity. Storage at low relative humidity resulting in an increase in tuber specific gravity results in a loss of water from tubers. Although some dehydration may seem beneficial because it raises the specific gravity, it also results in increased pressure bruising and after-cooking darkening. Inability to adequately control or predict the level of dehydration results in more undesirable than desirable effects.

SPECIFIC GRAVITY AND THE USE OF POTATOES

Some of the most desirable cooking characteristics of potatoes are closely correlated with dry matter content and starch grain size. There is also a high correlation between starch grain size and tuber specific gravity (Sharma and Thompson 1956).

Tubers from a given cultivar with high specific gravity will break apart more when boiled but when baked or fried they will be more mealy and have better color than tubers with low specific gravity from the same crop. Tubers of different cultivars with the same specific gravity may cook quite differently.

A high correlation has been found between shear force of either raw or processed potatoes and tuber specific gravity (Iritani 1981). A higher shear force means a more mealy texture.

During processing, french fries and potato chips absorb cooking oil. When potatoes with low specific gravity are being fried, more oil is absorbed than when high specific gravity potatoes are fried. Since today's health-conscious consumers are trying to reduce dietary fat, high specific gravity potatoes which absorb less oil are more desirable. Tubers with high specific gravity also yield more finished product per pound of fresh potatoes.

DETERMINING SPECIFIC GRAVITY

Three methods are used by the potato industry to determine the specific gravity of potato tubers: 1) hydrometer, 2) weight in air/weight in water, and 3) salt brine solutions.

1) Hydrometer: A hydrometer developed for use by the potato chip industry quickly determines the specific gravity of raw potatoes. It consists of a plastic bulb attached to a clear plastic tube that contains a calibration and measurement sleeve. The plastic tube is closed with a cork. Precisely eight pounds of tubers are placed into a calibrated stainless steel basket. The hydrometer is attached to the basket, the sample and hydrometer are placed in a container of clean water and a reading is made. The hydrometer is calibrated for tuber and water temperatures of 50°F. If the water is not at 50°F, the specific gravity reading must be adjusted (Table 5). This method is widely used in the potato chip manufacturing industry.

2) Weight in Air/Weight in Water: A weighing scale is placed over a container of water with room underneath to suspend a wire basket containing the sample. The weight in air is determined, the basket is then completely submerged and the weight is determined while the sample is in the water. The scale is tared for the wire basket weight before weighing begins. The specific gravity is calculated by subtracting the sample weight in water from its weight in air, then dividing this number into the in-air sample weight.

$$\text{Specific gravity} = \frac{\text{weight in air}}{\text{weight in air - weight in water}}$$

TABLE 5. Correlation Factors for Specific Gravity of Potatoes (Corrected to Zero at 50°F Potato Temperature and 50°F Water Temperature).

Tuber Temperature \ Water Temperature	38°	40°	45°	50°	55°	60°	65°	70°	75°	80°
38°	-0.0021	-0.0020	-0.0018	-0.0018	-0.0020	-0.0023	-0.0029	-0.0038	-0.0047	-0.0058
40°	-0.0017	-0.0016	-0.0014	-0.0014	-0.0016	-0.0019	-0.0025	-0.0034	-0.0043	-0.0052
45°	-0.0009	-0.0008	-0.0006	-0.0006	-0.0008	-0.0011	-0.0017	-0.0026	-0.0035	-0.0044
50°	-0.0003	-0.0002	0.0000	0.0000	-0.0002	-0.0005	-0.0011	-0.0020	-0.0029	-0.0038
55°	+0.0001	+0.0002	+0.0004	+0.0004	+0.0002	-0.0001	-0.0007	-0.0016	-0.0025	-0.0034
60°	+0.0004	+0.0005	+0.0007	+0.0007	+0.0005	+0.0002	-0.0004	-0.0013	-0.0022	-0.0031
65°	+0.0005	+0.0006	+0.0008	+0.0008	+0.0006	+0.0003	-0.0003	-0.0012	-0.0021	-0.0030
70°	+0.0006	+0.0007	+0.0009	+0.0009	+0.0007	+0.0004	-0.0002	-0.0011	-0.0020	-0.0029
75°	+0.0007	+0.0008	+0.0010	+0.0010	+0.0008	+0.0005	-0.0001	-0.0010	-0.0019	-0.0028
80°	+0.0008	+0.0009	+0.0011	+0.0011	+0.0009	+0.0006	0.0000	-0.0009	-0.0018	-0.0027
85°	+0.0009	+0.0010	+0.0012	+0.0012	+0.0010	+0.0007	+0.0001	-0.0008	-0.0017	-0.0026
90°	+0.0010	+0.0011	+0.0013	+0.0013	+0.0011	+0.0008	+0.0002	-0.0007	-0.0016	-0.0025
95°	+0.0011	+0.0012	+0.0014	+0.0014	+0.0012	+0.0009	+0.0003	-0.0006	-0.0015	-0.0024
100°	+0.0012	+0.0013	+0.0015	+0.0015	+0.0013	+0.0010	+0.0004	-0.0005	-0.0014	-0.0023

Source: U.S Standards for Grades of Potatoes for Processing, revised effective April 14, 1983

This calculation can be accomplished by computers if the appropriate equipment is available (Figure 3). A correction factor is used for water and/or tuber temperatures other than 50°F (Table 5). If individual tubers are weighed separately this method will give the average, range and variance in tuber specific gravity for each sample, but it takes longer than the brine solution method. This method (weight in air/weight in water) is widely used in the frozen french fry manufacturing industry.

Figure 3. A Grav-O-Tater, used to measure specific gravity (Adapted from Tai, G. C. C., et al. 1985. Grav-O-Tater: a computer apparatus for measuring specific gravity. Ag. Canada. Research Station, Fredericton, N.B. E3B 4Z7, Canada).

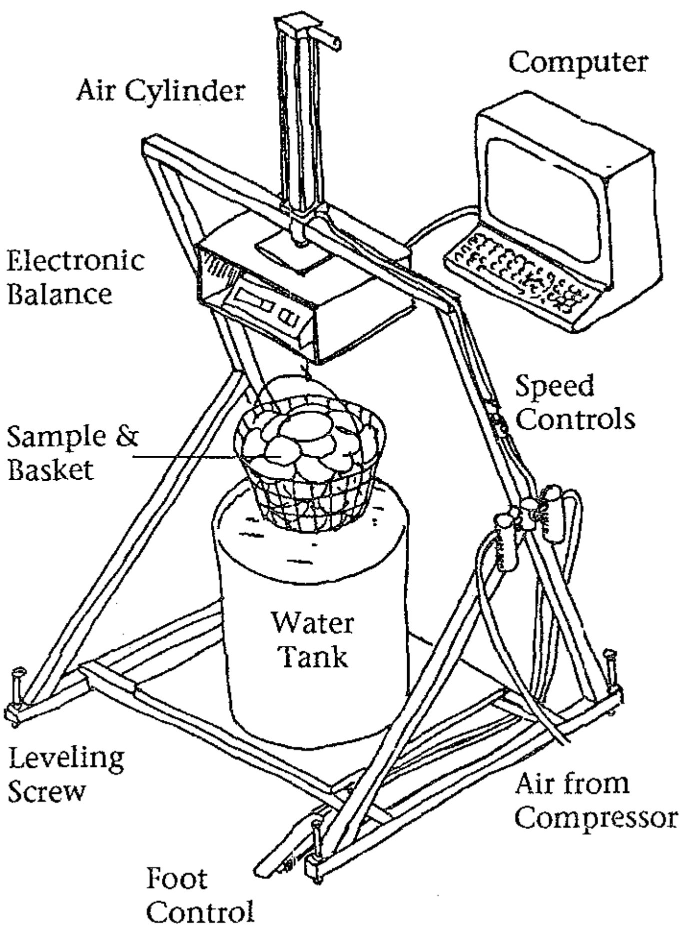


TABLE 6. Salt Solution Density Series.

Salt (NaCl) weight (g/100ml)	Density at 68°F (sp. gr.)	Salt (NaCl) weight (g/100ml)	Density at 68°F (sp. gr.)
8.5	1.0615	11.9	1.0868
8.7	1.0630	12.1	1.0884
8.9	1.0645	12.3	1.0899
9.1	1.0660	12.5	1.0914
9.3	1.0675	12.7	1.0929
9.5	1.0689	12.9	1.0944
9.7	1.0704	13.9	1.1020
10.7	1.0778	14.1	1.1035
10.9	1.0793	14.3	1.1050
11.1	1.0808	14.5	1.1065
11.3	1.0823	14.7	1.1080
11.5	1.0838	14.9	1.1095
11.7	1.0853	15.1	1.1110

Source: *CRC Handbook of Chemistry and Physics*, 47th edition.

3) Brine Solution: Brine solutions of varying densities are made up using differing amounts of salt (Table 6). Table salt (NaCl) is usually used because it is relatively inexpensive. A potato will float in a solution of a density equal to or greater than its own. For example, a potato with a specific gravity of 1.080 will float in a solution with a density of 1.080 or greater and it will sink at a density lower than this. In practice, tubers are placed in the lowest density solution first. Potatoes that float in this solution have a density the same as or lower than that of the solution. Tubers that sink to the bottom are removed, drained of excess water and placed in the solution with the next higher density. Tubers that float in this solution have a specific gravity somewhere between the first and second solution. The procedure is continued for as many solutions as desired. By preparing a series of solutions of varying densities, a sample of tubers can be separated into specific gravity groups. From this data, the average specific gravity and the range and variance of specific gravity is obtained for each sample. This method is slower and more detailed than the others, but provides important additional information.

Special Considerations for Specific Gravity Tests

TUBER SIZE

Tubers of different sizes can have different specific gravities, therefore the size of tubers in a sample influences the specific gravity. Larger tubers generally have a higher specific gravity. Therefore, a sample should contain tubers of all sizes, or specific gravity of tuber samples from all sizes should be determined.

TUBER CLEANLINESS

Soil and debris present in samples will gradually change the specific gravity of the water. Therefore potatoes should be clean before measuring specific gravity.

TUBER DRYNESS

Wet tubers will have about 0.001 units higher specific gravity than dry tubers. Therefore, it is important to consistently have dry or wet tubers when weighing them.

TUBER TEMPERATURE

Tubers with a flesh temperature other than 50°F will have a different specific gravity, therefore the temperature of the tubers being tested should be determined and adjustments in the readings made.

WATER TEMPERATURE

A water bath with a temperature other than 50°F will result in a specific gravity reading that is different. Therefore, maintain water at 50° or make the appropriate adjustment in the reading.

SAMPLE WEIGHT

Small errors in water weights can make a large difference in the specific gravity value obtained. Therefore, weigh samples both in air and in water precisely.

SAMPLE AGITATION

Air bubbles trapped in the sample as it is submerged will result in a different specific gravity. Therefore, lightly agitate tubers in the basket as it is lowered into the water.

Converting Specific Gravity Values to Dry Matter Content

The dry matter content of tubers is a major factor in tuber processing quality. Since specific gravity is used to estimate dry matter, specific gravity units are often converted to dry matter percentage. A number of conversion tables have been published for this purpose. Tubers having the same specific gravity may not have the same dry matter content. Generally, however, the higher the specific gravity, the higher the dry matter content.

A conversion table is generated by determining the specific gravity of a number of tubers representing a wide range of dry matter percentages, then oven-drying the same tubers (at 105°C) and recording the weight of each tuber. The resulting values are used to place points on a graph and draw a line that represents the relationship between dry matter and specific gravity. This is called a regression line (Figure 4). Not all data points fall on this line, but it indicates an approximate dry matter percentage for any specific gravity value and vice versa.

Regression lines have been determined for different potato cultivars, different years and different locations. It is not known why there is so much variation. Producers and processors have developed lines representative of their areas.

Summary and Recommendations

Measurement of specific gravity provides an acceptable estimate of tuber dry matter content. Dry matter content is a major factor in processing quality. Measurements of specific gravity are not absolute and are subject to known as well as poorly understood variables.

Select the appropriate cultivar for the end use of the crop.

Fertility Effects

Plant nutrition influences the specific gravity of tubers produced. Specific fertilizer practices cannot be recommended here but the following guidelines can be offered: 1) If any growth factor is limiting, production potential will not be realized; 2) The optimum nutrient level occurs between a deficiency level and an excess level.

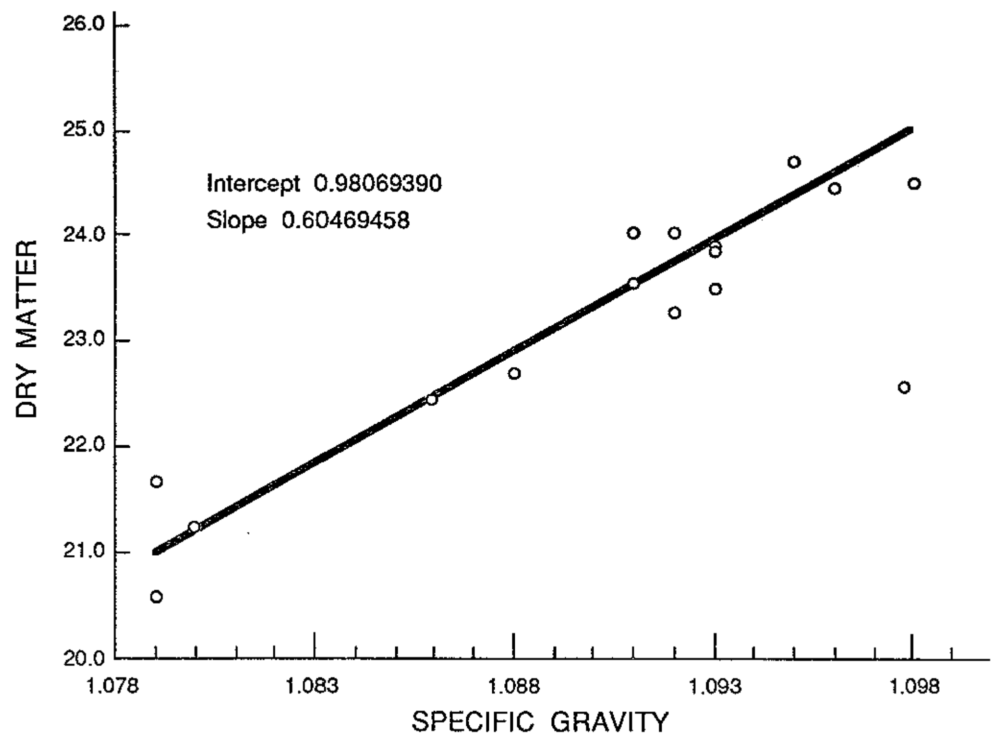
At planting, have available in the soil no more than 100-200 pounds of nitrogen, from 100-300 pounds of phosphorus, and 375-525 pounds of potassium per acre. Additional nitrogen should be applied just following tuber initiation at moderate rates until the total needs are supplied based on anticipated yields and desired harvest date.

Plant when soil temperatures have been above 50°F (10°C) at seed piece depth for 3 or 4 days.

Irrigation

The amount of water applied to a potato crop (within reasonable limits) does not appear to affect specific gravity. However, irrigation consistency can significantly influence distribution of dry matter content and sugars in the tuber. Moisture stresses may result in tubers with so-called sugar, jelly or translucent ends. As with plant nutrients, a constant adequate

Figure 4. A regression line showing the relationship between dry matter and specific gravity.



amount of irrigation or rain is needed to maximize the general health of the plant and produce a good crop with high specific gravity.

Miscellaneous Factors

Many cultural practices such as cultivation and vine killing, the presence of diseases, insects and weeds can all impact specific gravity of the crop. Soil fumigation may affect specific gravity by reducing the effect of pests. Any factor that limits the LAI, LAD or the photosynthetic rate of the crop will reduce specific gravity. Control diseases and insects to maintain an adequate LAI and a long LAD.

Avoid regrowth at the end of the season. If the field dies back in late August or early September, vine killing may be appropriate to maintain the specific gravity levels achieved earlier. The monetary incentive for specific gravity should be weighed against the value of total yield and other quality factors such as bruising, cooking color and texture.

Maintain storage temperatures of 42°F to 45°F with 95% relative humidity. The amount of starch in potato tubers will not be significantly changed during storage if proper storage conditions are maintained. Storage temperatures above 48°F increase respiration rates, reduce the tuber's starch content, and lower specific gravity. Storage at low relative humidity increases specific gravity as a result of water loss from tubers. Although some dehydration may seem beneficial because it raises the specific gravity, it also results in increased pressure bruising and after-cooking darkening. Inability to adequately control or predict levels of dehydration results in more undesirable than desirable effects.

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