Gem Russet: A Long Russet Potato Variety with Excellent Fresh Market and French Fry Processing Quality

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ABSTRACT

Gem Russet, a new medium maturing, long russet potato variety, was released in 2000 by the USDA/ARS and the experiment stations of Idaho, Oregon, and Washington. It is suited for use in the fresh, frozen-fried processing, and dehydration markets. Total tuber yield of Gem Russet is similar to that of Russet Burbank when grown in eastern Idaho, but lower when grown in the long-season areas of western Idaho and the Columbia Basin of Oregon and Washington. U.S. No. 1 yield is consistently higher that that of Russet Burbank. Tubers of Gem Russet have good processing and baked quality. Gem Russet is resistant to most external and internal physiological defects, including second growth, growth cracks, shatter bruise, and hollow heart. It is moderately susceptible to blackspot bruise. Gem Russet shows extreme resistance to potato virus X, resistance to common scab, and moderate resistance to early dying. Biochemical analysis of Gem Russet tubers has shown higher solids, lower reducing sugar and glycoalkaloid content, and higher concentration of protein and vitamin C when compared with tubers of Russet Burbank.

INTRODUCTION

Gem Russet, released by the USDA Agricultural Research Service and the experiment stations of Idaho, Oregon, and Washington, was first selected at Aberdeen, Idaho, in 1986. Designated A8495-1, it originated from a 1984 cross of A77182-1 and Russet Norkotah (Johansen et al. 1988) (see pedigree in Figure 1). Prominent varieties included in the parentage are Atlantic (Webb et al. 1988), Lemhi Russet (Pavek et al. 1981), Norgold Russet (Johansen 1965), Nooksack (Hoyman and Holland 1974). Russet Burbank (Clark and Lombard 1951) is in the pedigrees of four ancestors, namely A63126-8, A6673-4, Norgold Russet, and Nooksack.

Gem Russet progressed through 12-hill, preliminary, intermediate, and advanced yield trials in Idaho from 1987 to 1991. From 1992 to 1995, it was evaluated in Tri-state and Western Regional Trials. Prior to release, seed increases and commercial trials were conducted in Idaho, Oregon, and Washington. Release documents were completed by the USDA/ARS on August 29, 2000.

DESCRIPTION

See color pictures of a plant, flowers, leaf, and tubers of Gem Russet in Figure 2.

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Abbreviation:
RHSCC = Royal Horticulture Society color chart.

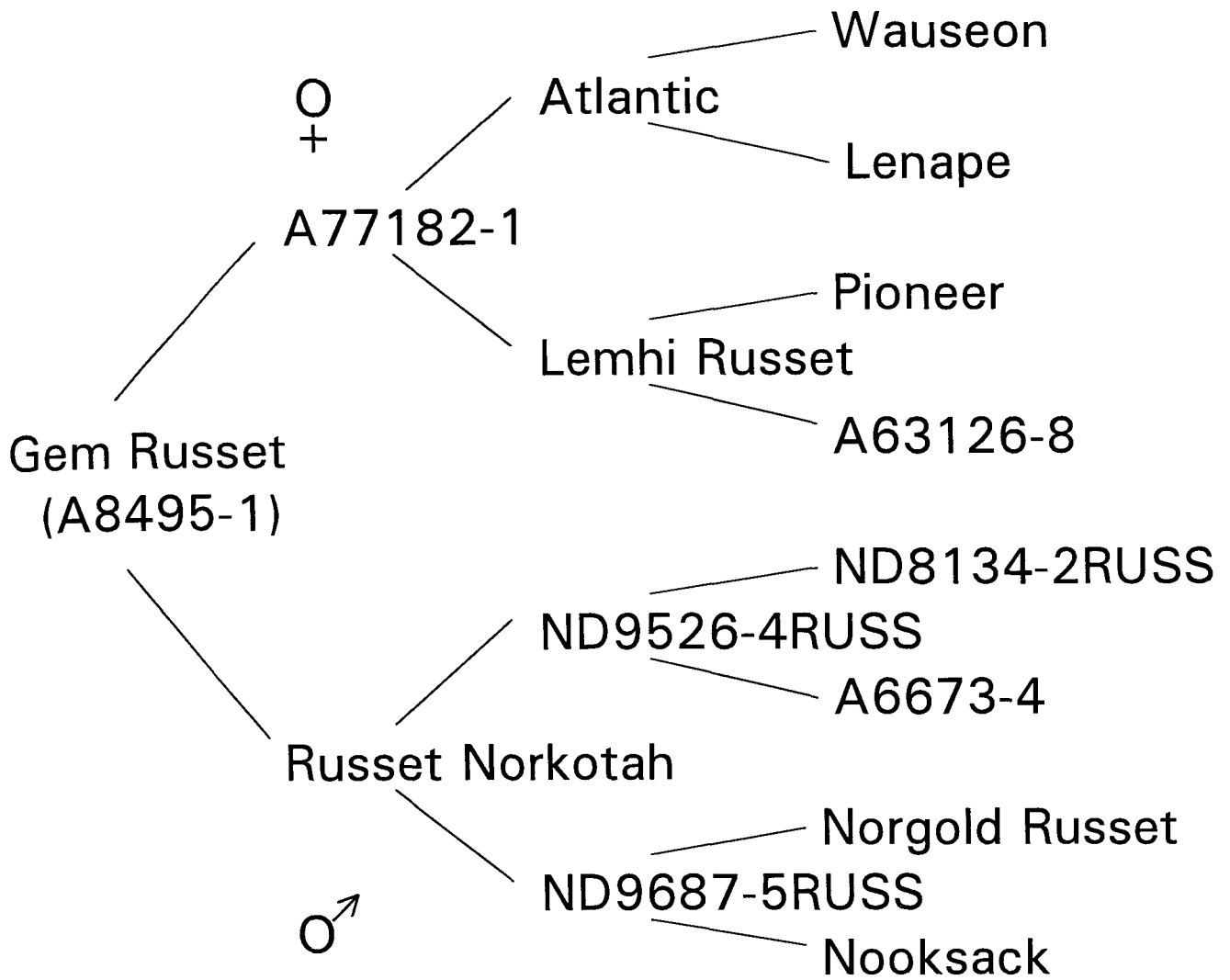

FIGURE 1.
Four-generation pedigree of Gem Russet.

Plants

Growth habit: Medium-sized, upright vine expressing medium to medium-late maturity (110-130 days from planting to harvest, compared with 120-150 days for Russet Burbank). *Stems:* medium thick, green, lacking anthocyanin pigmentation, with weakly prominent wings (≅ 1 mm wide). *Leaves:* medium-sized, yellowish-green (Royal Horticulture Society Color Chart [RHSCC] 146A), with a closed silhouette, and lacking anthocyanin pigmentation on the petioles and midribs. *Terminal leaflets:* broadly ovate shape with a cuspidate tip and cordate base; slightly wavy margins; average length 84 mm, width 42 mm (100 leaves). *Primary leaflets:* 3-6 pairs with an average of 5.0 pairs; medium ovate with an acuminate tip and cordate base. *Secondary leaflets:* 2-5 pairs, average 4.1 pairs. *Tertiary leaflets:* 0-9 pairs, average 3.1 pairs. *Stipules:* large, non-clasping.

Flowers

Abundant, averaging 12.2 florets per inflorescence and 2.0 inflorescences per plant. *Buds:* anthocyanin pigmentation lacking; moderately to heavily pubescent calyx and pedicel; pedicel articulation not prominent; buds seldom abort. *Calyx:* sepals awl-shaped, fused to one-fourth the length of the bud. *Corolla:* white (RHSCC 155A) on both inside and outside surfaces; medium large, averaging 34 mm across. *Anthers:* yellowish-orange (RHSCC 15A) color; arranged as a narrow cone. *Stigma:* capitate, yellow-green (RHSCC 146A) color. *Pollen:* Abundant, fertile. *Berries:* low to medium production in the field.

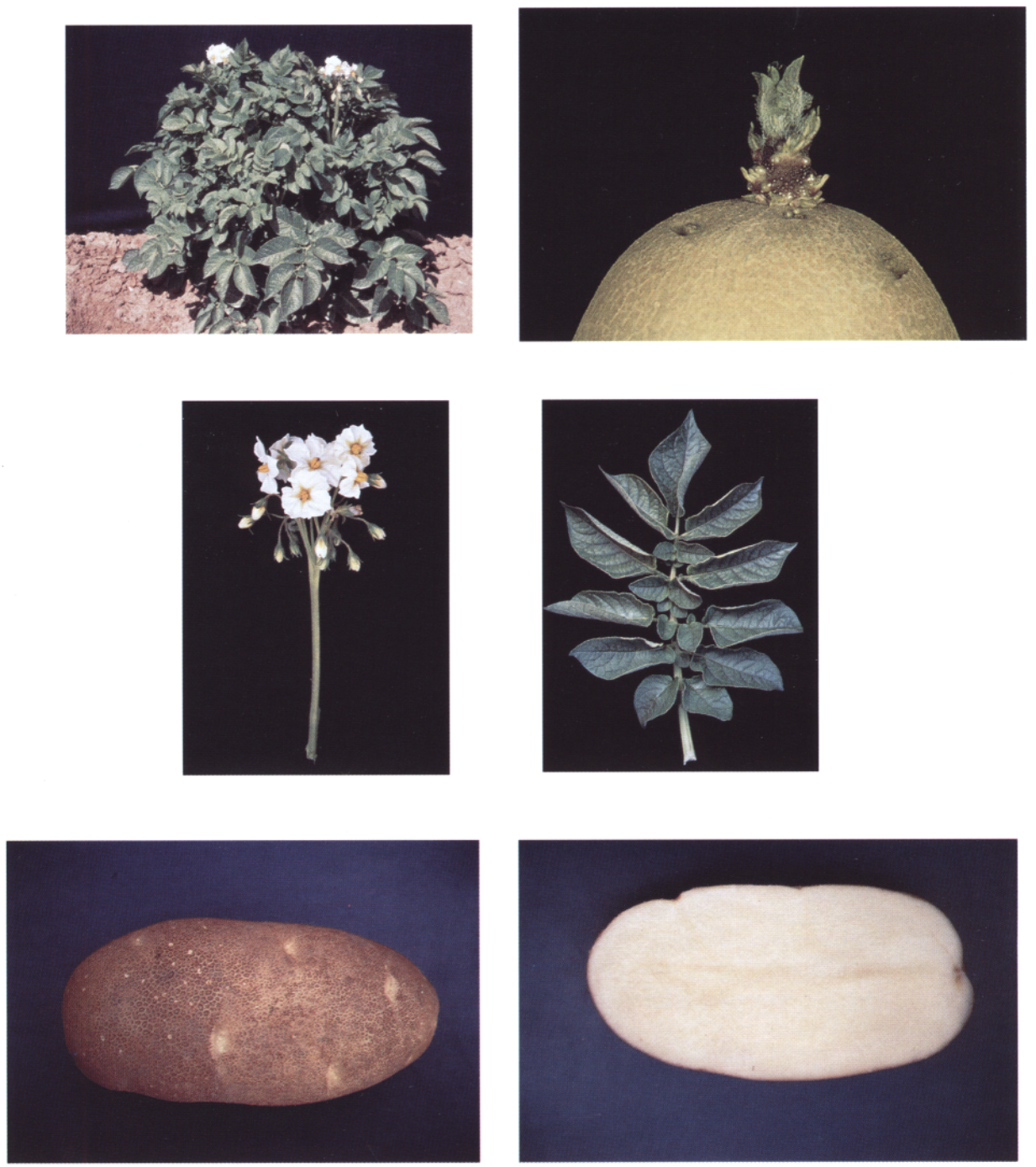

FIGURE 2.
Photographs of Gem Russet plant (A), light sprout (B), flower (C), leaf (D), and outside (E) and inside (F) of a tuber.

Tubers

Oblong to long; cylindrical to slightly flattened; similar in appearance to Russet Norkotah, but slightly shorter and less flattened; mean length 112 mm, range 86 to 139 mm; mean width 63 mm, range 54 to 74 mm; mean thickness 56 mm, range 46 to 69 mm (average of 100 tubers). *Skin:* tan to brown (RHSCC 199B) color; medium to heavy russet pattern; not scaly. *Eyes:* shallow; slightly prominent eyebrow; predominantly apical; mean num-

ber of eyes per tuber 16.4, range 10 to 21. *Flesh:* cream (RHSCC 158D) colored; moderately prominent pith region. *Dormancy:* long, 120 to 140 days when stored at 7 C.

Light Sprouts

Moderate brownish-red anthocyanin pigmentation; slightly elongated; moderately open bud scales; glabrous base with moderately hirsute bud scales; slow rate of development.

CHARACTERISTICS

Agronomic Performance

Gem Russet produced total yields that on average were similar to those of Russet Burbank in late-harvest trials (approximately 130 days from planting to harvest) in southern Idaho (Table 1). U.S. No. 1 yields for Gem Russet were substantially higher. In late harvest trials in the cool areas of eastern Idaho, Gem Russet total yields averaged 177% of those of Russet Norkotah (Table 2). U.S. No. 1 yields were higher by a similar degree of magnitude.

In three years of testing in the Idaho, Oregon, and Washington locations of the Western Regional Variety Trial, Gem Russet produced lower total yields than did Russet Burbank (Table 3). In Idaho, total yields were slightly lower, while in Oregon and Washington Gem Russet produced only 76 % and 85%, respectively, of Russet Burbank yields. Gem Russet generally produced higher yields of U.S. No. 1 tubers than did Russet Burbank, the exception being the average for Oregon locations.

TABLE 1—*Total yield, U.S. No. 1 yield, tuber specific gravity, and french fry color of Gem Russet and Russet Burbank in late harvest trials grown in 26 southern Idaho trials.*[1]

Variety	Total Yield	U.S. No. 1 Yield	Specific[2] Gravity	Fry Color[3] 4.4°C	Fry Color[3] 7.3°C
	- mt/ha -	- mt/ha -			
Gem Russet	42.4	32.6	1.088	2.7	1.2
Russet Burbank	43.0	25.8	1.080	3.7	1.7

[1]Trial locations included Aberdeen (4 years), Parma (6 years), Raft River (2 years), Rexburg (8 years), and Shelley (6 years).
[2]Specific gravity determined using the weight-in-air, weight-in-water method.
[3]French fry color rated using USDA standards, where 0=light, 4-dark. Color rated 3 or above is considered unacceptable. Tubers were evaluated after 3-6 months storage at 4.4 or 7.3 C.

TABLE 2—*Total yield, U.S. No. 1 yield, and tuber specific gravity of Gem Russet and Russet Norkotah in late harvest trials grown in seven southeastern Idaho trials.*[1]

Variety	Total Yield	U.S. No. 1 Yield	Specific[2] Gravity
	- mt/ha -	- mt/ha -	
Gem Russet	42.4	31.0	1.089
Russet Norkotah	24.0	15.8	1.071

[1]Trial locations included Rexburg (3 years) and Shelley (4 years).
[2]Tuber specific gravity determined using the weight-in-air, weight-in-water method.

TABLE 3—*Total yield, U.S. No. 1 yield, and tuber specific gravity of Gem Russet and Russet Burbank in late harvest trials grown in the Idaho, Oregon, and Washington locations of the Western Regional Variety Trials.*[1]

Variety	Total Yield	U.S. No. 1 Yield	Specific[2] Gravity
	- mt/ha -	- mt/ha -	
Idaho			
Gem Russet	54.2	46.1	1.090
Russet Burbank	56.4	37.9	1.083
Oregon			
Gem Russet	56.1	48.7	1.086
Russet Burbank	73.5	52.5	1.084
Washington			
Gem Russet	57.1	46.7	1.082
Russet Burbank	68.3	45.4	1.081
Overall Mean			
Gem Russet	55.7	47.5	1.087
Russet Burbank	67.0	46.4	1.083

[1]Data collected from three years of trials at Kimberly and Aberdeen, Idaho; Hermiston, Klamath Falls, and Ontario, Oregon; and Othello, Washington.
[2]Tuber specific gravity determined using the weight-in-air, weight-in-water method.

At Northwest early harvest sites for the Western Regional Trials (approximately 100 days from planting to harvest in Idaho, 130 days in Washington and Oregon), Gem Russet produced total yields that were generally very similar to those produced by Russet Norkotah, showing it to be an acceptable variety for early harvest (Table 4). U.S. No. 1 yields of Russet Norkotah tended to be higher than those for Gem Russet.

TABLE 4—*Total yield, U.S. No. 1 yield, and tuber specific gravity of Gem Russet and Russet Norkotah in early harvest trials in the Idaho, Oregon, and Washington locations of the Western Regional Variety Trials.*[1]

Variety	Total Yield	U.S. No. 1 Yield	Specific[2] Gravity
	- mt/ha -	- mt/ha -	
Idaho			
Gem Russet	35.7	27.3	1.086
Russet Norkotah	34.8	28.1	1.075
Oregon			
Gem Russet	43.0	32.3	1.085
Russet Norkotah	45.1	37.3	1.075
Washington			
Gem Russet	42.1	28.4	1.083
Russet Norkotah	43.0	34.5	1.074
Overall Mean			
Gem Russet	40.2	29.3	1.085
Russet Norkotah	41.0	33.3	1.074

[1]Data included 3 years from Kimberly, Idaho; Hermiston, Oregon; and Othello, Washington.
[2]Tuber specific gravity determined using the weight-in-air, weight-in-water method.

When compared with Russet Norkotah, Gem Russet performed better for yield in eastern Idaho than in other areas of the Northwest. This is likely attributable to two factors. First, Gem Russet has shown a shorter period of maturity than Russet Burbank and consequently did not yield as well where seasons are long such as in the Columbia Basin of Oregon and Washington. Second, Gem Russet has shown some resistance to early dying and maintained its yield potential, especially in eastern Idaho where crop rotations tend to be short and high levels of Verticillium were deleterious to yields of Russet Burbank and Russet Norkotah.

TABLE 5—*Internal and external defects for Gem Russet, Russet Burbank, and Russet Norkotah grown in seven southeastern Idaho locations.*[1]

Variety	Second[2] Growth	Growth[2] Cracks	Shatter[2] Bruise	Blackspot[2] Bruise	Hollow[3] Heart	Stem-end Discoloration
Gem Russet	4.8	5.0	2.7	2.3	3	0
Russet Burbank	3.3	4.1	2.4	2.6	14	1
Russet Norkotah	5.0	4.9	3.0	2.4	2	0

[1]Includes trials at Rexburg (3 years) and Shelley (4 years), Idaho.
[2]Second growth, growth cracks, shatter bruise, and blackspot bruise rated with 1 = severe, 5 = none.
[3]Incidence of hollow heart and stem-end discoloration reported as a percentage of tubers over 336 g with visible symptoms.

Quality Characteristics

Gem Russet consistently produced tubers with higher specific gravity than did Russet Burbank or Russet Norkotah in trials in southern Idaho (Tables 1-4). It also maintained better french fry color following 3-5 months storage than did Russet Burbank. This was particularly apparent following storage at or near 4.4 C (Table 1).

Gem Russet has shown good resistance to most external and internal defects, similar to the response shown by Russet Norkotah and better than that shown by Russet Burbank (Table 5). It has a high level of resistance to second growth, and growth cracks. In trials, Gem Russet showed little stem-end discoloration, but has shown occasional stem-end problems in grower storages. Gem Russet is slightly less susceptible to shatter bruise and slightly more susceptible to blackspot bruise than is Russet Burbank.

In taste panel sensory evaluations of baked potatoes, Gem Russet compared favorably with Russet Burbank (Table 6). For the characteristics of color, flavor, and general appeal, Gem Russet, on average, scored slightly higher than Russet Burbank. For texture, Gem Russet scored slightly lower in pre-storage evaluations, and similar in post-storage evaluations. Boiling quality of Gem Russet tubers has not been experimentally evaluated, but personal experience of the breeders suggests they tend toward a moderate level of sloughing.

TABLE 6—*Sensory evaluations of Gem Russet and Russet Burbank baked potatoes.*[1]

	Pre-storage[2]				Post-storage[3]			
Variety	Color	Texture	Flavor	General	Color	Texture	Flavor	General
Gem Russet	6.6	6.0	6.2	6.1	6.6	6.1	6.3	6.3
Russet Burbank	6.5	6.2	6.0	6.1	6.5	6.1	6.0	6.1

[1]Tests were conducted over 6 years and consisted of ten sessions with each of 10-12 trained panelists. Tubers were rated for color, texture, flavor, and general appeal on a 1-9 scale with 1=very poor quality, 9=exceptionally good quality.
[2]Pre-storage evaluations were conducted in early November, approximately 1 month after harvest, and before the storage temperature was brought to its final holding point.
[3]Post-storage evaluations were conducted in March, after 5-6 months storage at approximately 4.4 C.

TABLE 7—Disease response ratings for Gem Russet, Russet Burbank, and Russet Norkotah.[1]

Variety	Common Scab	Vert. Wilt	Foliar Early Blight	PVX	PVY	PLRV	Net Necrosis
Gem Russet	1	5	7	1	8[2]	7	4
Russet Burbank	1	7	7	7	7	7	7
Russet Norkotah	1	9	9	7	8[2]	7	4

[1]Relative disease responses were made based on controlled field trials conducted between 1991 and 1998 and rated 1-9 where 1=very resistant and 9=very susceptible. Values were rounded to the nearest integer.
[2]Russet Norkotah and Gem Russet express very mild symptoms of PVY infection, however, spread within the crop is rapid.

Disease Response

Gem Russet is resistant to common scab (*Streptomyces scabies*), susceptible to foliar early blight (*Alternaria solani*), but resistant to early blight tuber rot (Table 7). Response of Gem Russet foliage to late blight (*Phytophthora infestans*) is similar to that of Russet Burbank and it is considered to be susceptible. The tubers show a moderate degree of resistance to late blight tuber rot. Gem Russet is moderately resistant to Verticillium wilt and is moderately susceptible to Fusarium dry rot. Observations from growers fields in south-central Idaho have shown Gem Russet to be moderately susceptible to white mold (*Sclerotinia sclerotiorum*).

Gem Russet shows a typical response to bacterial ringrot (*Corynebacterium sepedonicum*), with good symptom expression. It shows typical responses to storage rot organisms and shows a moderate level of resistance to soft rot (*Erwinia* sp.). In commercial storages, tuber rot problems with Gem Russet have been rare.

Gem Russet shows extreme resistance to potato virus X (PVX) (Table 7). It is susceptible to other common viruses, including potato leafroll virus (PLRV), but is moderately resistant to net necrosis caused by PLRV. Gem Russet is very susceptible to potato virus Y (PVY) and shows a response similar to that expressed by Russet Norkotah and Shepody, with rapid spread and weak symptoms. Control in seed crops of Gem Russet requires the planting of early generation seed that is completely free of PVY, intergenerational and geographical isolation, and extra attention to details of sanitation.

Gem Russet is susceptible to the cyst (*Globodera* sp.) and Columbia root-knot (*Meloidogyne chitwoodii*) nematodes. Evaluations in the Egin Bench area of Idaho have shown Gem Russet to be susceptible to corky ringspot, a disease vectored by the stubby root nematode (*Paratrichodorus* allius) and caused by the tobacco rattle virus (TRV).

Biochemical and Nutritional Characteristics

Three years of biochemical analyses on tubers have shown that compared to Russet Burbank, Gem Russet is higher in dry matter, slightly higher in sucrose, lower in dextrose (reducing sugars), higher in protein, and substantially higher in vitamin C (Table 8). Gem Russet tubers produced at Aberdeen have had a very low total glycoalkaloid content, with a three-year average for tubers grown at Aberdeen of 2.8 mg/100g.

Usage

Based on its excellent appearance, high grade, high tuber solids, low tuber reducing sugar content, excellent baking quality, and resistance to defects, Gem Russet appears to be suited for fresh market, french fry processing, and dehydration. Gem Russet is marginally suited for boiling due to a tendency for sloughing.

Management

Studies on management factors for Gem Russet have been conducted primarily in southeastern Idaho. Soils infested with root-knot or stubby root nematodes, or heavily infested with Verticillium should be fumigated. Seed production of Gem Russet should incorporate isolation techniques for control of potato virus Y. In spacing studies, optimum yield and size distribution occurred with seed pieces spaced at 28-33 cm on 91 cm rows.

Gem Russet requires relatively high amounts of nitrogen fertilizer, with best yields at rates approximately 10% higher than required for Russet Burbank. Based on two years of trials, the

TABLE 8—*Biochemical analyses of Gem Russet and Russet Burbank tubers.*[1]

Variety	Dry Matter	Sucrose	Dextrose	Protein	Vitamin C	Total Glyco-alkaloids
Gem Russet	23.8	0.21	0.04	5.9	25.3	2.8
Russet Burbank	21.9	0.17	0.09	4.5	17.9	7.0

[1]Data from three trials grown at Aberdeen, Idaho, from 1993-1995. Tubers were stored for 1 month at 7.3-12.7 C prior to sample preparation. All samples were cubed, freeze-dried, and ground prior to analyses.

optimum range in southeastern Idaho has been determined to be 224-280 kg N/ha (200-250 lbs N/acre). Gem Russet has responded to early nitrogen availability and the best response is with all nitrogen applied preplant or with the last seasonal application made by the end of early tuber bulking. Petiole nitrate sufficiency ranges for Gem Russet are emergence until tuberization, 21,000 to 23,000 ppm; during tuberization 21,000 to 23,000 ppm; during early tuber bulking, 16,000 to 19,000 ppm; during late tuber bulking, 10,000 to 13,000 ppm; and during maturation, 6,000 to 11,000 ppm.

Gem Russet has long tuber dormancy, similar to Russet Burbank's, and can be stored for up to 12 months. Because the tubers have some resistance to cold sweetening, they can be stored for french-fry processing at 5.5 to 6.7 C. Sprout inhibition may be required after 3-5 months.

AVAILABILITY

An application for Plant Variety Protection has been filed for Gem Russet. Seed is widely available from potato seed growers in Idaho, Montana, Oregon, Colorado, and Canada. Small amounts of seed, for research purposes, can be obtained by contacting the corresponding author.

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