Effect of Whole Seed Tuber Size and Pre-plant Storage Conditions on Yield and Tuber Size Distribution of Russet Burbank

Walter J. Arsenault* and Bert R. Christie

Agriculture and Agri-Food Canada, Crops and Livestock Research Centre, 440 University Avenue, Charlottetown, PE, Canada, C1A 4N6

*Corresponding author: Tel: 902-566-6834; Fax: 902-566-6821; Email: arsenaultw@agr.gc.ca

ABSTRACT

Field experiments were conducted in 1995, 1996, and 1997 at Agriculture and Agri-Food Canada’s Harrington Research Farm to assess the effect of whole seed tuber size and pre-plant seed storage conditions on processing yield (>51 mm dia.) of potato (Solanum tuberosum L. cv Russet Burbank). Following commercial storage, seed tubers were stored at 4.4 C then subjected to one of three pre-plant treatments: (1) planted directly from storage, (2) held at 10 C for 3 wk before planting, or (3) green-sprouted for 3 wk before planting. Five sizes of whole seed were used (28, 42, 56, 70, and 84 g) with a variable size cut seed treatment added for comparison. Plots were harvested 138, 134, and 131 days after planting in 1995, 1996, and 1997, respectively. Cut seed produced a higher yield of tubers >51 mm diameter in comparison to all whole tuber seed sizes, with the exception of the 28 and 56 g sizes. In terms of total yield, the 28- and 42-g whole seed tubers yielded significantly less than all other seed sizes examined. Warming or greensprouting seed tubers prior to planting did not increase tuber yield. The larger whole seed tuber sizes tended to result in greater numbers of stems and tubers per plant. To maximize marketable yield of Russet Burbank planted from whole seed tubers, it is recommended that the seed be between 28 and 42 g in size.

RESUMEN

Durante los años 1995, 1996 y 1997 se realizaron experimentos de campo en papa (Solanum tuberosum L. cv Russet Burbank) en la Granja Experimental “Agriculture and Agri-food Canada’s Harrington” con el objeto de evaluar el efecto del tamaño de tubérculo-semilla entero y condiciones de almacenamiento antes de la siembra, sobre el rendimiento de papa para procesamiento (>51 mm de diámetro). Después de almacenados comercialmente, los tubérculos-semilla se almacenaron a 4 C y luego fueron sometidos a tres tratamientos de pre-siembra (1) siembra inmediata después del almacén, (2) mantenidos por tres semanas a 10 C antes de la siembra, o (3) brotados por tres semanas antes de la siembra. Se trabajó con cinco tamaños de semilla entera (28, 42, 56, 70, y 84g), conjuntamente con semilla cortada de varios tamaños para comparación. Las parcelas fueron cosechadas a los 138, 134, y 131 días después de la siembra en 1995, 1996, 1997 respectivamente. La semilla cortada produjo un mayor rendimiento de tubérculos > de 51 mm de diámetro en comparación con todos los tamaños de semilla entera, con excepción de los de 28 y 51g. En términos de rendimiento total, los tubérculos enteros de 28 y 42g rindieron significativamente menos que los de otros tamaños examinados. El reacondicionamiento de tubérculos brotados antes de la siembra no incrementó el rendimiento. Los tubérculos enteros de mayor tamaño mostraron tendencia a producir mayor número de tallos y tubérculos por planta. Para incrementar el rendimiento comercial de Russet Burbank sembrado de tubérculos- semilla entera, se recomienda una semilla de tamaño entre los 28 y 42g.

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ADDITIONAL KEY WORDS: tuber storage temperature, processing yield, Solanum tuberosum, stem density, tubers per plant, total yield
INTRODUCTION

The Russet Burbank potato cultivar (Solanum tuberosum L.) is grown for processing and table markets in most areas of North America. Russet Burbank requires a long growing season for optimum production because it is indeterminate with a large tuber set (Rowe 1983). In comparison to many other potato-growing areas in North America, the climate on Prince Edward Island (PEI), Canada, is generally cool with a short growing season. These climactic conditions, when combined with inadequate rainfall, can result in substantial yields of small-sized tubers.

Although climate can influence yield and tuber size distribution of Russet Burbank, other factors, such as stem number per plant, can affect yield. Work by Iritani et al. (1983) has shown that more stems per plant can decrease yield of U.S. No. 1 size tubers and increase the yield of small tubers. Earlier work by Iritani et al. (1972) with Russet Burbank has shown that large cut seedpieces can result in a significant increase in the number of stems per plant. With whole seed tubers, Wurr and Morris (1979) determined a linear relationship between the number of stems per tuber and seed tuber weight using the Desiree and Maris Piper cultivars.

Physiological age and size of seed tubers can also strongly influence yield parameters of many potato cultivars. Experiments conducted by Wurr (1974), using the Maris Piper and Pentland Crown cultivars, revealed that larger cut seedpieces (100 g) can result in an increase in total yield. This was later supported by Rykbost and Locke (1999), who examined a variety of cultivars and found that larger cut seedpieces (64 g) optimized yield of fresh-market potatoes. However, some reports suggest that the total yield of many cultivars is not substantially affected by seed tuber weight (Allen et al. 1992). Iritani (1968) and Struik and Wiersema (1990) suggest that the physiological age of seed tubers is influenced by many factors including photoperiod, temperature, soil moisture, nitrogen, maturity at vinekill, and storage temperature; both propose that storing seed tubers at high temperatures may lead to increased physiological age of the tubers with a resultant increase of stem numbers. However, Toosey (1964) found that cold-storage-delayed sprouting can result in an increase in the number of stems produced by seed tubers, although year-to-year variability can occur.

During the late 1990s, potato virus levels increased in North America, thought to be a result of larger populations of virus-transmitting aphids (Novy et al. 2002). As a result, growers of seed tubers on PEI opted to apply vine desiccants earlier than normal, before the arrival of virus-transmitting aphids, in order to assure production of disease-free seed. However, early vine desiccation of late-maturing cultivars, such as Russet Burbank, can reduce yields of seed tubers of the size that require cutting, thus increasing yields of seed suitable for whole seed planting. The objective of the current work was to determine the impact of size of whole seed tubers and the effects of pre-plant seed tuber storage conditions on the production of Russet Burbank for processing.

MATERIALS AND METHODS

Experiments were conducted in 1995, 1996, and 1997 at Agriculture and Agri-Food Canada’s Research Farm, Harrington, PEI, Canada (63°10’W, 46°21’N). Soil at the research farm is a fine sandy loam (Orthic Humo-Ferric Podzol) containing 60.4% sand, 29.0% silt, and 10.6% clay; pH and organic matter range from 5.7% to 6.0% and 2.2% to 3.1%, respectively (MacDougall et al. 1988). Commercially grown Elite 3 (cv Russet Burbank) seed tubers were purchased annually in late winter or early spring from the same commercial grower, then stored at 4.4°C until needed. Pre-plant seed treatments were (1) seed planted directly from 4.4°C (+2°C) storage, (2) seed warmed to 10°C (+2°C) for 3 wk before planting, and (3) seed greensprouted 3 wk before planting. Seed tubers were greensprouted in trays stacked on shelves in a greenhouse kept at a temperature range of 15-27°C. Treatments included whole seed tubers 28, 42, 56, 72, and 84 g (+2 g) in weight, with a variable-size cut seedpiece treatment added for comparison; cut seedpiece sizes ranged from 45 to 72 g and were cut from 113- to 226-g whole tubers. To minimize sprout damage, a planter modified to allow for hand placement of seed in a cup-type planting system was used.

All field plots were involved in a 3-year rotation of barley, annual ryegrass, and potatoes. Each plot consisted of a single row 7.5 x 0.9 m (Rykbost et al. 1999; Zvomuya et al. 2002) with an in-row seedpiece spacing of 38 cm. Plots were machine-planted on 25 May, 3 June, and 24 May in 1995, 1996, and 1997, respectively. Fertilizer (N:P:K 15-15-15) was band-applied at planting at a rate of 1,306 kg ha⁻¹. Above ground per plant stem number was recorded on 27 June, 5 July, and 3 July in 1995, 1996, and 1997, respectively. Pesticides were applied as needed according to current protocol (Atlantic Canada Potato Guide