IS YOUR POTATO PLANTER RESTRICTING YOUR PROFIT POTENTIAL?

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INTRODUCTION

From the onset of mechanized agriculture, missing and irregularly spaced potato plants have impacted grower returns. As far back as 1919, researchers investigated yield changes due to missing plants in potato fields (Stewart 1919). Placing a value on missing plants is difficult and can be misleading. When a potato plant is missing, neighboring plants often take advantage of open space and may compensate in yield for their missing neighbor (Hide 1995). Research that fails to consider neighbor plant compensation could drastically overstate economic and yield losses due to missing plants. Additionally, differences in varieties, regions, soil types, grower practices, etc., increase the complexity of assigning an economic value to missing and irregularly spaced plants. More times than not, plants are missing in potato fields because planters fail to plant seed consistently (Thornton 1971). To a lesser extent, plants are missing due to seed that rotted or failed to sprout (Thornton 1971).

Giving consideration to neighbor plant compensation, tuber size distribution and modern potato market values, how important is plant spacing and do missing plants cost potato growers money? To answer this question, the research reported measured grower, seed, and planter performance in Washington State during 2000, 2001, and 2002. Through small-plot research, economic values were placed on common potato stand issues found in the industry survey.

MATERIALS AND METHODS

Commercial Field Survey:

During 2000 and 2001, 70 commercial potato fields representing 57 mechanized planters were sampled for number of missing plants and reason why plants were missing in Washington State. In addition to missing plant information, in-row spacing between each emerged plant or seed piece was measured and compared to grower intentions. Results from commercial field samples were compared to seed planted by hand and a custom-built assist feed planter used for small-plot research.

Irregular Spacing Study:

Four errors common to mechanized potato planters were mimicked in treatments and compared to optimum spacing for Russet Burbank and Russet Norkotah during 2001 and 2002. Treatments included: 1) optimum spacing 2) planter-skipped seed piece (skip), 3)

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two clumped seed pieces side by side (double), 4) planter-skip followed by two clumped seed pieces (skip-double), and 5) neighbor-row plants next to a skip (neighbor). The neighbor-row treatment was designed to determine if plants in the row adjacent to a skip compensate for their missing neighbor.

Twelve-inch in-row spacing was chosen as optimum spacing for Russet Burbank and 10 inches for Russet Norkotah. Treatments were planted in a 3-plant-unit area design allowing for measurement of agronomic compensation from plants surrounding each planter error (Figure 1). Each 3-plant unit was repeated 8 times for Russet Burbank and 10 times for Russet Norkotah in each plot. Each plot was replicated 6 times. Seed piece number and spacing within each 3-plant unit area for Russet Burbank were: 1) Optimum = 3 pieces evenly spaced at 12 inches, 2) skip = 2 pieces 24 inches apart, 3) double = 1 piece, a 12 inch gap, 2 clumped pieces, a 12 inch gap, and 1 piece, 4) skip followed by a double = 1 piece followed by 24 inch gap and 2 pieces clumped together, and 5) neighbor-row treatment, planted same as optimum treatment except one adjacent row contained a planting pattern similar to the skip treatment. Treatments were the same for Russet Norkotah but based on a spacing of 10 inches rather than 12. Certified seed between 1.5 and 3 oz was hand-planted for each treatment.

Seed-cost-adjusted gross income ($/3-plant-unit) was determined for both varieties. Russet Norkotah was valued under fresh-market parameters and Russet Burbank under process-market criteria. During the economic analysis, two new missing-plant treatments, “blind/rot” and “blind/rot-double,” were created by charging the skip and skip-double treatments, respectively, each the cost of one additional seed piece. The new treatments simulated plants missing due to a rotten or blind (failure to sprout) seed piece rather than from a planter skip.

RESULTS

Commercial Field Survey

In-row spacing variability averaged 13% for hand-planted plots while Washington growers averaged 34%, ranging from 18 to 69% (Figure 2). Each in-row spaced seed or plant deviated an average of 25% (± 2.6 inches) from the grower-intended spacing. The range was from 15 to 43%. In-row spacing variability for 5 planter-types or brands common to Washington State are displayed in Figure 2. Within a planter-type or brand, in-row spacing variability ranged widely due to planter design and mechanical condition, seed shape and size, tractor speed, etc.

During 2000-02, growers planted 94% of the seed piecies they intended. This can be compared with a 1970 Washington survey that found growers planted only 87% of intended. (Thornton 1971). An average of 7% (1,190 plants/acre) of the grower-intended stand was missing, with a range of 1 to 25%. Similar to the 1970 survey (Thornton 1971), most plants were missing because planters failed to plant seed pieces consistently. Skips alone average 1100/acre and ranged from 150 to 4500. The breakdown of missing plants in Washington follows:

Why potato plants are missing in Washington state and average frequency.

	1970	2000-02	2000-02
	%	%	Frequency/Acre
Planter Skips	81	92	1100
Blind/Non-sprouted seed	10	4	60
Rot or Disease	9	4	40

Seed piece clumps averaged 800/acre and were generally doubles. Skips followed by double seed clumps averaged 200/acre.

Irregular Spacing Study

For both Russet Norkotah and Russet Burbank, market yields of the skip and skip-double spacing treatments were significantly lower than the other spacing regimes. Together, the two in-row plants next to a skip compensated for about 50 to 60% of the missing plants total yield. Additionally, plants next to a skip produced 1 to 2 more tubers than plants under optimum spacing. On average, all tubers from the plants next to skips weighed significantly more than those coming from optimally spaced plants. An opposite trend was seen under the double spacing; average tuber weight and number declined from optimum-spacing values. Neighbor-row plants next to a skip failed to compensate for their missing neighbors with tuber values similar to optimum spacing. Average tuber number and weight for skips followed by doubles were somewhere between optimum and skip-treatment values.

Skips and irregular spacing are costing growers money! Table 1 shows the economic breakdown of each 3-plant-unit and the percent difference from optimum spacing. For both cultivars, in-row plants next to a skip together compensated for 55% or more of the missing plants value. Neighbor-row plants next to a skip failed to compensate in economic value for their missing neighbor. Under a process market, Russet Burbank doubles had a value similar to one plant at optimum spacing. However, fresh-marketed tubers from a double-clumped Russet Norkotah plant were worth 45% less than those from one uniformly spaced plant. For both cultivars, missing plants from blind or rotten seed and skips followed by double clumped seed pieces were similar in value to a planter skip.

So what does this mean to Washington growers? By applying the statistically significant economic values of the irregular spacing study to the planter errors common to Washington growers one can sense the importance of seed and planter performance. Russet Burbank growers lose an average of $80 per acre or 2.9% of seed-adjusted-gross income per acre from missing plants (Table 2.) Russet Norkotah growers are losing an average of $102/acre or 4.4% under fresh marketing (Table 3). From skips alone, growers are losing from $8 to $300 (0.3 to 11%) per acre of seed-cost-adjusted gross (Tables 4 and 5). Because actual dollar values will change from situation to situation, the percentage lost will mean more for the individual grower.

DISCUSSION

Compared to 1970, Washington Growers are planting better quality seed and are planting more of their intended plant population. However, grower surveys and associated economic values indicate a serious problem in potato fields throughout the world. Plants are poorly spaced and often missing. Surveys show growers have faced this problem for close to a century, with little change, especially in planter design. One reason is that potato farming is a relatively small sector of agriculture, creating limited demand. The other is that growers have been accepting of poor-performing planters. Granted, management of the planting operation is crucial to making a planter perform regardless of how well a planter might be designed. Variability in planter performance can be attributed to many factors such as seed shape and size, tractor speed, planter condition, and design. Despite intense management efforts by many growers globally, most planters are restricted to a performance level dictated by poor mechanical design. The largest issue facing designers is that most U.S. growers use seed that is cut into irregular shapes and sizes.

A Call for New Technology:

Can a better potato planter be built? Necessity is the mother of invention. With the right economic incentive and grower demand, it will happen. New technologies such as vacuum planter mechanisms appear promising, but research with various planter types under the same conditions is needed to make a fair judgment. At this time, it does not seem prudent to replace an old planter unless there is good evidence you can manage a new one to perform at a higher level. To obtain optimum plant spacing and populations, use only certified seed that is sorted by size prior to cutting and adjust the cutting mechanisms as needed. Discard chips and trim oversized tuber pieces prior to planting. Monitor seed piece profile to obtain the desired seed piece size and to keep under or oversize pieces to a minimum. Monitor planter performance frequently and maintain proper speed and seed bowl levels at all times.

LITERATURE CITED

Hide, G.A., S.J. Welham, P.J. Read, and A.E. Ainsley. 1995. Influence of planting seed tubers with gangrene (*Phoma foveata*) and of neighbouring healthy, diseased and missing plants on the yield and size of potatoes. J Agric Sci 125:51-60.

Stewart, F.C. 1919. Missing hills in potato fields: their effect upon yield. NY Agr Exp Sta (Geneva) Bull 459:45-69.

Thornton, R.E. 1971. Potato stands in Washington. Proc. 10th Annual Washington Potato Conference, Moses Lake, WA. pp. 63-65.

TABLE 1. R. Burbank and R. Norkotah market values[a]. Years 2001 and 2002 combined

	R.Burbank - Process Market				R. Norkotah - Fresh Market			
			% of Optimum Value[b]				% of Optimum Value[b]	
Treatment	$/3-Plant-Unit	$/Plant	3-Plant-Unit	Plant	$/3-Plant-Unit	$/Plant	3-Plant-Unit	Plant
Optimum	0.53 a[c]	0.18 b			0.37 a	0.12 b		
Neighbor-Row	0.50 ab	0.17 bc	95	95	0.37 a	0.12 b	98	98
Double	0.50 ab	0.13 e	95	71	0.32 b	0.08 d	85	64
Skip	0.46 c	0.23 a	87	131	0.32 b	0.16 a	86	129
Skip-Double	0.47 bc	0.16 cd	89	89	0.31 b	0.10 c	82	82
Blind/Rot	0.44 c	0.22 a	84	126	0.30 b	0.15 a	81	122
Blind/Rot-Double	0.45 c	0.15 d	86	86	0.29 b	0.09 cd	77	77
(p-Value)	0.0001	0.0001			0.0028	0.0001		
Year 1	0.42 b	0.16 b			0.38 a	0.14 a		
Year 2	0.54 a	0.20 a			0.27 b	0.10 b		
(p-Value)	0.0001	0.0001			0.0002	0.0005		

[a]Grower-paid gross income per unit or plant, less seed cost.

[b]Percentages were calculated prior to rounding 3-plant-unit and per plant $ values to nearest 100th.

[c]Means in a column followed by the same letter are not significantly different by Fisher's Protected LSD Test at 0.05 level.

Table 2. Process market: estimated cost of missing and irregularly spaced Russet Burbank plants to Washington State potato growers with a plant population similar to the average of the 70-field survey.

	Adjusted Gross Income[a]		
		$/Center Pivot	
Russet Burbank – Spatial Arrangement	$/A	($/125 acres)	%
Optimum spacing	2,710	339,000	100.0
70-Field Ave., Error[b] Frequency/ha	Difference from Optimum Spacing		
2,200 planter skips	-60	-7,590	-2.2
500 skips followed by doubles	-12	-1,500	-0.4
250 blind or rotten seed pieces	-8	-1,000	-0.3
POTENTIAL GROWER LOSS	-80	-10,100	-2.9

[a]Gross income from process market, less seed expense.

[b]Only those errors and associated values that were significantly different from the optimum spacing value were included in this table. Most values have been rounded.

Table 3. Fresh market: estimated cost of missing and irregularly spaced Russet Norkotah plants to Washington State potato growers with a plant population similar to the average of the 70-field survey.

	Adjusted Gross Income[a]		
		$/Center Pivot	
Russet Norkotah – Spatial Arrangement	$/A	($/125 acres)	%
Optimum spacing	2,296	287,000	100.0
70-Field Ave., Error[b] Frequency/ha	Difference from Optimum Spacing		
2,200 planter skips	-47	-5,820	-2.0
500 skips followed by doubles	-14	-1,720	-0.6
1,480 doubles	-34	-4,300	-1.5
250 blind or rotten seed pieces	-7	-860	-0.3
POTENTIAL GROWER LOSS	-102	-12,700	-4.4

[a]Gross income from fresh market, less seed expense.

[b]Only those errors and associated values that were significantly different from the optimum spacing value were included in this table. Most values have been rounded.

TABLE 4. Cost of planter skips only for R. Norkotah in Washington State (2001-02).

R. Norkotah	Best Field	Worst Field
Skips/Acre	150	4500
$/Acre	-$8	-$230
$/Pivot	-$1,000	-$28,800
% of Gross Income Lost	**-0.3%**	**-10%**

TABLE 5. Cost of planter skips only for R. Burbank in Washington State (2001-02).

R. Burbank	Best Field	Worst Field
Skips/Acre	150	4500
$/Acre	-$10	-$300
$/Pivot	-$1,300	-$38,000
% of Gross Income Lost	**-0.4%**	**-11%**

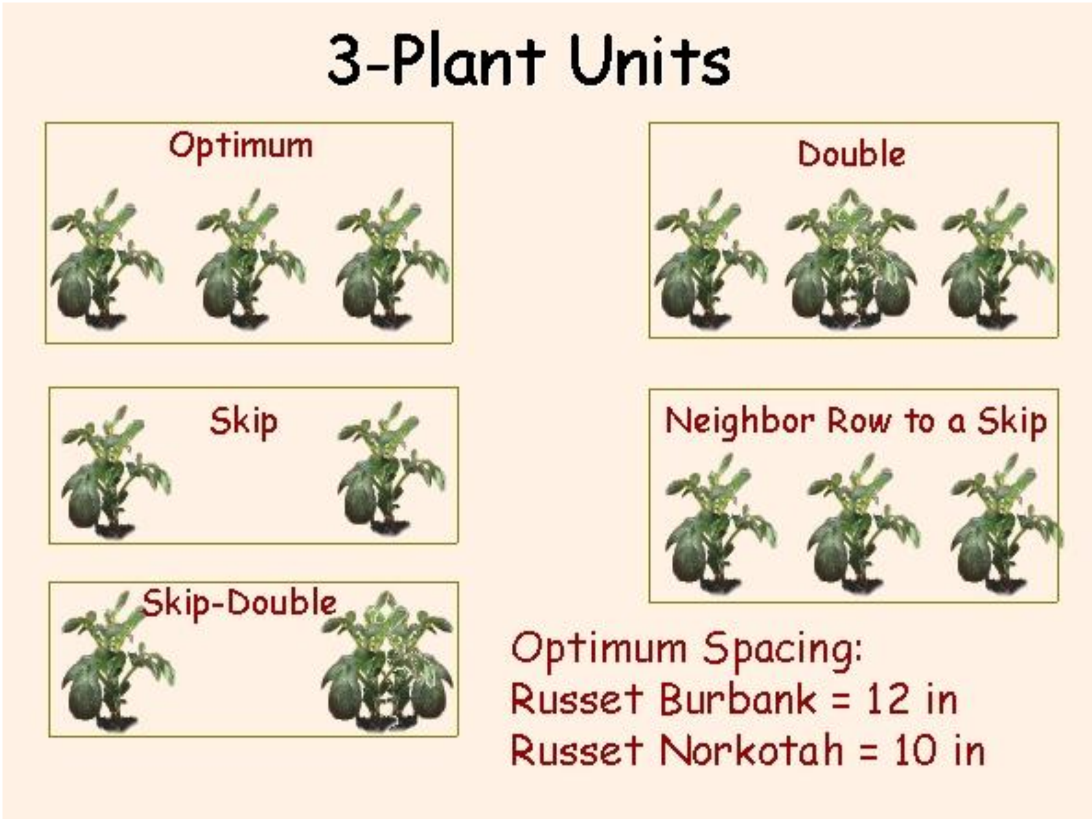

FIGURE 1. *Three-plant-unit design of the irregular spacing study.*

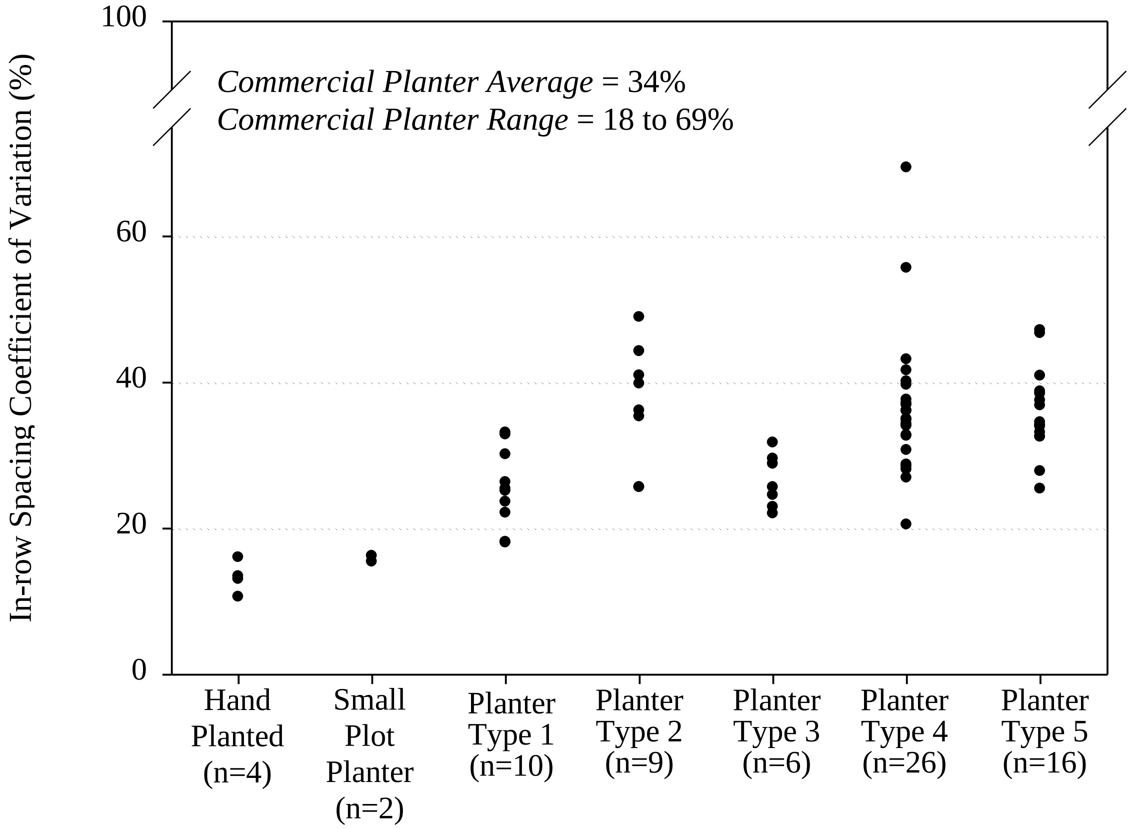

Figure 2. Variation of in-row plant and seed piece spacing in Washington State potato fields during 2001-2002. Each dot represents the mean of 4 to 6 replications of spacing variation between each of 25 or more plants or seed pieces. The number of means per category is indicated by "n"; some means overlap. Plant and seed piece spacing from commercial planters averaged 29 cm (11 in).