Poor Planter Performance: What's It Costing the Average Washington Potato Grower?

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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 (G.A. 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 Washington potato growers money? To answer this question, we 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:
Between 2000 and 2001, 70 commercial potato fields representing 57 mechanized planters were sampled for number 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) 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 R. Burbank and 10 inches for R. 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 R. Burbank and 10 times for R. Norkotah in each plot. Each plot was replicated 6 times. Seed piece number and spacing within each 3-plant unit area for R. 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 R. Norkotah but based on a factor of 10 rather than 12 inches. 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. R. Norkotah was valued under fresh-market parameters and R. 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). Variation of 34% meant each in-row spaced seed or plant was off an average of +-2.8 inches from the grower-intended spacing. The range was from +-1.2 to 6.3 inches. 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.

Between 2000-02, Growers planted 94% of what they intended. This can be compared with a 1970 Washington survey that found growers planted only 87% of intended. (Thornton 1971). Eight percent of the grower-intended plant population was missing with a range of 150 to 4950 missing plants/acre. 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

On average, 7% of each field was not planted (Figure 3.) and there was a wide range among and within each planter type. Seed piece clumps averaged 800/acre and were generally doubles. Skips followed by double seed clumps averaged 200/acre.

Irregular Spacing Study

For both R. Norkotah and R. 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 about 60% of the missing plants value. In a 3-plant-unit area, the 2 plants next to a skip were worth 86 to 87% of 3 plants in the optimum spacing unit for R. Norkotah and R. Burbank, respectively. Again, neighbor-row plants next to a skip failed to compensate for their missing neighbor. Under a process market, R. Burbank doubles paid for themselves with the double-clumped plant's value similar to one plant at optimum spacing. However, fresh-marketed tubers from a double-clumped R. 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. R. Burbank growers lose an average of $80 per acre or 3% of seed-adjusted-gross income per acre from missing plants (Table 2.) R. Norkotah growers are losing an average of $110/acre or 4.8% 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. Cost of missing and irregularly spaced R. Burbank plants to the average Washington State potato grower (2001-02).

	$ Value per		
R. Burbank	Acre	Pivot (125 Acres)	% of Gross Income
Optimum Spacing	$2,710	$339,000	100%
Average WA Grower[a]:			
1100 Skips	-74	-9200	-2.5
100 Rot/Blind	-9	-1070	-0.3
POTENTIAL LOSS	**$80**	**$10,000**	**-3%**

[a]Only those stand issues that were significantly less in $ value than the optimum spacing were included in this table.

TABLE 3. Cost of missing and irregularly spaced R. Norkotah plants to the average Washington State potato grower (2001-02).

	$ Value per		
		Pivot	% of Gross
R. Norkotah	Acre	(125 Acres)	Income
Optimum Spacing	$2,296	$287,000	100%
Average WA Grower[a]:			
1100 Skips	-57	-7100	-2.5
800 Doubles	-46	-5800	-2.0
100 Rot/Blind	-7	-900	-0.3
POTENTIAL LOSS	**$110**	**$13,800**	**-4.8%**

[a]Only those stand issues that were significantly less in $ value than the optimum spacing were included in this table.

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%**

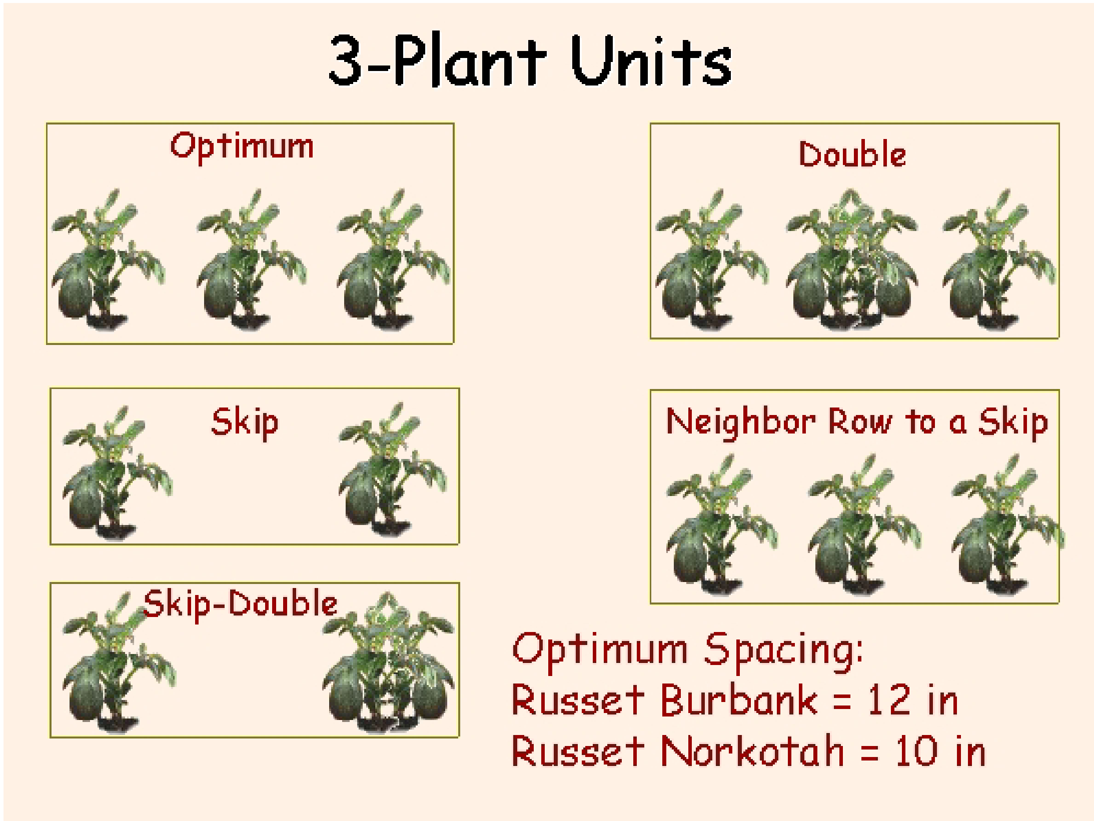

FIGURE 1. *Three-plant-unit design of the irregular spacing study.*

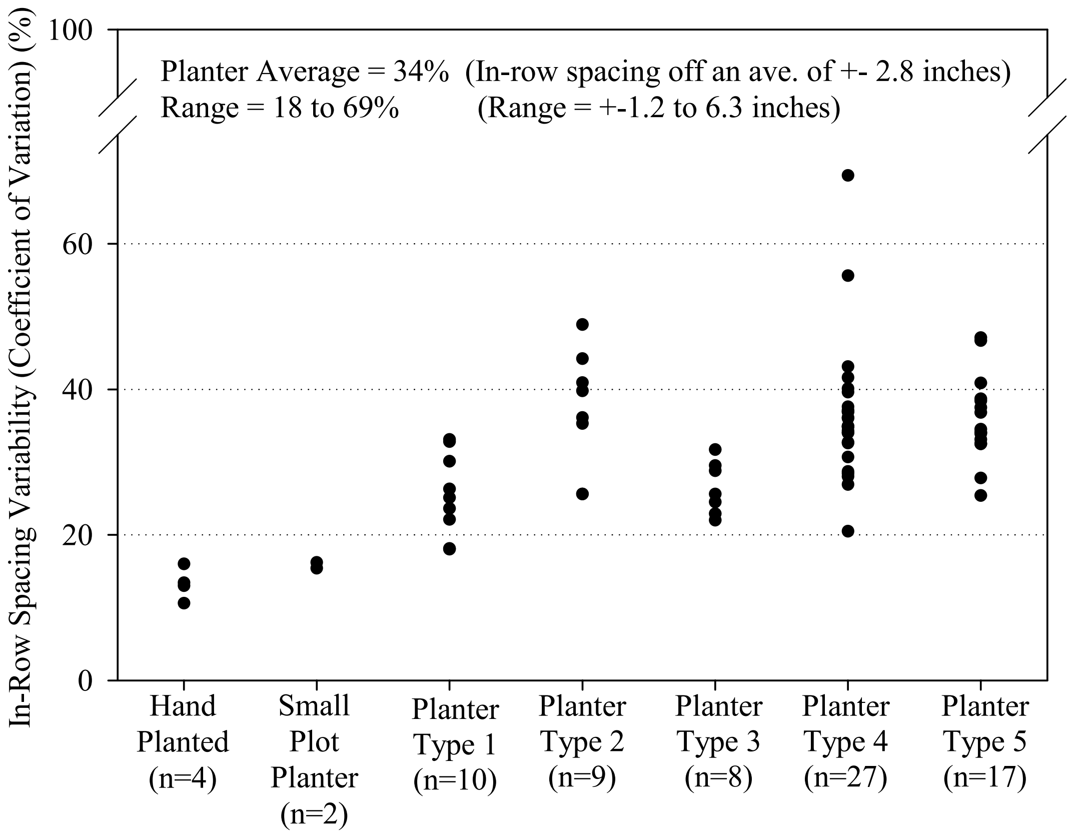

FIGURE 2. *In-row spacing variability per planter. Cofficient of variation from seed and emerged plants 2001 & 2002. Averages of 4 to 6 replications per planter. N refers to number of planters or units sampled*

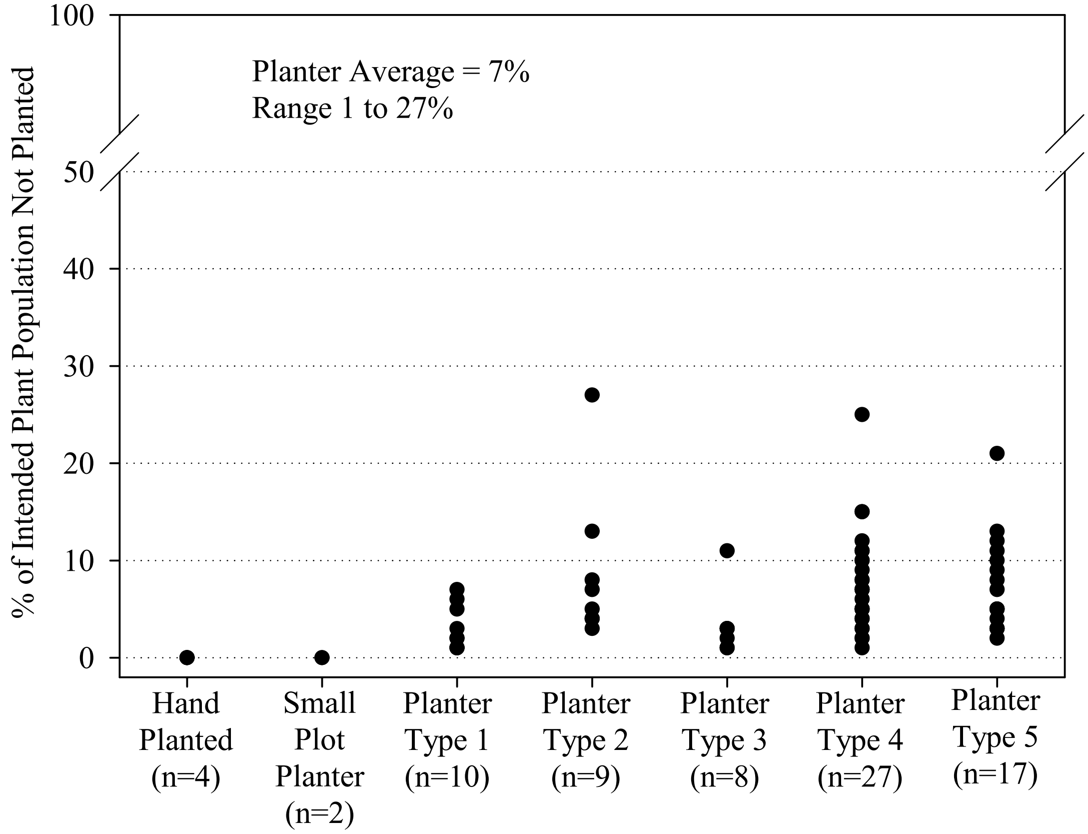

FIGURE 3. *Percent of intended potato plant population not planted due to planter skips and irregular spacing. Averages of 4 to 6 replications per planter. N refers to number of planters or units sampled.*