

FEASIBILITY OF USING MICROTUBERS IN SEED POTATO PRODUCTION¹

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Introduction

All seed potatoes grown under the Limited Generation System originate from micropropagated potatoes. Currently most programs generate certified seed potatoes within 3 to 5 years after being planted in the field. The trend has been to produce certified seed in fewer generations. An influential processor believes that seed will soon only sell if it has only three or four years in the field (Voglewede, 1993). There is a market demand to produce seed potatoes in fewer years in order to rapidly scale up new varieties, including genetically engineered varieties. There is also a need to grow some disease susceptible varieties in fewer years, such as the varieties that show poor expression of PVY symptoms, for example Russet Norkotah. The rapid production of certified seed potatoes is currently restricted by the high cost of seed in the first field year. In the first field year, the micropropagated seed potatoes need to yield well and cost very little.

There are many components that affect plant yield from mini and microtubers. Tuber size, physiological age, green sprouting method, size grading and crop husbandry techniques all have an impact on mini and microtuber field performance (Lommen and Struik, 1993). Microtuber size is one factor that is a main determinant of yield, and is easy to measure (Peterson, et. al, 1985). Minitubers that ranged in size from 0.13 grams to 4.0 grams were found to have different stem and root weights and ratios at emergence (Lommen, 1993). The minitubers under .75 grams tended to have substantially lower shoot:root fresh weight ratios at emergence. The purpose of this field trial is to measure the impact of microtuber size on yield.

Micropropagated potatoes can be introduced to the field in the form of transplants, microtubers or minitubers. Transplants are grown from either microshoots or microtubers and are grown

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initially in sterile soil in a greenhouse before being transplanted to the field. Transplants are planted in the field for \$0.60 to \$0.75 each. Minitubers are produced from either microshoots or microtubers and are grown in sterile soil in an aphid-proof screenhouse. Minitubers vary in size from 2 to 50 grams, but are high cost ranging from \$0.50 to \$1.00 each. Microtubers are produced in test-tubes, providing for the highest phytosanitary quality. The sizes of microtubers tend to be lower than those of minitubers, ranging from 0.1 to 5 grams. The price of microtubers is its principle advantage, with a cost of \$0.25. At high volumes, microtubers are projected to sell for less than \$0.10.

This preliminary study looks at the relative yield of microtubers for the variety Russet Burbank grown at the Langlade County Airport.

Materials and Methods

Microtubers

Russet Burbank microtubers for this trial were produced by Small Potatoes, Inc. using the patented Microtuber Multiplication System (US Patent No. 5,047,343, 1991). There were three treatments developed for the trial based on size classification. The large size class had a median fresh weight of 1.31 g, the medium size class had a median fresh weight of 0.64 grams and the small size class had a median fresh weight of 0.31 grams (Figure 1). All microtubers had their dormancy broken naturally and were green sprouted.

Figure 1. The microtuber size classifications.

Size class	Median Fresh Weight (grams)	High Fresh Weight (grams)	Low Fresh Weight (grams)
I	1.28	7.81	0.75
II	0.61	1.03	0.46
III	0.37	0.59	0.22

Field plots

The microtubers were planted by hand at the Langlade County Airport on May 20th, 1993. Each replicate consisted of a four row plot with two twenty foot rows and a guard row on each side. The guard rows were planted with Russet Burbank transplants, transplanted on June 10, 1994. The three treatments were planted in a Randomized Complete Block with three replications.

The plants were hilled on July 15th and were given standard irrigation, fertilization and pest control. The treatments were vine killed on September 15th and 23rd and were harvested on September 27th. Each treatment was harvested with a two row mechanical harvester. The resulting tubers were stored until October 8th and were graded at the Hancock Experimental Station.

Data

The tubers were sorted, counted and weighed into 6 size categories, B's and culls. The relative canopy sizes were measured by photographing from five feet high randomly selected plants from each treatment 32, 43, 56 and 68 days after planting. After 68 days, the rows closed on most plots and it was not possible to take more photographs. The slides were then projected on an 8x11 sheet of copy paper where the outlines of the leaves were traced. The outlines were then cut out and weighed individually. The weights of the cut-up copy paper gives an estimate of the relative amount of light intercepted by each plant.

Results and discussion

Influence of microtuber size

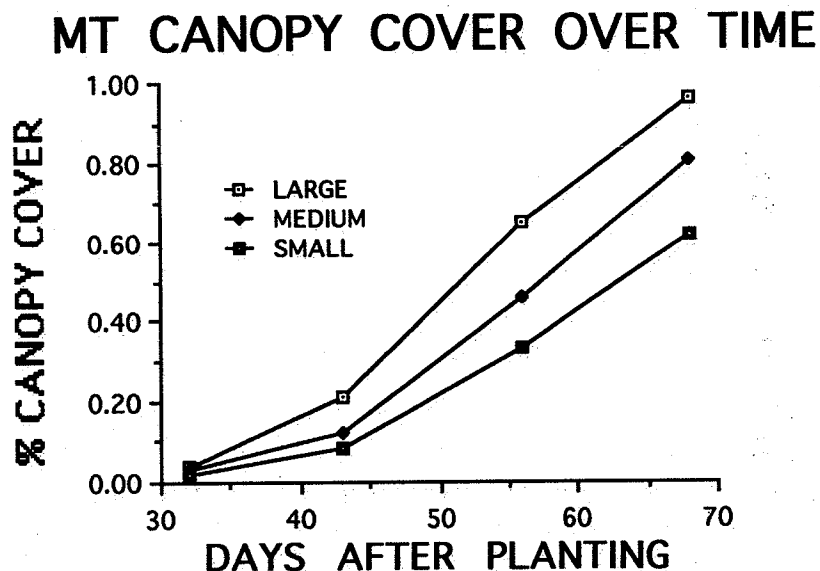
Emergence. Uniform emergence of microtubers, obviously is essential for success in the field. Under stressful field conditions emergence can be difficult for microtubers. However, with a certain size microtuber, the difficulties are minimized. Although the differences were not significant, the largest microtuber size category, had the highest emergence rate after 29 days of 96% (Figure 2). The uniformity of the stand was also best with the larger sized microtubers.

 Figure 2. This chart is a listing of the mean number of microtubers emerged, the standard deviation and the percentage of emergence of the three size classifications after 29 days. Each plot had forty microtubers with three replicates per treatment.

<u>Microtuber Size</u>	<u>Average No. emerged</u>	<u>std. dev.</u>	<u>% emergence</u>
Large	38.7	2.1	97%
Medium	34.0	2.5	85%
Small	33.7	3.1	84%

Canopy. The growth of the plant canopy has a critical impact on the yield of potatoes. The establishment of a plant canopy with micropropagated potatoes is often the limiting factor for yields. The faster a full canopy can be established, the more sunlight can be intercepted and more starch can be produced. For this field trial, the large sized microtubers also had the highest canopy growth rate. Once the microtubers emerged, the large sized microtubers grew faster and set up their canopy approximately two weeks ahead of the small sized microtubers (Figure 3). This difference in canopy growth may account for the difference in yields of the microtubers.

Figure 3. This chart represents the relative canopy cover of the microtuber plants over time. A value of 1.00 indicates full row closure.



Yield. The large size microtubers outyielded the smaller sized microtubers, but not significantly so (Figure 4). The differences in yield were not suprizing considering the differences in canopy growth throughout the season. The large sized microtubers produced a larger vine, quicker. The microtuber plants produced a full range of tuber sizes, with several tubers over 16 ounces (Figure 5). The largest numbers of tubers were produced in the 2 to 10 ounce categories. There were a large percentage of culled potatoes, mostly due to odd shapes.

 Figure 4. These data represent the total tuber weight collected from each treatment. The extrapolated yields represents the estimated yield in an acre planted with microtubers at 12 inch spacings on 36 inch rows.

<u>Size Class</u>	<u>(lbs/plot)</u> <u>(lbs/plant)</u>	<u>(cwt/A)</u>	
I	97.34	353	2.43
II	69.22	251	1.73
III	71.82	260	1.80

LSD (5%)=28.56

CV =13.84

The differences between treatments were not significantly different as determined by the LSD test at the 5% significance level.

 Figure 5. The average tuber weight of each size classification in pounds harvested from each plot. The size categories are expressed in ounces.

	<u>B's</u>	<u>Culls</u>	<u>2-4</u>	<u>4-6</u>	<u>6-10</u>	<u>10-13</u>	<u>13-16</u>	<u>16+</u>
Lrg	10.2	25.0	7.4	18.1	24.0	7.9	3.0	1.7
Med	8.8	16.1	6.8	16.4	16.0	4.4	0.9	0.0
Sml	9.3	17.0	9.0	17.4	13.0	4.3	1.6	0.3

Economics

Microtuber yields and costs. The 1993 growing season was not the best for Wisconsin overall, and yields were down in Langlade County. In addition the Antigo silt loam soil can be difficult for growing Russet Burbank. In spite of these difficulties, the yields for the large sized microtubers were quite good at 353 cwt/A. If

the large size microtubers were to sell for \$0.25 each, then the resulting potatoes from the second year of field production would have a cost of approximately \$6.09 (Figure 6).

 Figure 6. The costs of producing Generation 3 certified seed potatoes from \$0.25 microtubers. Assumptions for this chart include: 1) a seeding rate of 20 cwt/A for the second and third field years; 2) spacing of 12 inches within the row and 36 inches between the rows for microtubers planted in the first field year; 3) a seed cost per acre in the second and third years being equal to the previous years price plus and additional \$1.00/cwt for storage.

<u>Field Year</u>	<u>Seed Cost/A \$\$\$ /CWT</u>	<u>Other Cost/A</u>	<u>Total Costs</u>	<u>Yield CWT/A</u>	<u>Seed Cost</u>
1	\$3625	\$1800	\$5425	350	\$15.50
2	\$330	\$1800	\$2130	350	\$6.09
3	\$142	\$1800	\$1942	350	\$5.55

Economic feasibility of microtubers

Ultimately, the economic feasibility of microtubers will be determined by growers themselves. Russet Burbank microtubers grown in 1993 produced yields that would have produced economical yields if they sold for \$0.25, and if the price for Russet Burbank certified seed potatoes was above \$6.50. The real question is how the yields, costs, and benefits would compare with plantlets and minitubers. More field trials are needed to compare the three propagules.

References

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