CIS/INTRAGENICS: A DIFFERENT KIND OF GENETIC MODIFICATION

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The J.R. Simplot Company, one of the world's largest frozen potato processors, has recently announced plans to apply for regulatory approval to grow "cisgenic" potatoes. These potatoes have been genetically modified – but the only DNA that has been added comes from other potatoes. Since these potatoes may soon be on the market, a review of cisgenic technology seems timely.

In an attempt to allay consumer concern about the presence of "foreign" DNA in GM potato, over the past ten years methods have been developed that allow potato to be engineered without introducing any non-potato DNA. In the past, transgenic potatoes generally contained several types of foreign DNA, including: 1) the payload gene 2) regulatory sequences to direct expression of the payload gene 3) an antibiotic resistance gene, which facilitated transformation, and 4) left and right "border elements" from *Agrobacterium*, required for introducing DNA into the potato genome. It is now possible to engineer potato by adding one or more potato genes, under the control of potato regulatory sequences, and to do so without the use of antibiotic resistance genes or border elements. To indicate that these plants contain no foreign DNA, they are sometimes called "cisgenic" or "intragenic" rather than "transgenic". The number of genes available to use as payload is accelerating rapidly, as more genes are characterized in potato, as well as many other species. Perhaps the most interesting potato gene is from a wild potato species (*Solanum bulbocastanum*) that confers resistance to late blight. Other potato genes of note include polyphenol oxidase (turning off this gene reduces blackspot bruise symptoms), asparagine synthetase (shutting down this gene reduces acrylamide levels in fries and chips), and starch-associated R1 and phosphorylase-L (down-regulating these genes reduces cold-induced sweetening).

On a more conventional note, descriptions of four of our most promising candidate varieties follow below. Comments on the performance of these clones or any previously released Cornell varieties, or on desired attributes of future varieties, are always welcome.

NY138 (Y18-16) = Marcy x NY115 (1998). Late maturity chipstock and tablestock. Large tubers, attractive shape, moderately textured skin.

- Tompkins County marketable yields over the past eight years have averaged 90% of Atlantic (21 trials).
- Yields in Steuben and Wyoming County trials averaged 103% of Atlantic in 2004, 114% in 2005, 102% in 2006, 103% in 2007, 107% in 2008, 90% in 2009, and 103% of Atlantic in 2010. Seven year average: 103%.
- Wayne County (muck soil) yield was 120% of Atlantic in 2006, 81% in 2007, and 118% of Atlantic in 2009.

- Riverhead yields were 84% of Norwis in 2004. Yields were 90% of Reba in 2005, 98% in 2006, 79% in 2007, 107% in 2008, 106% in 2009, and 116% of Reba in 2010.

- Yields in PA were 111% of Atlantic (3 trials) in 2005, 82% in 2006 (3 trials), 100% in 2007 (3 trials), 93% in 2008 (2 trials), and 87% of Atlantic in 2009 (3 trials).

A few pickouts due to growth cracks and misshapes. Large tubers have shown 5-10% hollow heart in most trials. Tuber size is similar to Atlantic. Specific gravity has averaged 0.010 less than Atlantic (36 trials). Moderate resistance to common scab. Chip color out of 44F has been very good to date: visual chip scores over the past six years averaged 3.3 compared to 3.8 for Snowden (lower is better). In eleven SFA trials Agtron scores for NY138 averaged 65, compared to 62 for Snowden. Tubers sometimes darken slightly after boiling. Less susceptible to blackspot bruise than Snowden, presumably because of lower specific gravity. Relatively long tuber dormancy; six weeks longer than Atlantic. Vines have a slow start but soon develop into a nice type. Pale purple flowers, some fruit at end of season. Some resistance to powdery scab has been observed in PA tests. Resistant to race Ro1 of the golden nematode. We have submitted an application for PVP.

NY139 (Y28-9) = NY120 x NY115 (1998). Late season chipstock.

- Marketable yields in Tompkins County over the past eight years have averaged 91% of Atlantic (20 trials).

- Yields in Steuben and Wyoming County trials averaged 96% of Atlantic in 2004, 99% in 2005, 102% in 2006, 104% in 2007, 93% in 2008, 96% in 2009, and 80% of Atlantic in 2010. Seven year average: 96%.

- Wayne County (muck soil) yield was 128% of Atlantic in 2006 and 104% in 2009.

- Riverhead, Long Island yield was 85% of Norwis in 2004. Yield was 106% of Reba in 2005, 88% in 2006, 79% in 2007, 109% in 2008, 103% in 2009, and 129% of Reba in 2010.

- In PA yield averaged 125% of Atlantic in 2004 (2 trials), 83% in 2006 (4 trials), 104% in 2007 (4 trials), 90% in 2008 (2 trials), and 87% of Atlantic in 2009 (3 trials).

A low frequency of pickouts due to misshapes and growth cracks. Very few standard internal defects have been observed. In Ithaca, but not yet elsewhere, we have observed small spots of translucent tissue inside NY139 tubers. Specific gravity has been very good, averaging 0.004 less than Atlantic (33 trials). Chip color out of 44F has been excellent, averaging 3.0 over the past six years, compared to 3.8 for Snowden (lower is better). In eleven SFA trials in 2008 and 2009, Agtron scores averaged 64 for NY139 compared to 62 for Snowden. Moderate resistance to common scab. Less susceptible to blackspot bruise than Snowden. Tubers darken slightly after boiling. Tuber dormancy is one week longer than Atlantic. Very nice light green vines, magenta flowers with white tips, sets many fruit. Resistant to race Ro1 of the golden nematode. We have submitted an application for PVP.

NY140 (Y36-4) = NY121 x NY115 (1998). Late season, dual purpose chip and tablestock. High yields of large tubers, lightly textured skin. Resistant to race Ro1 of the golden nematode and moderately resistant to race Ro2.

- Marketable yields in Tompkins County over the past eight years have averaged 114% of Atlantic (20 trials).

- Yields in Steuben and Wyoming County trials averaged 111% of Atlantic in 2006, 119% in 2007, 117% in 2008, 119% in 2009, and 102% of Atlantic in 2010. Five year average: 114%.

- Yield in Wayne County was 129% of Atlantic in 2008 and 123% of Atlantic in 2009.

- Yields on Long Island were 108% of Norwis in 2004. Yields were 103% of Reba in 2005, 116% in 2006, 91% in 2007, 105% in 2008, 128% in 2009, and 139% of Reba in 2010.

- In PA yields averaged 106% of Atlantic in 2005 (3 trials), 124% in 2007 (4 trials), 119% in 2008 (2 trials), and 104% of Atlantic in 2009 (3 trials).

- Yield in North Carolina averaged 117% of Atlantic in 2009 (3 trials) and 96% of Atlantic in 2010 (2 trials).

A low frequency of pickouts due to knobs, misshapes and growth cracks. Some internal defects, most commonly hollow heart and internal necrosis, have been observed. Tuber size is unmistakably large, averaging 6.5 ounces per tuber (16 trials). Even at 6 inch spacing, tuber size remains large (2009 and 2010 trials). Specific gravity has averaged 0.012 less than Atlantic (24 trials). This will limit the locations where it could be grown for chips. Chip quality has generally been very good: over the past six years it has averaged 3.9, comparable to Snowden, which averaged 3.8 in the same trials (lower is better). Susceptible to common scab, comparable to Katahdin. Tubers remain white after boiling, and do not slough significantly. Tuber dormancy is about six weeks longer than Atlantic. Nice vines, white flowers, few fruit. Exhibited moderate resistance to late blight as well as early blight in PA trials in 2007 - 2009. Good resistance to blackspot bruise. Resistant to race Ro1 and moderately resistant to race **Ro2** of the golden nematode.

NY141 (Y41-67) = R6-4 x NY115 (1998). Early to mid season tablestock, attractive tubers.

- Marketable yields in Tompkins County over the past eight years have averaged 99% of Atlantic (21 trials).

- Yield in Wayne County was 107% of Atlantic in 2008 and 106% in 2009.

- Yields on Long Island were 82% of Norwis in 2004. Yields were 95% of Reba in 2005, 100% in 2006, 81% in 2007, 111% in 2008, 110% in 2009, and 118% of Reba in 2010.

- Yield in PA in 2005 was 107% of Atlantic in 2005 (1 trial), 92% in 2007 (4 trials), 79% in 2008 (2 trials), and 94% of Atlantic in 2009 (3 trials).

Typically 2 to 3% of tubers have knobs. A low frequency of internal defects, mostly brown center, have also been observed. Has set an average of 6.7 tubers per foot, with an average weight of 6.3 ounces (11 trials). Early yield, assessed at the end of July in Ithaca, has been good: 112% of Superior in 2010, 110% of Atlantic in 2009, 101% of Superior in 2006, and 122% of Superior in 2005. Specific gravity has averaged 0.011 less than Atlantic (21 trials). Does not chip. Good resistance to common scab. Tubers remain white after boiling, and do not slough significantly. Tuber dormancy is about two weeks longer than Atlantic. Nice vines, white flowers, some fruit. Very good resistance to blackspot bruise. Resistant to race Ro1 of the golden nematode.