# **SPECIFIC GRAVITY**

Factors Influencing Specific Gravity in Prince Edward Island Potato Production

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# **Specific Gravity**

- Tuber specific gravity refers to relative weight of tuber compared with the weight of the same volume of water.
- One of the most widely accepted measures of potato internal quality, because of its close relationship to tuber starch content and total solids
- Tubers with low specific gravity require more time and oil for processing and tend to have darker fry color, whereas tubers with excessively high specific gravity are susceptible to increased bruising (Mosley and Chase 1993).

### **Specific Gravity**



# Measuring Specific Gravity using a hydrometer.

Photo copyright Ohio State University https://u.osu.edu/vegprolab/resources/potato-chipping/







### Gravity vs. 10 oz – Russet Burbank

- There are about a third of growers who are able to achieve decent bonus for both Specific Gravity and 10 oz.
- For remaining two-thirds, gravity and 10 oz fluctuate up and down, and appear to be somewhat antagonistic.
- The "downward trend" of 10 oz vs. specific gravity is not as great as thought, and is highly variable.







### Gravity vs. 10 oz – Prospect

- Again, about a quarter to a third of growers are able to achieve decent bonus for both Specific Gravity and 10 oz.
- For remaining growers, it has appeared to be much easier to get 10 oz than gravity. Different relationship than Russet Burbank.
- Growers with high gravity scores don't have lower average 10 oz scores.

#### Marketable Yield vs. Spec Grav – RB 2016



#### Marketable Yield vs Spec Grav - 2016 Prospect



### **Biological Reasons for Low Specific Gravity**

- Low specific gravity (or low total solids) is a symptom of the tuber not being able to mature and senesce at the plant's ideal rate.
- We know that some varieties naturally have higher specific gravities than others (ie. Ranger Russet)
- Some factors influencing specific gravity are within the control of the grower, while others are largely outside of their control. Manage what can be managed!

# **Factors Impacting Specific Gravity**

- Length of Growing Season
- Precipitation (Too Much/Too Little)
- Seed Quality and Planting Practices
- Pests and Diseases
- Top-killing/Tube Maturity at Harvest
- Fertility Program

### Length of Growing Season

- To properly mature and senesce naturally, a variety must have the ability to complete its life cycle, the length of which varies by variety.
- Seed planted earlier, with more days of plant growth under increasing day length, is more likely to have higher specific gravity than seed planted late and forced to mature later into the fall.
- Early frosts can have a significant impact on gravity scores.

### Water Effects

- Too much precipitation, particularly before harvest, can result in tubers becoming water-logged. Not only are these tubers at a higher risk of bacterial/fungal infection, they also generally have lower specific gravity.
- Potatoes under drought-stress during the growing season face limits to photosynthesis, decreasing production of starch. Lack of rainfall is of course a factor, but so are factors that reduce the water holding capacity of soil:
  - Low Soil Organic Matter
  - Soil Compaction
  - Aggregate Stability

### **Seed Quality and Planting Practices**

- Small average seed size can impact the ability of the plant to quickly establish and develop, impacting specific gravity.
- Seed planted too close together or too far apart can have a detrimental impact on specific gravity. Important to know the physiological age of seed and recommended plant populations for the variety to optimize both yield and gravity.

### **Pests and Diseases**

- **Defoliating insects** (ie. Colorado potato beetle) reduce the leaf area of the plant, limiting ability to photosynthesize.
- Early Dying Complex (Verticillium/root lesion nematodes) often causes premature senescence of potato plants, cutting short their natural life cycle and reducing gravity scores.



### **Top-Killing / Maturity at Harvest**

- A number of studies over the years indicate that label rates of chemical vine dessication (Reglone/diquat) is associated with lower specific gravity scores.
- If plants die down too fast, they are unable to efficiently move sugars into the tubers and convert to starch.
- As well, water taken up by the plant's root system following dessication moves to the tubers, reducing dry matter percentage.

### **Top-Killing / Maturity at Harvest**

- Many Island growers now limit use of Reglone only when needed to ensure that tubers come off vines during harvest.
- Many growers using lower rates (0.25-0.35L/acre) to jump start senescence but not die down too quickly.

### **Top-Killing / Maturity at Harvest**

CROPS	RATE (L/ha)	APPLICATION METHOD	APPLICATION VOLUME (L/ha)		NOTES	
Potato - Vine Killing	3.5 1.4 L/ac	Ground	550-1100	Top growth heavy or weedy field	DO NOT apply to drought stressed potatoes (see additional notes on Potato	
	1.7-2.3 0.7 – 0.9 L/ac	1.7-2.3 Ground 550-1100 Top growth light, little weed growth or top growth heavy and in early stage of maturity   1.25-2.3 Ground 550-1100 Top growth light, little weed growth or top growth heavy and in early stage of maturity	Top growth light, little weed growth or top growth heavy and in early stage of maturity	Vine Killing). Use of AGRAL 90 or LI 700 is not recommended for this crop, except as noted.		
	1.25-2.3 0 plus 1.25 0.5 – 0.9 plus 0.5	Ground	550-1100	Top growth heavy <u>or</u> top growth light and weedy field (for Eastern	Second application 4-6 days after first application at normal top killing time.	
1.7-2.3 plus 1.25Aerial1.25Ground0.5 L/acImage: Control of the second se	Aerial	at least 45	All top growth conditions. No geographic limitation.	application on denser or immature vines. A fungicide may be added.		
	1.25 0.5 L/ac	Ground	550-1100 (add 1 L AGRAL 90 /1000 L or 2.5 L LI 700/ 1000 L in the prairie provinces)	Top growth fully mature, little or no weeds	1.25 L rate may require more than 10-14 days to give a complete kill. Do not use 1.25 L rate in BC.	

### Nitrogen

- Rates of N higher than required by the plant can lead to excessive vegetative growth. This extends the life cycle of the plant, delays natural senescence, and can lead to lower specific gravities.
- Only apply the amount of N required for your target yield, and consider split application of N or use of slow release N products.



Source:

Laboski and Kelling, Amer Journal of Potato Research 2007

#### FIGURE 1.

Effect of nitrogen fertilizer rate on specific gravity of two potato varieties (adapted from Belanger et al. 2002; average of 12 site-years).



#### Source: Nitrogen Fertility Requirements for Commonly Grown

Potato Varieties in Saskatchewan

### Phosphorus

- According to Laboski and Kelling, it appears that if soil test phosphorus (P) levels are low or very low, the addition of fertilizer P will usually increase tuber specific gravity.
- However, where soil test P levels were high or very high (such as the case in most PEI soils), additional P had relatively little impact on specific gravity.

### Potassium (K)

- Research trials both in PEI and elsewhere in North America have shown that excessive rates of muriate of potash (MOP or KCI) banded at planting can have a negative effect on specific gravity.
- Laboski and Kelling, 2007 say "this is mostly likely due to the osmotic effects of the increased tissue salt concentrations present with potassium chloride (KCI)."

### Potassium (K)

- Replacing KCI with K<sub>2</sub>SO<sub>4</sub> or K-Mag in the planter blend has been shown by a number of growers to have a beneficial effect on specific gravity.
- KCI should ideally be applied either in the fall before potatoes or as a pre-plant fertilizer application, to allow the chlorine to leach out and reduce the salt effect.

# Main Effect of Potassium Rate and Source on Tuber Specific Gravity at Three Wisconsin locations

	Rate or Source*		
	Hancock - 4 yr	Antigo - 4 yr — Specific Gravity —	Spooner - 3 yr
ксі	1.082	1.089	1.085

Rate	0.0003	<0.0001	<0.0001
Source	0.0008	<0.0001	0.0011

\*All rates and sources were evaluated at each site in each year (adapted from Panique et al. 1997).

#### Fig: Effect of 4R candidate BMP fertilizer program on tuber specific gravity in Russet Burbank potatoes – PEI Farming 4R Island Demonstration Trials 2013-2017



gravity

nutrient stewardship Average GSP 1.084 Average 4R 1.087

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Comparing 2016 data on farms where KCI has removed completely or in large part from the planter blend versus farms with primarily KCI in the planter

### **Black Pond Farms**

- Major factor influencing gravity scores for our farm is allowing the plants to mature and senesce as naturally as possible. This involved reducing the amount of Reglone used for vine killing.
- 2014 field trial. 3 split fields. Russet Burbank Not a great year for specific gravities.

# Reglone Apps	Field 1	Field 2	Field 3
1x (0.45 L/ac)	1.086	1.088	1.086
2x (0.45 L/ac each)	1.083	1.084	1.083

### **Black Pond Farms**

- Major Changes in Practice Resulting in Higher Gravities:
  - Limiting top-killing to one spray only
  - Reduction in the amount of banded Nitrogen
  - Fall application of 50% of total K needs for coming year
- Other changes having some effect:
  - Increasing crop available Mg
  - Limiting amount of MOP in planter blend

# R & L Farms

- In last few years, our farm has struggled with below average specific gravity.
- For 2017 growing season, we looked at making changes to our fertility program to try and improve specific gravity.
- In 2017, reduced K in planter blend by 40 lbs/ac and replaced about half of MOP (KCI) with K-Mag
- Also replaced AN primarily with Ammonium Sulfate

### R & L Farms

Variety	2015	2016	2017
Russet Burbank	1.084	1.082	1.090
Ranger Russet	1.087	1.087	1.091
Shepody	1.080	1.082	1.086
Prospect	1.076	1.081	1.089

### Summary

- There are many factors that impact specific gravity scores. Mother Nature has a large impact on gravity, but so do a number of management choices within the control of the grower.
- Above all, make choices that allow the crop to senesce as naturally as possible to maximize both yield and specific gravity.

## Summary

- Factors affecting natural maturity & senescence:
  - Early Planting
  - ✓ Avoiding excess N rates
  - Water holding capacity of soil (soil OM, compaction)
  - Limit use of Reglone



- Limit use of KCI (MOP) in the planter blend.
  - Apply KCI in the fall before or early spring before planting to reduce salt impact.
  - Replace KCI in the planter all or in part with K<sub>2</sub>SO<sub>4</sub> (SOP) or K-Mag

# **Thank You!**

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