UNIVERSITY OF SASKATCHEWAN

VEGETABLE CULTIVAR AND CULTURAL TRIALS 2009

PREPARED BY:
D. WATERER
D. ROY
P. SZAROZ

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Department of Plant Sciences
University of Saskatchewan, 51 Campus Drive
Saskatoon, Saskatchewan, Canada, S7N 5A8
Telephone: (306) 966-5855 Fax: (306) 966-5015
E-mail: doug.waterer@usask.ca paul.szaroz@usask.ca
Website: http://www.usask.ca/agriculture/plantsci/vegetable

Saskatchwan Agriculture and Food

Potential to use Plant Growth Regulators to Enhance the Appearance of Red-Skinned Potatoes

A uniform dark red skin color is highly desirable in table potatoes, however the color of the most popular red-skinned cultivar (cv Norland) is highly variable and also tends to fade during storage. At this time there are no methods that will reliably enhance the skin color of Norland potatoes - and as a consequence growers frequently receive less-than-otimum prices for their crop. Growers opting to grow cultivars with superior skin color (ie; Peregrine) have encountered problems with scab - and this has resulted in a similar devaluation of their crops.

Preliminary work conducted by the U of S and others suggests that the skin colour of red potatoes might be improved by applying non-toxic dosages of the herbicide 2,4-D or the naturally occuring hormone abscisic acid at key stages in crop development. 2,4-D is licensed for use in the United States to enhance the skin color of potatoes. Licensing of 2,4-D in Canada for a similar purpose is being considered by PMRA.

In trials conducted by the University of Saskatchewan in 2007 and 2008 a significant degree of enhancement of skin colour of Peregrine and Norland potatoes was achieved through the timely application of 2,4-D, while the ABA had limited efficacy. The enhancement of skin colour by the 2,4-D treatments was achieved without compromising yields or any aspect of crop quality.

2009 Trial – the methods used and treatments applied in this trial were built on previous trials. Two sites were employed in 2009 - the Main field and the Scab field. The Scab field is highly infested with both common scab (*Streptomyces scabies*) as well as powdery scab (*Spongospora subterranean*). The cultivars tested in 2009 were the red-skinned cultivars Norland and Peregrine. Both sites were again managed utilizing standard potato production practices. The trial was planted in mid-May using cut certified seed, with the seed pieces spaced 20 cm apart in the row, with 1 m between rows. The trial used a split plot design (spray treatments as main plots and cultivars as sub-plots), with the treatments laid out in a randomized complete block design (N=4). Each treatment row was 8 m long. An overhead irrigation system was employed whenever soil moisture potentials dropped below –50kPa.

The timing of application of the growth regulators, as well as the rates applied was based on previous research, as well as label recommendations for the 2,4-D. The first application was made as the flower buds were just beginning to form. This coincides with the tubers just beginning to form. The second application occurred 10 days later, at which time both cultivars were in full flower. The PGR's were applied prior to 10 a.m. utilizing a CO_2 powered small plot sprayer equipped with a 80-02 flat fan nozzle. The sprays were applied in the equivalent of 80L water/a which allowed for thorough coverage of the leaves. Conditions were calm and sunny on both spray dates. The crop was not watered for at least 3 days after application of the PGR's and there were no rain events within 24 h of treatment.

The spray treatments tested in 2009 were ;

1) 2,4-D as a LV ester – applied at the rate of 2.5 fl.oz/a. This represents the standard recommended rate for 2,4-D. This rate of 2,4-D provided some improvement in tuber color in previous trials.
2) 2,4-D as LV ester at 5 fl.oz/a. This heavier dosage was used to determine if the color enhancement provided by 2,4-D was dosage dependant. It was also used to explore the impact of heavier dosages of 2,4-D on crop growth, yields and tuber configuration.
3) ABA – PBI 365 applied at 10^{-4} M concentration. This rate of PBI 365 had caused some improvement in tuber color in the 2007 trial.

4) ABA - PBI 429 applied at 10^{-4} M. PBI 429 has even more potent and long lasting ABA effects than PBI 365.
The PBI 365 and PBI 429 were provided by Dr. Sue Abrams of PBI/NRC, Saskatoon, SK.
5) Control – sprayed with water alone.

Crop health status was monitored both prior to and after the spray events. In late August the plots were desiccated using Reglone (diquat) and then flailed 10 days later. The plots were machine harvested and then held in a darkened 15°C storage. The crop was weighed and graded within 3 weeks of harvest. After six weeks of cold storage (8°C), 25 potatoes randomly chosen from each treatment were washed and their skin color was evaluated visually and using a Hunter Lab colorimeter. The visual assessment involved having trained staff ranking the samples (darkest to lightest) for relative degree of red colour. The colorimeter was used to measure **L**, **a**, **b** and **hue** and **choma** values for each tuber.

The impact of the PGR treatments on potato health was evaluated by visually examining 25 randomly selected tubers from all treatment replicates grown in the scab field. The tubers were evaluated for incidence and severity of the skin lesions caused by common or powdery scab. Data collected were: a) the % of the tubers examined that had significant levels of each disease, b) the proportion of the tubers that would have been rendered unmarketable due to excessive levels of the disease in question.

Results

2009 Growing Season - temperatures in 2009 were well below normal from May through August and well above normal during harvest in September. The crop in the main field was slow to establish and lacked vigor especially early in the growing season. This likely reflects the extremely dry conditions that persisted through late June at this site. The crop in the scab field appeared more vigorous.

As in previous years, the effects of the 2,4-D treatments were obvious within 3 days of application – the upper leaves became twisted and cupped while the petioles tended to grow more quickly than normal giving the crop a "leggy, spindly appearance". These symptoms persisted for at least 2 weeks after treatment. As in previous trials there was no apparent relationship between the dosage of 2,4-D applied and the severity or duration of the symptoms described. Neither of the ABA treatments had any obvious impact of growth or appearance of the crop.

Yields – in the Main Field, the various spray treatments had no significant impact on yields of Norland (Table 2009-1). Both the ABA treatments increased Peregrine yields relative to the control. In the Scab Field, the high rate of 2,4-D reduced yields of all three cultivars relative to the controls (Table 2009-2). The ABA treatments had no consistent impact on yields in the scab field.

Tuber colour - In the 2009 trial the responses of the two red skinned cultivars to the PGR treatments were quite comparable. In Norland and to a lesser extent Peregrine, treatment with 2,4-D decreased the **L** values – indicating that the skins were darker than the controls (Table 2009-1). The same effect of 2,4-D on **L** values was observed in both the 2007 and 2008 trial. The impact of the various PGR treatments on the **a** values in 2009 differed for the two red-skinned cultivars. In Norland, the highest **a** value was seen with the high rate of 2,4-D, while the lowest **a** value was seen when the low concentration of 2,4-D was applied. In Peregrine, both rates of 2,4-D reduced the **a** values relative to the controls. As a higher **a** value indicates a

"redder" colour this result runs contrary to overall expectations, but corresponds with the findings from previous years. By contrast, the **b** values of both cultivars were consistently reduced by the 2,4-D treatments – indicating that the 2,4-D treatments were increasing the relative amount of blue in the skin colour. A similar response to the 2,4-D treatments was seen in both the 2007 and 2008 trials. The **hue angle** represents the balance between red/green and blue/yellow. A low hue angle represents a preponderance of red and blue tones in the skin color, with this mixture appearing purple. In Norland, the treatments receiving 2,4-D had a lower **hue angle** (more purple color) than the controls, but this effect was not seen in the darker skinned Peregrines. A similar effect of the 2,4-D on **hue angle** of Norland was seen in 2007 and 2008. As was seen in 2008, neither of the ABA analogue treatments any consistent impact on skin color of either Norland or Peregrine.

Table 2009-1. Influence of plant growth regulators on yields and skin colour attributes of Norland and Peregrine potatoes in the Main Field in 2009

	Yield	**L-value**	**a-value**	**B-value**	**Hue angle**	**Chroma**
				F-Values		
Cultivar (C)	**	***	***	***	***	***
PGR (T)	*	**	*	**	*	**
C*T	*	**	*	0.46	*	**
			Peregrine			
				F-Values		
PGR	*	*	**	*	0.27	*
	(T/ha)					
Control	46.0 c	35.8 ab	15.2 a	6.9 a	0.42	16.7 ab
2,4 D (2.5 oz/a)	48.5 bc	35.5 ab	14.5 b	6.3 b	0.41	15.9 b
2,4D (5 oz/a)	49.8 bc	34.8 b	14.7 b	6.3 b	0.40	16.0 b
PBI 365	56.4 a	35.5 ab	15.6 a	7.4 a	0.44	17.3 a
PBI 429	52.8 ab	36.8 a	15.3 a	7.1 a	0.44	16.9 a
Avg	**50.7**	**35.7**	**15.1**	**6.8**	**0.42**	**16.6**
			Norland			
PGR	0.34	***	*	**	*	*
	(T/ha)					
Control	53.3	39.7 a	14.1 b	8.8 a	0.56 a	16.7 a
2,4-D (2.5 oz/a)	55.9	36.3 c	13.7 b	6.5 b	0.44 b	15.2 b
2,4-D (5 oz/a)	52.9	37.2 b	15.0 a	6.7 b	0.42 b	16.4 a
PBI 365	50.0	39.2 a	14.1 b	8.1 a	0.52 a	16.3 a
PBI 429	54.0	39.4 a	14.5 ab	8.5 a	0.53 a	16.8 a
Avg	**53.2**	**38.4**	**14.3**	**7.7**	**0.49**	**16.3**

Values within columns followed by the same letter are not significantly different at *P*=0.05.
*, **,*** Indicate significant at P = 0.05, 0.01 and 0.001, respectively.

Table 2009-2. Influence of plant growth regulators on yields and scab ratings (common and powdery) of Norland and Peregrine potatoes in the Scab Field in 2009.

	Yield	Common (%)	Common Severity [y]	Powdery (%)	Powdery Severity
Cultivar (C)	*	*	**	*	*
PGR (T)	*	*	**	0.54	*
C*T	0.74	*	**	0.23	*
			Peregrine		
PGR	*	0.66	**	0.09	*
	(T/ha)	**%**	**Severity**	**%**	**Severity**
Control	45.7cd	96	38b	98	60a
2,4-D (2.5 oz/a)	51.2ab	83	20c	94	61a
2,4-D (5 oz/a)	42.5d	93	22c	95	64a
PBI 365	54.0a	99	59a	95	64a
PBI 429	48.6bc	98	65a	79	37b
Avg	**48.4**	**94**	**41**	**93**	**57**
			Norland		
PGR	**	*	**	0.42	**
	(T/ha)	**%**	**Severity**	**%**	**Severity**
Control	42.7a	60b	11a	88	50b
2,4-D (2.5 oz/a)	45.8a	46b	0b	96	74a
2,4-D (5 oz/a)	37.4b	19c	0b	93	79a
PBI 365	42.9a	63ab	0a	93	49b
PBI 429	43.9a	81a	8a	95	54b
Avg	**42.4**	**54**	**5**	**93**	**61**

Values within columns followed by the same letter are not significantly different at P=0.05.

[z] Ranking of 1 = lightest, ranking of 5 = darkest.

[y] Severity rating represent what % of the tubers would be graded out due to excess levels of the disease

*, **,*** Indicate significant at P = 0.05, 0.01 and 0.001, respectively.

As expected, the incidence and severity of both common and powdery scab were quite high in the Scab Field. The overall incidence and severity of common scab was more intense in Peregrine than in Norland. **Both rates of 2,4-D significantly reduced grade out of Norland to excess common scab relative to the controls. A similar effect of the 2,4-D reducing grade out to common scab was seen in Peregrine. This effect of 2,4-D treatment reducing common scab levels in red skinned potato cultivars corresponds with the results seen in previous trials.** The degree of mitigation of the common scab was again not related to the rate of 2,4-D applied. Both ABA analog treatments increased grade out of Peregrine to excess scab.

The overall incidence and severity of powdery scab was similar in Peregrine and Norland. In Norland, while treatment with 2,4-D appeared to reduce problems with common scab in the 2009 trial, **both levels of 2,4-D increased grade out due to powdery scab.** This corresponds to the effects of 2,4-D on powdery scab seen in Peregrine in 2008. In Peregrine in 2009, the 2,4-D treatments had no impact on powdery scab.

Summary

Field trials conducted from 2007-2009 suggest that foliar applications of 2,4-D at label recommended dosages can enhance the colour of the cultivars of red-skinned potatoes commonly grown in Saskatchewan with minimal risk of negative impact on crop vigor, yields or tuber quality. The nature and extent of colour change achieved by applying the 2,4-D was influenced by growing conditions and the cultivar being treated. There were also indications that the 2,4-D treatments protected the tubers from common scab, but tended to increase levels of tuber damage by powdery scab. From a grower's perspective the type of scab causing a tuber to be culled is of limited initial importance. If however the 2,4-D treatments are actually causing a shift in scab population or pathogenicity this could have significant ramifications in terms of longterm crop management. While common scab is already widespread across Saskatchewan, powdery scab is more localized. Adoption of 2,4-D treatments may have no net effect on grade out to scab at sites where both types of scab are already endemic, but they should reduce losses at the sites where only common scab is found. Similarly, dryland growers may see greater benefit from the apparent disease control provided by the 2,4-D treatments, as dryland conditions tend to favour common scab rather than powdery. Conversely, irrigated growers interested in improving crop color should be careful as the 2,4-D treatments seem to have the potential to exacerbate the issues with powdery scab that already tend to be more prevalent at wetter sites.

Neither 2,4-D or ABA are presently registered for use on potatoes in Western Canada

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