Do Potatoes Respond to Nitrogen and Phosphorus Placement?

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ABSTRACT

Potato requires large amounts of fertilizer. Proper fertility management is essential to optimize potato yield and quality under the relatively cool and short growing conditions in Saskatchewan. Important aspects of fertility management include rate, placement, and timing of fertilizer. This study examined the effects of placement (broadcast, side-band) of nitrogen and phosphorus fertilizer on productivity for contrasting potato cultivars (Atlantic, Norland, Ranger Russet, Russet Burbank, Russet Norkotah, Shepody) grown under dryland and irrigated conditions. Three pre-plant nitrogen rates (50, 100, 150 kg N/ha) and three pre-plant phosphorus rates (40, 80, 120 kg P_2O_5/ha) were tested in separate trials.

In the nitrogen study under dryland, the average 'seed' and 'consumption' grade yields were 25 and 19 t/ha respectively. Under irrigation, 'seed' and 'consumption' grade yields averaged 40 t/ha. Nitrogen application method or rate had no effect on 'seed' or 'consumption' grade yields under both dryland and irrigated production.

In the phosphorus study, the average dryland yields for 'seed' and 'consumption' grade tubers were 24 and 19 t/ha respectively. Under irrigation, 'seed' and 'consumption' grade yields averaged 38 and 34 t/ha respectively. Under irrigation, the rate and method of phosphorus application had no effect on tuber yields. Under dryland, there was no significant effect of rate of phosphorus on tuber yield. Side-banding tended to produce higher 'seed' and 'consumption' grade yields than broadcast application.

Cultivars responded differently under dryland and irrigated production. The various cultivars responded similarly to rates and methods of nitrogen and phosphorus application under both production conditions. Further work is necessary to verify the effects of rate and method of nitrogen and phosphorus application on yield and quality of potato cultivars grown commercially under dryland and under irrigation in Saskatchewan.

INTRODUCTION

The concept of Northern Vigour™ and high quality disease-free seed potato produced in the cooler northern Saskatchewan environments has significantly increased the demand for Saskatchewan seed potato from domestic (Alberta, Manitoba, Prince Edward Island) and export (Pacific North Western USA and Mexico) markets. Smaller amounts of seed potato have also been shipped to several offshore destinations.

The processing potato industry is growing very rapidly in Western Canada. Recent expansion of processing plants in Alberta and Manitoba has increased demand for high quality processing potato. Potato processors are now insisting on irrigated production to ensure consistency of supply and to maintain superior processing quality. Saskatchewan has the potential to significantly expand irrigated production at relatively low cost as Saskatchewan is one of the lowest cost potato producers in North America due to (i) lower land cost (ii) minimal disease pressure under less humid environmental conditions. Approximately 29,500 ha of irrigated land presently available for potato production and 64,500 ha awaiting development. Research has shown that high quality processing potatoes can be grown in Saskatchewan. The potato industry in the province is well positioned to expand and diversify into processing potatoes to supply expanding regional and distant markets.

Efficient agronomic practices and careful management of production inputs including fertilizers are essential to economically produce high quality 'seed' or 'processing' potatoes. Potato requires a large amount of nutrients and the requirements change with its growth stage. Under Saskatchewan growing conditions, fertility practices should be carefully managed to ensure superior yield and quality. Both excess and shortage of nutrients can adversely affect yield and quality. This is particularly important for processing potato.

Pre-plant fertilizers can be applied to potato using different methods including broadcasting and side-banding. Side-banding of fertilizer is considered superior to broadcasting because of the efficiency of fertilizer use.

The present study was designed to examine the effects of rate and placement of nitrogen and phosphorus fertilizers on productivity of 'French fry', 'chipping', and 'fresh market' potato cultivars grown under irrigated and dryland growing conditions.

METHODOLOGY:

Two field trials were conducted at the Canada-Saskatchewan Irrigation Diversification Centre during the summer of 2002 to examine the effects of rate and placement of nitrogen and phosphorus fertilizers on 'seed' and 'consumption' grade yields for cultivars Atlantic, Russet Burbank, Russet Norkotah, Dark Red Norland, Ranger Russet, and Shepody. Nitrogen and phosphorus fertilizers were applied at rates of 50, 75, and 150 kg N/ha, and 40, 80, and 120 kg P_2O_5/ha respectively. Fertilizers were side-banded or broadcast applied at planting. For the nitrogen study, a uniform application of 120 kg P_2O_5/ha and 100 kg K_2O/ha were given at planting. For the phosphorus study, a uniform application of 100 kg N/ha and 100 kg K_2O/ha were given at planting. One hundred kg N/ha was applied at second hilling for both trials. The fertilizer sources included 46-0-0 for nitrogen, 12-51-0 for phosphorus, and 0-0-60 for

potassium. Field plots were laid out as split-split-plot design (Main-plot = Fertilizer placement, Sub-plot = Fertilizer rate, Sub-sub-plot = Cultivar) with four replications.

The crop was raised under irrigation using standard management practices with treatments applied appropriately as required by the different tests. The crop received 145 mm of rain during the growing season. For the irrigated crop, 365 mm of supplemental irrigation was applied to maintain soil moisture status above approximately 60% Field Capacity. The crop was harvested after top-killing by flailing followed by desiccation using Reglone. Harvested tubers were graded according to Canadian Seed Standards based on tuber diameter for different shaped tubers.

Size grades:

Oblong tubers: Grade A- 45 mm - 70 mm; Grade B- 30 mm - 45 mm

Round tubers: Grade A- 50 mm - 80 mm; Grade B- 30 mm - 50 mm

The 'consumption' category included tubers larger than 45 mm (1.75 in) diameter.

RESULTS:

Spring soil analysis indicated at the test site indicated soil nutrient levels at 40 kg N/ha, 14 kg P_2O_5/ha, and 582 kg K_2O/ha at 0 cm to 30 cm soil depth.

Irrigated potato produced higher yields than dryland potato in both nitrogen and phosphorus studies. In the nitrogen study, irrigated potato on average produced 62% higher 'seed' grade yield and over two-fold 'consumption' grade yields than dryland production (Table 1). In the phosphorus study, the irrigated crop produced 60% higher 'seed' grade yield and 81% higher 'consumption' grade yield relative to dryland production (Table 2).

Under dryland, Dark Red Norland and Shepody produced the highest and the lowest 'seed' grade yields in both studies (Table 1, Table 2). Under irrigation, Shepody and Dark Red Norland produced higher 'seed' grade yields in both tests, whereas, Ranger Russet was the lowest yielder in the nitrogen test and Atlantic in the phosphorus test. Russet Norkotah and Russet Burbank produced the highest and the lowest 'consumption' grade yields respectively under both irrigated and dryland production in the nitrogen test and under irrigated production in the phosphorus test (Table 1, Table 2).

Nitrogen rates and methods of application had no effect on 'seed' and 'consumption' grade yields (Table 1). This indicates that there was no benefit to side-banding nitrogen fertilizer compared to broadcast application. The lack of first and second order interactions (Table 1) indicate that all cultivars respond similarly to nitrogen rates and methods of application.

Under irrigation, the rate and method of phosphorus application had no effect on 'seed' and 'consumption' grade yields (Table 2). Under dryland, side-banding tended to produce slightly higher 'seed' and 'consumption' grade yields than broadcast application (Table 2). Significant phosphorus application method x phosphorus rate was observed for 'seed' and 'consumption' grade tuber yields under dryland production (Table 2). It was found that side-banding produced higher 'seed' and 'consumption' grade yields at 40 and 120 kg P_2O_5/ha

phosphorus application (Figure 1). By contrast at 80 kg P_2O_5/ha, side-banding produced lower yields than broadcasting. The reason for this phenomenon is not clear at present. Further work is needed to substantiate this observation.

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Table 1. Nitrogen placement and rate effects on 'seed' and 'consumption' grade yield for potato cultivars grown under irrigation and dryland				
	'Seed' grade yield (t/ha)		Consumption' grade yield (t/ha)	
Treatment	Irrigation	Dryland	Irrigation	Dryland
Nitrogen ap. Method:				
Broadcast	40.0	24.4	40.3	19.2
Side-band	40.2	25.1	40.3	19.5
Nitrogen rate (kg N/ha):				
50	40.0	25.0	39.7	20.0
75	41.3	24.9	41.1	18.9
100	39.0	24.3	40.0	19.1
Cultivar:				
Atlantic	39.2	24.4	44.5	21.1
Russet Burbank	40.9	25.5	35.8	16.5
Russet Norkotah	39.7	25.8	45.8	23.0
Dark Red Norland	41.1	28.1	38.3	21.2
Ranger Russet	38.1	23.1	41.3	17.1
Shepody	41.6	21.6	36.0	16.9
Analyses of Variance				
Source:				
Nitrogen ap. method (A)	ns	ns	ns	ns
Nitrogen rate (R)	ns	ns	ns	ns
Cultivar (C)	***(2.1)	***(2.3)	***(2.2)	***(2.3)
A x R	ns	ns	ns	ns
A x C	ns	ns	ns	ns
R x C	ns	ns	ns	ns
A x R x C	ns	ns	ns	
C.V. (%)	9.2	16.5	9.5	21.0
*** and ns indicate significance at P<0.001 level of probability and not significant respectively. Values within parentheses are LSD estimates at 5.0% significance.				

Table 2. Phosphorus placement and rate effects on 'seed' and 'consumption' grade yield for potato cultivars grown under irrigation and dryland

Treatment	'Seed' grade yield (t/ha)		Consumption' grade yield (t/ha)	
	Irrigation	Dryland	Irrigation	Dryland
Phosphorus ap. Method:				
Broadcast	38.7	22.9	34.4	17.9
Side-band	37.7	24.9	33.2	19.4
Phosphorus rate (kg P_2O_5/ha):				
40	38.4	24.0	33.6	18.9
80	.8.5	24.2	34.0	19.3
120	37.8	23.5	33.9	17.8
Cultivar:				
Atlantic	35.8	24.4	36.3	21.9
Russet Burbank	38.6	24.9	28.4	17.2
Russet Norkotah	37.0	23.1	38.7	21.1
Dark Red Norland	41.1	25.8	34.3	18.0
Ranger Russet	36.6	23.8	31.5	18.1
Shepody	40.1	21.5	33.8	15.6
Source:				
Phosphorus ap. method (A)	ns	ns	ns	ns
Phosphorus rate (R)	ns	ns	ns	ns
Cultivar (C)	***(2.2)	***(1.8)	***(2.1)	***(1.8)
A x R	ns	*(5.8)	ns	*(6.9)
A x C	ns	ns	ns	ns
R x C	ns	ns	ns	ns
A x R x C	ns	ns	ns	ns
C.V. (%)	9.8	12.8	11.0	16.8

*, *** and ns indicate significance at P<0.05, 0.001 levels of probability and not significant respectively. Values within parentheses are LSD estimates at 5.0% significance.

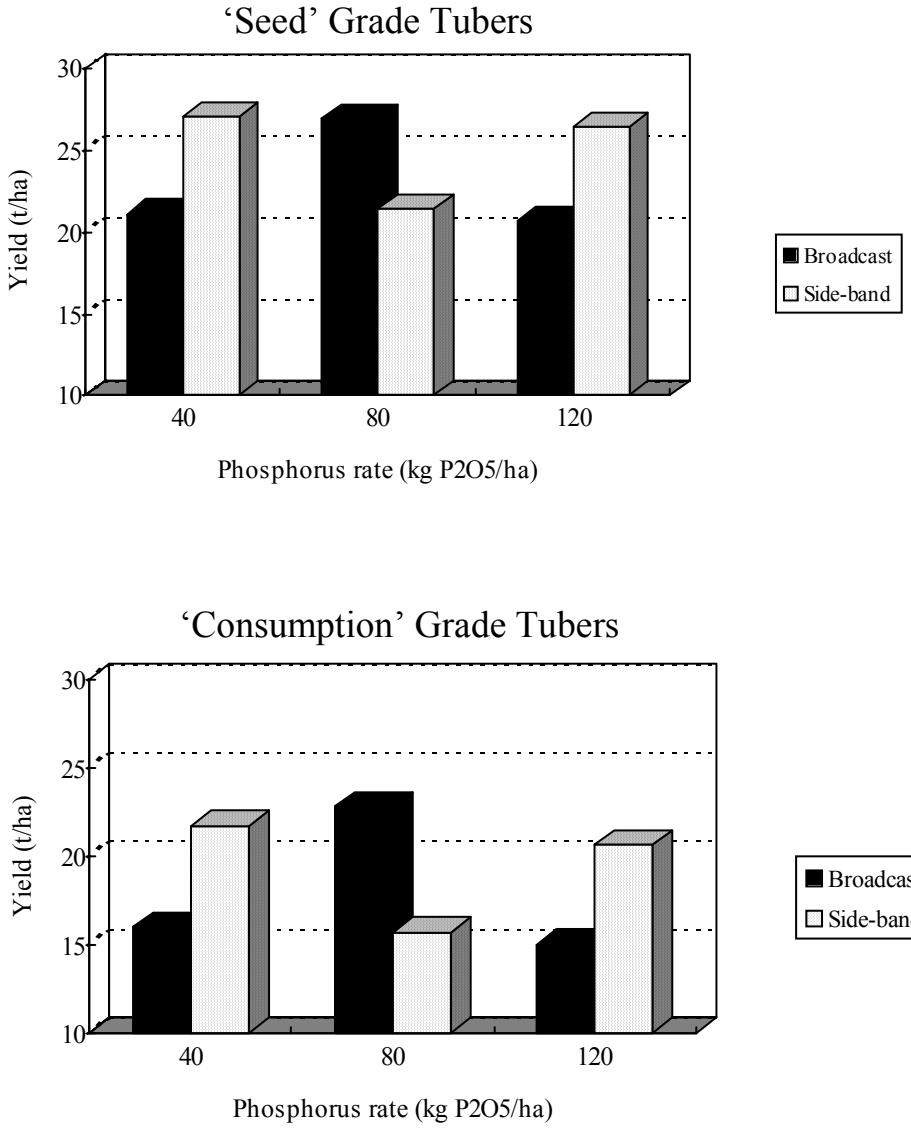

Figure 1. Phosphorus rate and placement interaction on 'seed' and 'consumption' grade yields for potatoes grown under dryland.