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Economic response of processing potato to nitrogen fertilizer rate as affected by nitrogen timing and soil moisture

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Canada ranks among the top 20 potato-producing countries globally. Manitoba accounts for 18% of Canada's total production, making this province second only to PEI in potato production. Despite this, little information is available in the published literature regarding optimum N management practices for this region. Many factors may influence crop responses to fertilizer nitrogen (N) application including the timing of fertilizer N application and soil moisture conditions.

Two 3-year field trials were conducted on processing potato (cv. Russet Burbank) in Manitoba in order to:

- Assess the effect of timing of N application under irrigated conditions, and to assess the effect of irrigated versus rainfed production on the response of processing potato yield and profitability to increasing fertilizer N rate.
- Determine the optimal economic N rate associated with each of the best management practices identified.

Materials and Methods

In Study 1, a factorial combination of N rate and timing of N application (pre-plant, split application) arranged in a randomized complete block design was applied to irrigated potato at 3 sites (Table 1). In Study 2, a factorial combination of N rate and moisture regime (irrigated, rainfed) was arranged in a split plot design (Table 1) at 3 sites. Marketable yield and net revenue (NR, ie. total revenue minus total costs) were determined, and crop responses assessed using ANOVA and regression analysis.

Fig. 1. Effect of split application on yield and net revenue responses to fertilizer N rate

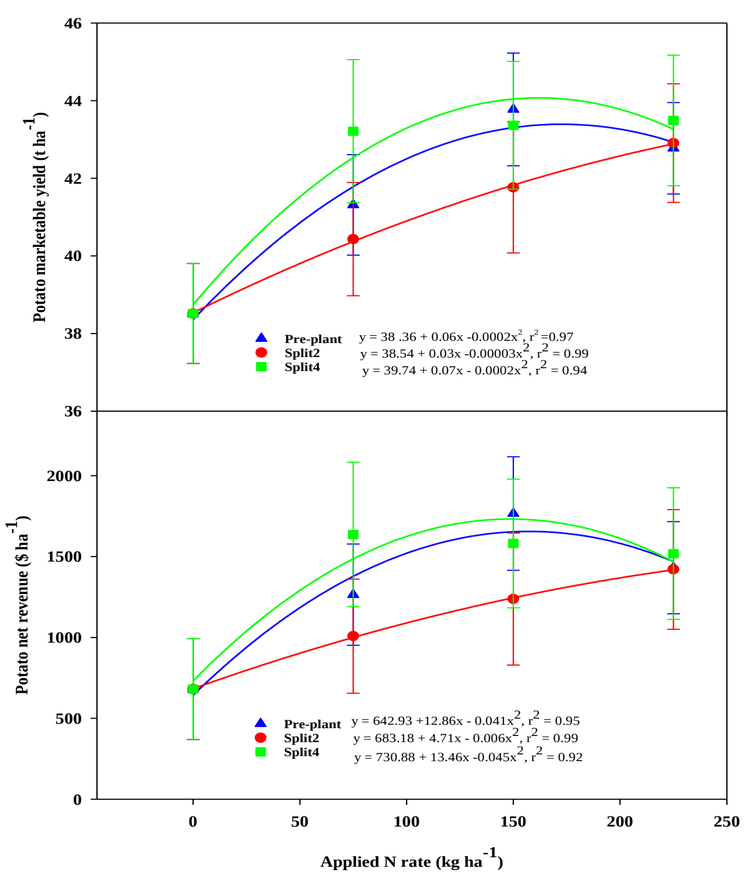

Fig. 2. Effect of fertilizer N rate on yield and net revenue under irrigated and rainfed conditions

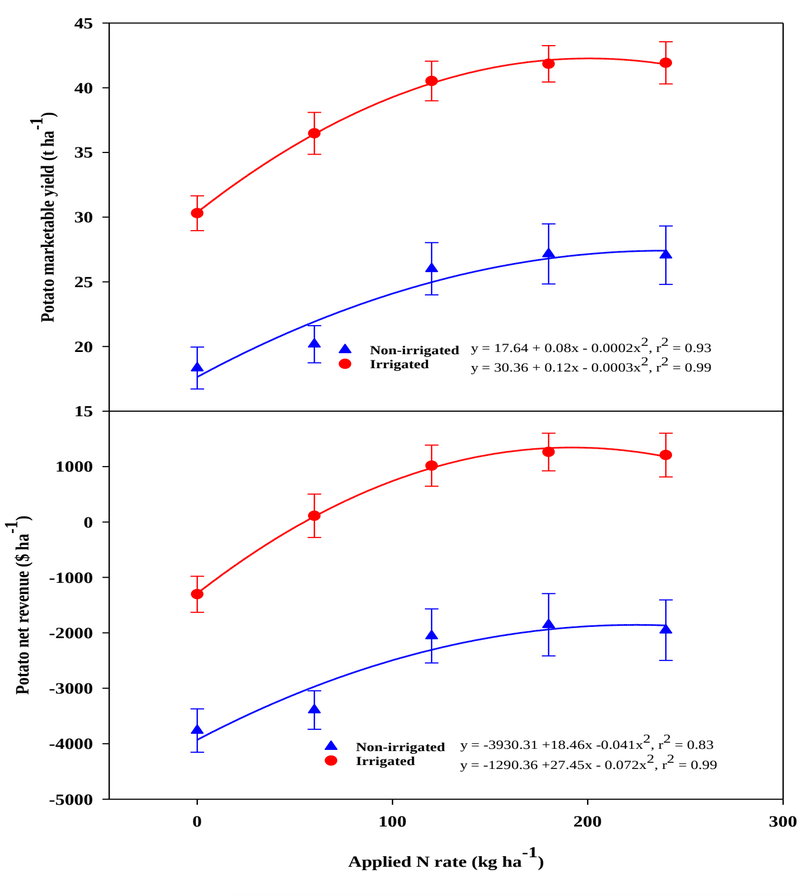

Table 1. Nitrogen fertilizer treatments applied in Studies 1 and 2

Treatment	Effect	N rate (kg ha^{-1})
Fertilizer split application[a]	Timing of application	
Control	-	0
Pre-plant_75	Pre-plant	75
Pre-plant_150	Pre-plant	150
Pre-plant_225	Pre-plant	225
Split2_75	Split2	75
Split2_150	Split2	150
Split2_225	Split2	225
Split4_75	Split4	75
Split4_150	Split4	150
Split4_225	Split4	225
Soil moisture regime	Irrigation	
Non-irrigated_0	No	0
Non-irrigated_60	No	60
Non-irrigated_120	No	120
Non-irrigated_180	No	180
Non-irrigated_240	No	240
Irrigated_0	Yes	0
Irrigated_60	Yes	60
Irrigated_120	Yes	120
Irrigated_180	Yes	180
Irrigated_240	Yes	240

[a] Pre-plant=applied all fertilizer as pre-plant broadcast, Split2=applied half of total fertilizer amount as pre-plant broadcast and the other half as topdressed just prior to final hilling, Split4=applied one third of total fertilizer amount as pre-plant broadcast, one third as topdressed just prior to final hilling, one sixth as hand broadcast midway between final hilling and beginning of August and final one sixth application as hand broadcast at beginning of August

Table 2. Yield and net revenue responses to N management

N rate (kg ha^{-1})	Yield (Mg ha^{-1})				NR ($ ha^{-1})			
Fertilizer split application								
	Pre-plant	Split2	Split4	P value	Pre-plant	Split2	Split4	P value
0	38.5	38.5	38.5		681	681	681	-
75	41.3	40.4	43.2	0.2841	1265	1008	1637	0.3337
150	43.8	41.8	43.4	0.3767	1766	1237	1581	0.3489
225	42.8	42.9	43.5	0.8876	1431	1420	1518	0.9600
Soil moisture regime								
	Non-irrigated	Irrigated	P value		Non-irrigated	Irrigated	P value	
0	18.3	30.3	<0.0001		-3762	-1304	<0.0001	
60	20.2	36.5	0.0010		-3392	112	0.0014	
120	26.0	40.5	0.0006		-2055	1017	0.0009	
180	27.2	41.9	0.0021		-1853	1263	0.0031	
240	27.1	41.9	0.0018		-1951	1207	0.0026	

Conclusions

- Split application showed similar marketable yield and NR performance to pre-plant N under the study conditions (Fig. 1, Table 2). (The potential for N losses with split vs preplant application was not measured in this study.)
- Irrigation significantly increased NR over rainfed production, with a rate of 193 kg N ha^{-1} under irrigation producing the highest NR (Fig 2, Table 2).
- The optimal economic N rate based on net revenue ranged from 157 kg N ha^{-1} for pre-plant N application in Study 1 to 193 kg N ha^{-1} for irrigated production in Study 2 or averaged about 180 kg N ha^{-1}. (Soil test N at experimental sites ranged from 24 to 45 kg NO_3-N ha^{-1} to 60 cm.)

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