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Irrigation, nitrogen and potassium management of potatoes

A report prepared for the Vegetable and Potato
Growers Federation

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1 Executive summary

In response to requests from the Potato Section of the New Zealand Vegetable and Potato Growers Federation DSIR Crop Research conducted an experiment with Rua potatoes in the 1990/91 season to determine the environmental causes of yield and quality variation in potato crops. The purpose was to determine whether these could be overcome with improved agronomic management.

Environmental variation was provided by varying irrigation, nitrogen and potassium fertilisers. "Good" irrigation practice followed the recommendations for Russet Burbank potatoes, "poor" irrigation was half as often, and one treatment received no supplementary irrigation. N and K treatments were applications of 200 kg N ha⁻¹, 300 kg K ha⁻¹, or none. The crop was monitored during the season and at harvest was graded into table, undersize and misshapen tubers. A selection of tubers were tested for quality.

The influence of treatments on quality were statistically significant, but small and of no practical consequence. Although K had no significant effect on yield, the effects of both irrigation and N were significant and substantial. Treatments without added N yielded about 20% less than those with it. "Good" irrigation resulted in yields 10 t ha⁻¹ larger than "poor" irrigation, and 25 t ha⁻¹ larger than rainfed. Drought resulted in a yield decrease of 1% of potential yield per 10 mm of potential deficit.

Growers are encouraged to follow the Russet Burbank management recommendations for all cultivars. Potatoes are a valuable crop requiring careful management to achieve maximum yield, quality and profitability.

2 Background

Growers are concerned that despite cultivar improvements there is still substantial variation in potato yield and quality from season to season, and from site to site within seasons. The causes of these variations are not well understood and they are generally attributed to environmental factors. Hence, with partial financial support from the New Zealand Vegetable and Potato Growers' Federation, an experiment was planned in which large changes in the environment of a Rua potato crop were induced by varying applied fertiliser (N and K) and irrigation. The crop was monitored frequently, sampled at approximately three week intervals, and samples were retained for later chemical analysis. In this way it was hoped that the principal environmental causes of yield and quality variations would be identified, and management strategies to minimise them formulated.

3 The experiment

The treatments imposed were zero or 200 kg ha⁻¹ of N, zero or 300 kg ha⁻¹ of K, and full ("good" irrigation practice), partial ("poor" irrigation practice) or zero irrigation. All treatments had adequate basal P. The amounts of N and K applied to the fertilised treatments were calculated as the amounts required by an 80 t ha⁻¹ crop. The experiment was planted in three blocks for the irrigation treatments, with a randomised complete block factorial design with three replicates within each irrigation area. Plot size was 13 m by 7 rows.

The crop was planted on 11 October 1990 with 1200 kg ha⁻¹ N:P:K:S = 0:9:0:2. Pathogen tested Rua tubers were spaced 330 mm apart in the rows with rows 770 mm apart. The crop emerged by 22 November. Fertiliser treatments were applied on 3 December, and neutron probe access tubes were installed on 5 December. The "good" irrigation treatment received 7 irrigations of 30 mm (total 210 mm), and the "poor" irrigation treatment 3 (total 90 mm). There were 278 mm of rain during the season, giving total precipitations of 488, 368 and 278 mm for the three treatments.

Frost killed the crop on 22 April and it was harvested by machine on 21 and 24 May. Tubers were graded by machine and table, undersize and misshapen tubers separated and weighed. A sample of tubers were weighed in water and air at this time for determination of specific gravity, and these tubers retained for further quality evaluation.

The potatoes were given a steaming test for evaluation of sloughing, greying and stem end blackening, and a full crisping test. Both these procedures used standard methodology.

4 Results

4.1 Yield

Potassium had no significant effect on yield (Table 1). This was not surprising because the soil test results indicated that K was not limiting. However, both irrigation and N had significant and substantial effects on yield. The maximum table yield of a little over 63 t ha⁻¹ was obtained with "good" irrigation and added N (Figure 1). The minimum yield of 29 t ha⁻¹ was for the rainfed treatment without added N.

Averaged over all fertiliser treatments, irrigation increased table yield by 25 t ha⁻¹, and the difference between "good" and "poor" irrigation treatments was 10 t ha⁻¹. The results fitted together very well with those obtained previously at Lincoln (Jamieson, 1985), giving a yield loss of around 1% for every 10 mm of potential deficit, where this defined as the difference between what was required for maximum yield, and what was actually applied.

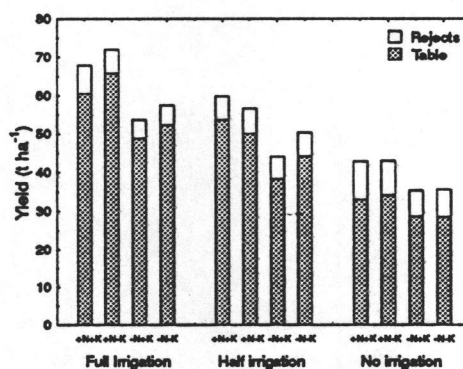


Figure 1. Individual treatment yields.

On average over all irrigation and N treatments, N increased table yields by 9.5 t ha⁻¹. In other words, the yield reduction from not applying N was around 20% - 1% for every 10 kg ha⁻¹ of N.

4.2 Quality

Sloughing was uniformly slight to moderate, and greying and stem end blackening uniformly slight across all treatments.

The largest quality effect was on the proportion of the crop rejected as undersize, and this increased from 9.5% in the fully irrigated treatment to 20% in the rainfed treatment, mostly associated with a decrease in mean tuber size.

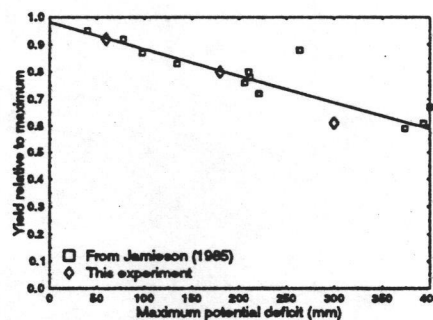


Figure 2. Yield response to drought.

Table I. Main treatment effects.

	Table Yield (t ha ⁻¹)	Total Yield (t ha ⁻¹)	Specific Gravity	Agtron Score
Irrigation				
Full	56.9	62.8	1.081	28.6
Partial	46.6	52.7	1.079	29.8
Nil	31.1	39.2	1.088	32.3
LSD 5%	4.6	4.6	0.005	2.9
Nitrogen				
+ N	49.6	57.0	1.080	29.6
- N	40.1	46.1	1.085	30.8
LSD 5%	3.6	3.6	0.004	2.3
Potassium				
+K	45.9	52.5	1.087	30.3
+K	43.9	50.6	1.079	30.2
LSD 5%	3.6	3.6	0.004	2.3

Other variations in tuber quality in this experiment were statistically significant but small.

Although there were significant effects of N and irrigation on the number of misshapen tubers, they represented only 1 or 2 %, so the differences were not important.

Specific gravity decreased a little with irrigation, N and K, but remained within the commercially acceptable range. Crisp colour tended to darken a little (lower Agtron score) with increased irrigation, but this was unacceptably dark in all treatments because of the cold conditions preceding the harvest. The minimum commercially acceptable Agtron score is 40.

5 Discussion

Although tuber quality variations were small, the strong sensitivity of yield to N and water management was well demonstrated. The response implies that a missed irrigation of 30 mm will cost a grower nearly 2 t ha⁻¹, or between \$500 and \$600 per hectare. If irrigations in this season had been consistently 1 week later than required, the yield loss would have been about 10 t ha⁻¹, equivalent to a financial loss of between \$2500 and \$3000 per hectare. Rua potatoes have a high potential yield, and any crop which fails to approach or exceed a yield of 60 t ha⁻¹ has not been managed adequately. Good growers in Canterbury are now achieving yields of this order with Russet Burbank (A. Davoren, Pers. Comm) - a cultivar which is more sensitive than Rua to both water and N deficits. Growers are therefore encouraged to follow the Russet Burbank management recommendations for all cultivars (Jamieson et al. 1990). Potatoes are a valuable crop requiring careful management to achieve maximum yield, quality and profitability.

6 References

- Jamieson, P.D. 1985. Irrigation response of potatoes. In G.D. Hill and G.S. Wratt (Eds) "Potato growing - a changing scene" Agronomy Society of New Zealand Special Publication. pp 17-20.
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