Potato Irrigation Management with Limited Water

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The potato industry is the fastest growing crop commodity in Manitoba. At around 70,000 acres, Manitoba is already second only to Prince Edward Island in planted acreage. About 80 percent of Manitoba's potato crop is used for processed foods such as frozen french fries. Continued expansion of french fry processing plants is expected to result in another 30,000 acres of additional potato land in the near future.

Potatoes must be irrigated to ensure uniform product quality for the process potato market. To maximize irrigation efficiency and to reduce the likelihood of ground water contamination producers are encouraged to irrigate according to crop demand. A typical recommendation is for irrigation at any time during the growing season when soil moisture tension falls below 60 kPa, or when estimated evapotranspiration deficit exceeds 20 mm. However, as water resources become increasingly scarce or costly, growers will need to know the risks associated with reducing irrigation frequency. In particular, they will need to know when potato yield and quality is most sensitive to drought stress.

This paper reports on the first of a three year study examining the effects of strategically manipulating the timing and amount of irrigation on potato yield and quality on a clay loam soil in Manitoba.

Materials and methods

The 1997 trial was laid out as a randomized complete block design with one cultivar (Russet Burbank), two seeding dates, recommended (May 16) and late (June 2), and four irrigation treatments (Table 1).

Table 1. Irrigation treatments

Treatment	Timing of stress	Growth stage	Number of irrigations	Moisture applied (mm)
Unstressed (NS)			10	200
Early stress (E)	July 17-25	Early tuber bulking	8	160
Late stress (L)	Aug. 1 -Sept 8	Mid - late bulking	5	100
Stress throughout (S)	July 17 -Sept 8	Early - late bulking	3	60

The unstressed (NS) controls were irrigated when the estimated evapotranspiration deficit exceeded 20 mm. Because the purpose of the stress treatments was not to critically damage the plants, but rather to induce mild stress symptoms, water was applied to the stressed treatments during the stress period. Potatoes were planted with a 95 cm between-row spacing and a 37.5 cm within-row seed piece spacing using a two-row planter, eight-rows per plot. Plots were 7.6 m wide and 20 m long. Fertilizer (80-60-o) was broadcast-incorporated prior to planting, according to soil test recommendations. Treatments were replicated three times.

Soil moisture was monitored weekly using neutron attenuation to a depth of 120 cm, and by soil tensiometers placed at 30 and 60 cm. Pre-dawn and mid-day plant water potential measurements were taken using a pressure chamber. All plots were harvested September 29.

Results and discussion

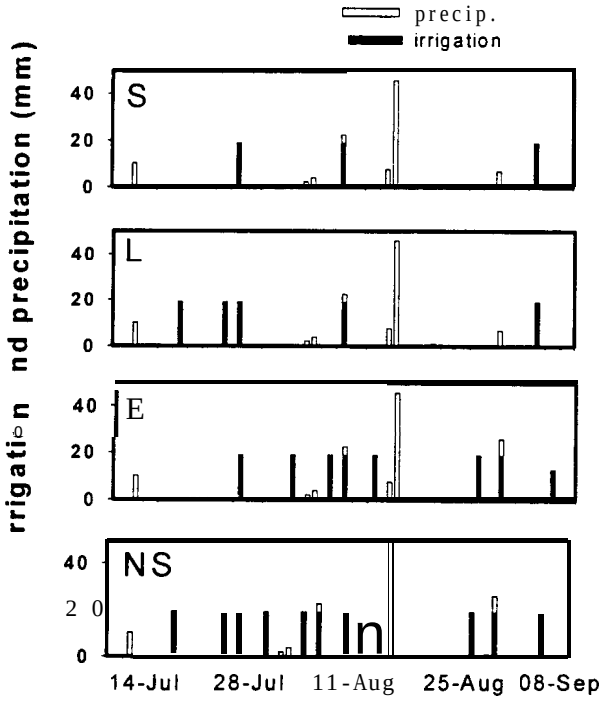


Fig. 1 Precipitation and irrigation during treatmen period.

Precipitation was below average during the early- to mid-tuber bulking stage of June and July (Fig. 1). The NS treatment, managed according to recommended practice, was irrigated four times in July, and twice more in early August, 20 mm per irrigation event. By comparison, the S and E treatments received irrigation once in July. A heavy rainfall event mid-August recharged the soil profile of all treatments, cancelling the potential impact of the late-stress (L) and stressed (S) treatments. However, continued relatively dry weather for the remainder of the season forced two additional irrigations of the E and NS treatments, while the S and L treatments remained unirrigated.

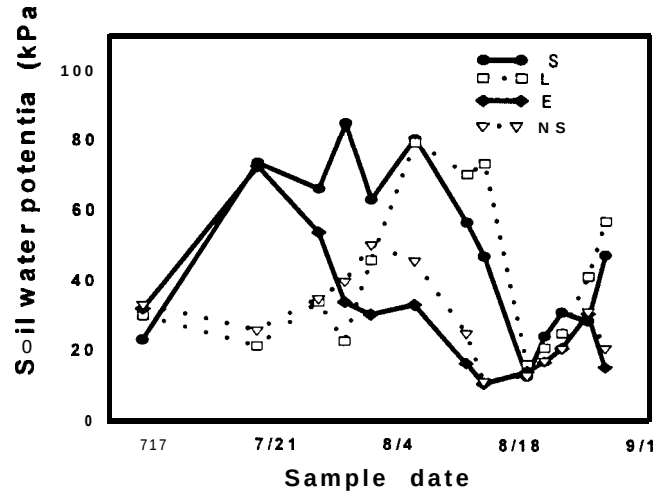


Fig. 2. Soil matric potential as affected by irrigation.

Soil moisture content at the time of treatment initiation (July 5) was similar among irrigation treatments (Fig. 2). Early stressed treatments had more negative soil moisture potentials than the unstressed treatments during most of July. Moisture potentials of unstressed plants never exceeded -50 ka throughout the season. The heavy rainfall mid-August resulted in the S and L treatments having less negative (more moist) soil matric potentials.

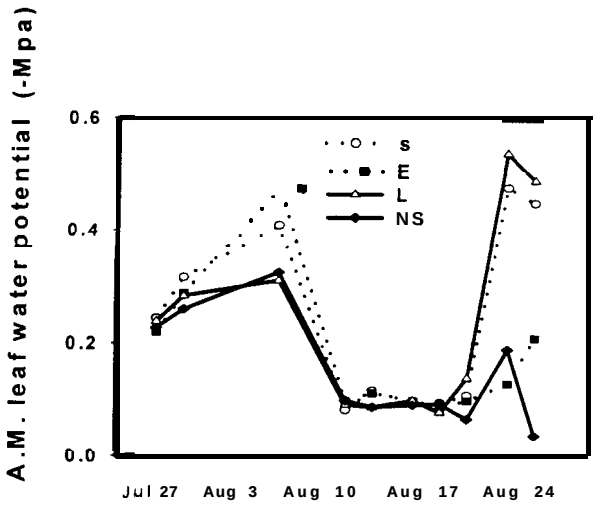


Fig. 3. Predawn leaf water potential as affected by irrigation..

Pre-dawn leaf water potentials the E and S treatments were significantly more negative (drier) than the unstressed and late-stressed irrigation treatments leading into August (Fig. 3). Treatment differences among all treatments were negligible following heavy precipitation mid-August.

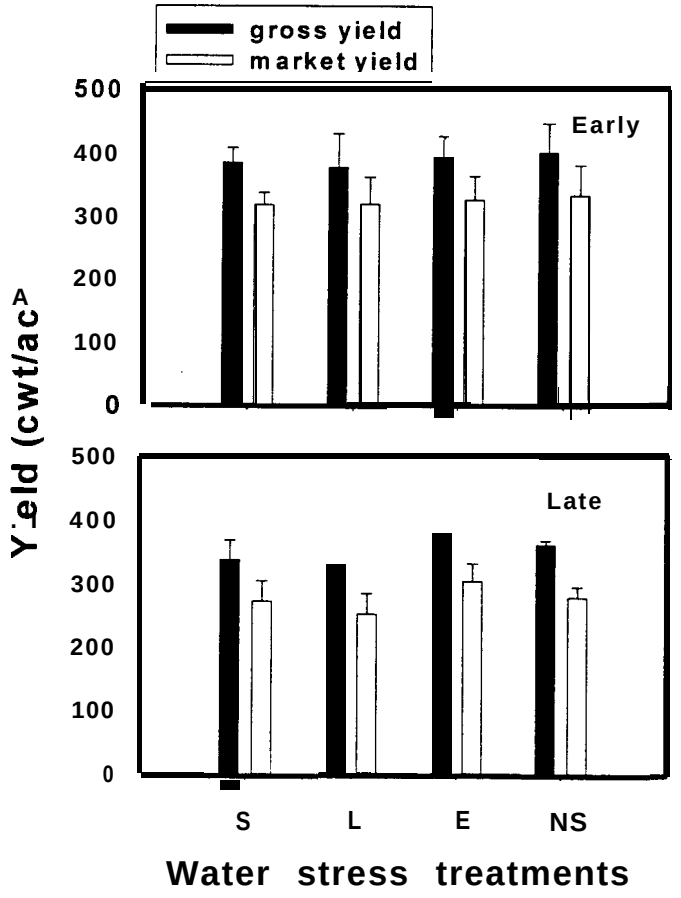
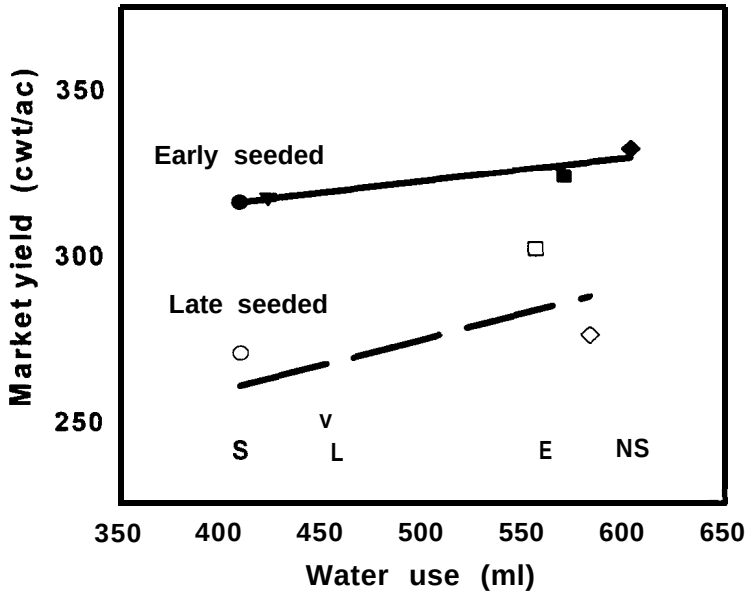


Fig. 4. Marketable yield as affected by irrigation and seeding date.

Both total and marketable potato yields were significantly reduced across all irrigation treatments as a result of delayed planting (Fig. 4). Irrigation treatments had no influence on either total or marketable tuber yields at either planting date.



The amount of water used per unit tuber yield was not affected by irrigation in either the early or late seeded treatments (Fig. 5). In spite of approximately 200 additional millimetres of water added to the unstressed plants over the course of the growing season the final yields of all treatments was similar. Water stress induced by the S, E, and L treatments was not detrimental to final tuber yield.

Fig. 5. Marketable potato yield as affected by seasonal water use.

The impact of late season drought on tuber bulking in the S and L treatments in this experiment was confounded by heavy late-season precipitation. While measurements of leaf water status indicated that S and L treatments were drought stressed within about 10 following the mid-August rainfall, this may have been sufficient time to enable the otherwise-stressed plants to regain potentially lost yield.

Conclusions

A water deficit of up to 200 mm imposed by withholding recommended irrigation during the mid-to-late stages of potato tuber bulking had no effect on either total or marketable yield of early or late-seeded Russet Burbank potatoes. Further evaluation of the effects of strategic manipulation of timing and amount of irrigation is needed to assess the extent of a confounding effect on yield of stressed plants caused by mid-August precipitation. More than one site year of data will be needed to understand how year-to-year variation in climate influences mid-season drought effects on yield quantity and quality.

Acknowledgements

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