Yield and water use of canola and mustard in water-limited environments

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Introduction

- Recently, poor economic returns for spring wheat have caused producers in the semiarid prairie to consider growing nontraditional, or alternate, crops such as canola and canola-quality mustard.
- Little information is available for the inherent adaptability of canola in the semiarid prairies (Brown and Dark Brown soil zones) .
- In the semiarid environment, water availability is the major limiting factor to agricultural production.
- Droughts are frequent often severe and vary in duration, lasting for short periods of less than two weeks to longer periods of months to years.
- Rainfall and temperature patterns contribute to the characteristic terminal drought pattern to be associated with crop development in the semiarid prairie.
- The key to securing good economic performance is to increase the water use efficiency ($ return per mm of water use) of cropping systems.
- There is a need to evaluate how effectively potential alternate crops use water and respond to drought.

Objective

To agronomically evaluate how effectively promising Brassica oilseeds (B. ***napus, B. rapa and B. juncea)*** use water and respond to drought conditions.

Materials and Methods

- **Three** water regimes: irrigation - water was not limiting to crop growth and yield; dryland; imposed drought - using a rainout shelter, all rain was withheld from the plots from about early to mid-June to harvest.
- Duration and location of study: 1996 and 1997, SPARC, Swift Current, SK
- Crops grown: Katepwa spring wheat, Quantum and Cyclone Argentine canola (B. ***napus),*** Tobin Polish canola (B. ***rapa),*** Cutlass Oriental mustard (B. ***juncea),*** breeder lines of Canola-quality mustard (B. ***juncea).***
- Measurements: grain yield and quality, crop phenology, water use and extraction patterns via neutron attenuation.

Results

- Note: Results and conclusions are preliminary. The third and final year of the 3-yr study will be completed during the summer of 1998.
- Grain yields decreased as water availability decreased. Under all water regimes, spring wheat significantly outyielded all Brassica entries (Figure 1, top).

- There were little yield differences among the Brassica species, especially under dryland and imposed drought water regimes.
- Under all water regimes, harvest index of wheat was significantly greater than harvest indexes for the Brassica species (Figure 1, bottom). The only differences among Brassica entries occurred under irrigation.
- As water availability decreased, harvest index for spring wheat tended to increase slightly whereas harvest indexes for the Brassica species tended to decrease.
- Brassica yields in proportion to wheat decreased as water availability decreased.
- Under dryland and imposed drought, total water use for the Brassica species were similar to wheat (Figure 2, top). Only under irrigation were there significant differences in water use between wheat and some of the Brassica entries.
- Under all water regimes, water use efficiency for wheat was significantly greater than for the Brassica species (Figure 2, bottom). Differences among Brassica entries only occurred under irrigation. Comparing across water regimes, mustard tended to have lower water use efficiency than canola.
- Water use efficiency for wheat increased as water availability decreased (Figure 2, bottom). Water use efficiency for the Brassica species was relatively constant across water regimes.
- Soil water measurements indicate that the Brassica species are deep rooted (150 cm) with water extraction patterns similar to spring wheat (data not shown).
- During the vegetative growth phase, there were no differences between wheat and the Brassica species in daily water use when grown under dryland and imposed drought (Figure 3, top). Under irrigation, mustard tended to have higher daily water requirements than canola and wheat.
- Under all water regimes, during the reproductive growth phase, daily water use for mustard tended to be greater than for canola (Figure 3, bottom). Wheat tended to have the lowest daily requirement for water. These differences were significant under irrigation.

Summary

Compared to wheat, the Brassica species are not drought tolerant. The poor drought tolerance is shown by the fact that, relative to spring wheat, yield, harvest index and water use efficiency for the Brassica oilseeds decreased as water availability decreased. In the semiarid climate of southwestern Saskatchewan the Brassica species used similar amounts of water as spring wheat. Two years of study have shown very little difference in water use or water relations between the Brassica species, although the mustards are showing a higher water use per day of growth than canola or wheat, especially during the reproductive growth phase. The evidence suggests that photosynthesis during grain fill is more important to grain yield for the Brassica species than for wheat. Thus, oilseeds should be seeded as early as possible to minimize the grain fill period occurring during the typically drier mid-summer and seeded on fallow where they typically have the greatest water supply and thereby the least chance of running out of water during grain fill. To date, we have found no consistent evidence that either the mustard- or canola-type B. *junceu is* more drought tolerant than B. napus For profitable production in a semiarid climate, Brassica oilseeds will need a large price advantage to be competitive with wheat.

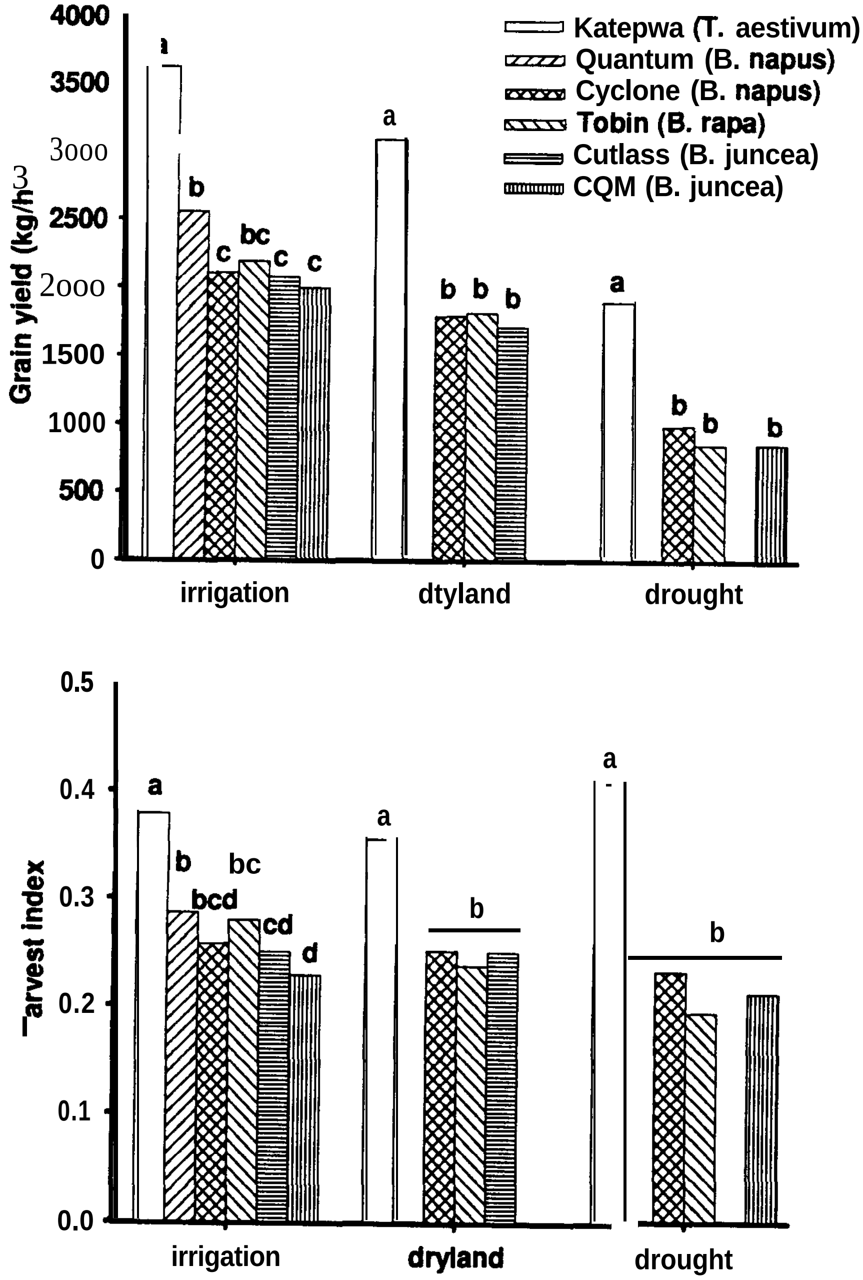

Figure 1: Grain yield (top) and harvest index (bottom) averaged across 1996 and 1997 for Katepwa spring wheat, Quantum and Cyclone canola (B. napus), Tobin canola (B. rapa), Cutlass and Canola-quality mustard (CQM) (B. juncea) grown at Swift Current, SK. (Means with different letters are statistically different, $P<(0.05)$.)

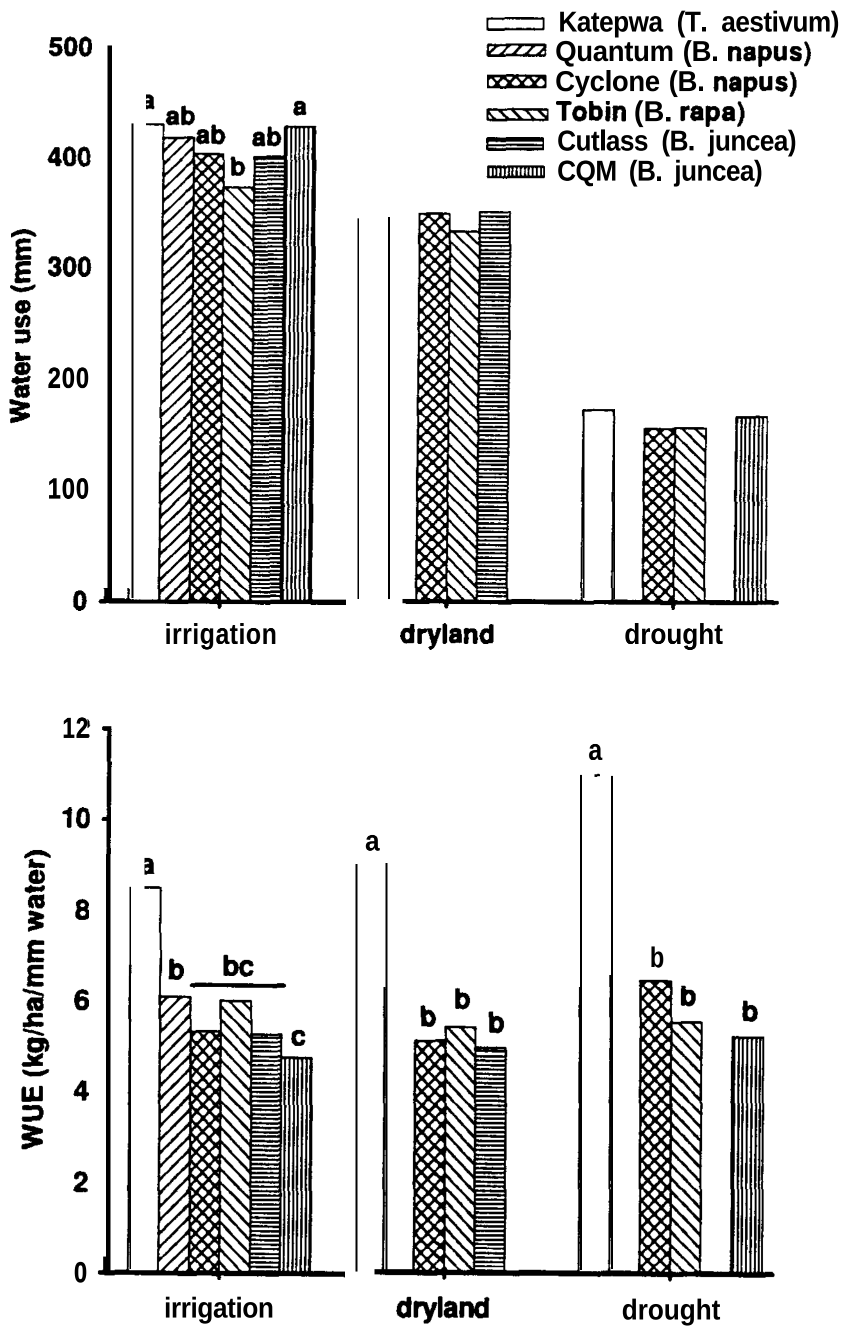

Figure 2: Water use (top) and water use efficiency (bottom) averaged across 1996 and 1997 for Katepwa spring wheat, Quantum and Cyclone canola (*B. napus*), Tobin canola (*B. rapa*), Cutlass and Canola-quality mustard (CQM) (*B. juncea*) grown at Swift Current, SK. (Means with different letters are statistically different, $P<(0.05)$; no letters, no differences.)

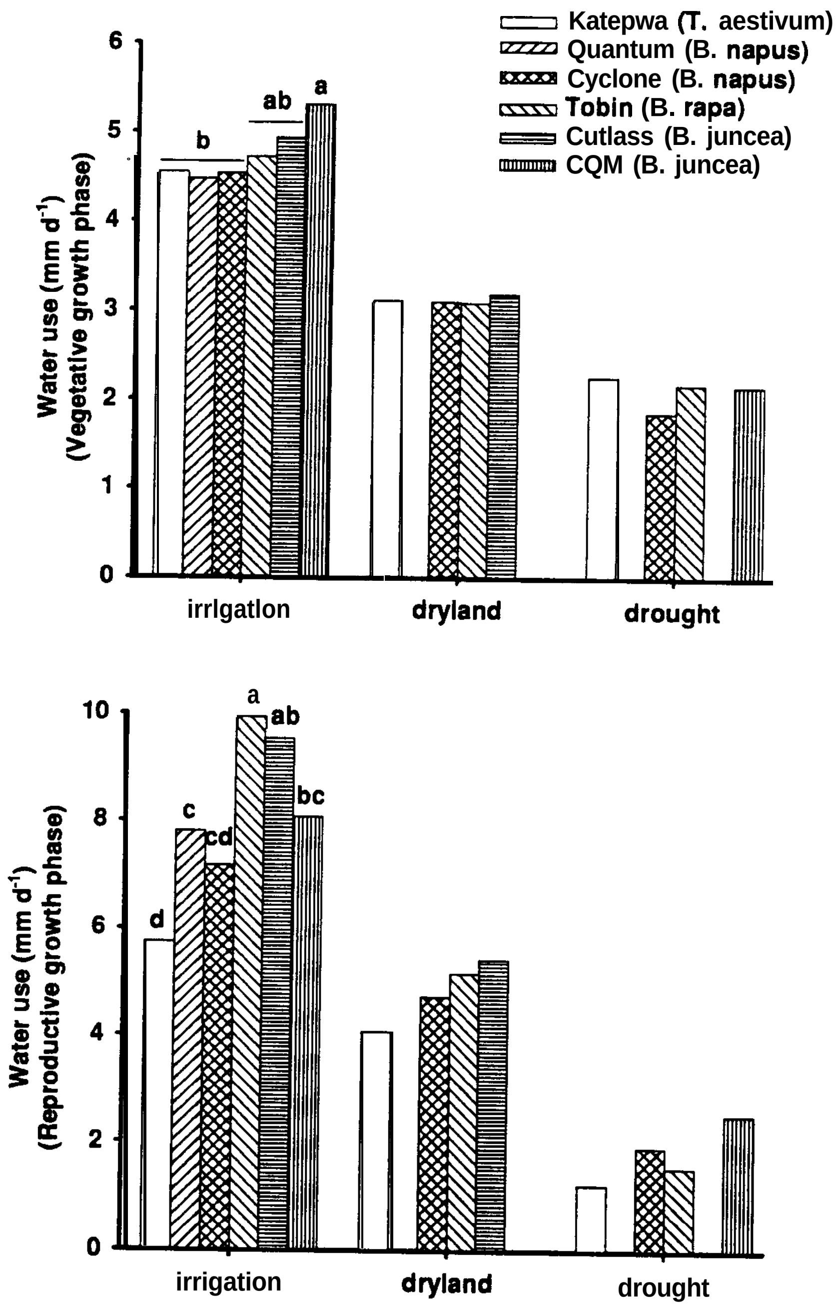

Figure 3: Daily water use during the vegetative (top) and reproductive (bottom) growth phases averaged across 1996 and 1997 for Katepwa spring wheat, Quantum and Cyclone canola (*B.* napus), Tobin canola (B. rapa Cutlass and Canola-quality mustard (CQM) (*B. juncea*) grown at Swift Current, SK. (Means with different letters are statistically different, $P<(0.05)$; no letters, no differences.)