Water Requirements for Winter Canola. An N. Hang, Irrigated Agriculture Research and Extension Center, Washington State University, Prosser, Washington.

INTRODUCTION

Canola (*Brassica napus,* L) is a relatively new crop for irrigated central Washington. Canola can compete with other crops in the area due to the increasing domestic demand for canola and rapeseed and good potential exists for export. Interest in the crop has increased in recent years as it provides a commercially viable and potentially profitable break crop for cereal rotations and potato production.

Irrigation information in the United States on rapeseed and canola is very limited, but is very well recognized that the crop is responsive to irrigation particularly in dry climates. Expansion of rapeseed production should be possible where supplemental irrigation can be provided. Irrigation has been shown to increase seed yield (Stoker and Carter, 1984; Wright et al., 1988; Hang and Gilliland, 1991). Response varied with the season, but there appeared to be no benefit from applying more than two irrigations (Stoker and Carter, 1984). Rapeseed responded largely to irrigation at the start of blooming (Davidson, 1976). Richards and Thurling (1978) showed three *Brassica napus* L. cultivars to be most sensitive to drought during pod filling. Bram (1981) showed that a reduction in yield occurred if soil moisture fell below 50% available during the period from flowering to green maturity. In a field study, Munoz and Fernandez (1979) tested 4 levels of irrigation and found that yield began to decline when the total water supply fell below 20 inches. Bhan et al. (1980) found that one irrigation at flower initiation gave higher yields than at pod development. However, irrigation at both stages gave maximum yields.

The effect of irrigation on oil concentration was not clear. In a pot or in a field experiment, various moisture regimes caused no difference in seed oil (Konicka and Kozakievicz, 1978; Munoz and Fernandez, 1979). However, the work of Bhan et al. (1980) showed maximum seed oil content resulted from one irrigation at flower initiation.

This research was initiated to study the effect of irrigation by sprinkler or furrow to yield and oil concentration of various canola rapeseed grown in central Washington. This study also calculates irrigation efficiency as well as water used by winter canola.

MATERIALS AND METHODS

Field experiment was conducted on a Warden loam soil (coarse silty, mixed, mesic Xerollic Camborthids) with about 45% sand and 9% clay in the surface. The plots were located at the Irrigated Agriculture Research and Extension Center, Washington State University - Prosser. Fresh cut wheat stubble was disked and rototilled into the ground before a broadcast application of 100 lb N and 28 kg P per acre. Trifluralin at the rate of 1 lb a.i. per acre and incorporated into the top 3 inches. The ground was then packed and pre-irrigated. Soil moisture was kept optimum for seed germination. Two irrigation were applied in the fall of about 1.5 in. for crop growth. Two winter canola rapeseed (Lindora and Santana) were seeded on August 31, 1986 and Sept 3, 1987 and Liradonna and Santana were seeded on Sept 7, 1988.

A two-year experiment on sprinkler irrigation was established in 1990-1991 and in 1992-1993 at the same location. Cascade, Liradonna, Norseman and Santana were seeded on Sept 12, 1990 and Arabella, Bienvenu, CC-349 and Liradonna were seeded Sept 2, 1992.

The seeding rate was 6 lb per acre using a precision cup seeder (Nibex 500[1]). Treatments of 1, 2, 3, 4, and 5 spring irrigations were applied by rill systems as presented in Table 1.

Table 1. Irrigation scheduling for winter canola in 1987, 1988 and 1989 at Prosser, Washington.

Trt	1987	1988	1989
I_0	No spring irrigation	No spring irrigation	No spring irrigation
I_1	NT	April 19	May 01
I_2	April 16 and May 5	April 19 and May 4	May 01 and May 15
I_3	April 16, May 5 and May 13	April 19, May 4 and May 18	May 01, May 15 and May 25
I_4	NT	April 19, May 4, May 18 and June 01	May 01, May 15, May 25 and June 4
I_5	April 16, May 5, May 29 and June 10	NT	NT

Each set of irrigation was for 24 hours.
NT: not tested.

Irrigation water was calculated by averaging the flow rates of small "V-notch weirs" over each 24-hr irrigation period.

In 1990-1991 and 1992-1993, experimental areas were 100 ft by 400 ft. A line source sprinkler system was installed lengthwise through the center of an area, with double nozzled Rainbird # 30[4] sprinkler heads spaced 15 ft apart, with 3/16" range nozzles and 3/32" spreader nozzles. Two sets of catch cans were installed across each field in two lines perpendicular to the line source with one line even with and one line midway between sprinkler heads. The cans were placed 5 ft to each side of the line source and then every 10 ft to the edge of the field. Water in the catch cans was measured after each irrigation. Fields were irrigated early in the morning to minimize wind interference. Amount of irrigation water was adjusted to maintain good soil moisture at the center of the field. Soil moisture was monitored before and after each irrigation with a neutron probe from ground level to 36" depth. Water applied was defined as the sum of irrigation water and total rainfall from the date the treatments started until harvest. The total amount of water used by the crops was the total amount of water applied plus soil water depletion.

Oil concentration was determined using a Newport MKIIIA Nuclear Magnetic Resonance (NMR) instrument on 12 g of oven-dried seed obtained from each replication. All samples were analyzed with a 32-second integration period. All samples in 1989, 1991 and 1993 were analyzed using the Soxtec[1] Oil Extraction System. Oven-dried samples were ground using a small coffee mill and oil was extracted by hexane which passed through the ground samples in the thimbles. Oil was collected into the extraction cups which were dried and weighed.

RESULTS AND DISCUSSION

Precipitation at this location is very limited and occurred mostly during the fall and winter. Successful crop production was dependent upon supplemental irrigation. Rainfall during the growing season was 1.22, 1.65, 0.59, 4.67 and 2.45 inches for spring 1987, 1988, 1989, 1991 and 1993, respectively (Tables 2, 3, 4 and 5). Early plant growth and development used soil moisture accumulated from fall and winter precipitation. First irrigations were started in the spring during bloom or after peak flowering, depending upon available soil moisture. Data showed that the more water we applied to the crop, the less the amount of the total available soil moisture that was used.

[4]Mention of product or company names is for the benefit of the reader and does not imply endorsement of the equipment or products by WSU.

Table 2. Irrigation water and calculated water used by Lindora, Liradonna and Santana winter canola cultivars during the treatment periods.

Treatment	Rainfall [2]	Irrigation water	Soil water used [3]	Total water used [4]
	in.	in.	in.	in.
	1987			
I_0	0.98	0	1.98	2.96
I_2	0.98	2.51	- 0.03	3.46
I_3	0.98	4.20	- 1.25	3.93
I_5	0.98	5.25	- 2.45	3.78
	1988			
I_0	1.33	0	0.73	2.06
I_1	1.33	1.23	0.50	3.06
I_2	1.33	2.46	-0.74	3.05
I_3	1.33	3.69	-1.86	3.16
I_4	1.33	4.92	-2.01	4.24
	1989			
I_0	0.46	0	0.92	1.38
I_1	0.46	1.25	0.77	2.48
I_2	0.46	2.50	-0.34	2.62
I_3	0.46	3.75	-1.12	3.09
I_4	0.46	5.04	-2.12	3.38

[2] Estimated at 80% of actual rainfall

[3] Soil water used = soil moisture before starting treatment - soil moisture at harvest.

[4] Total water used = irrigation water + rainfall + soil moisture.

Table 3. Irrigation water applied in the fall of 1990.

Treatment	Irrigation
	in.
1	0.33
2	0.40
3	0.56
4	0.58
5	0.76
6	0.98
7	1.07
8	1.32
9	1.46
10	1.50

Table 4. Irrigation water and calculated water used by Cascade, Liradonna, Norseman and Santana winter canola cultivars during the treatment period of 1991.

Treatment	Irrig. water	Water applied	Soil water used	Total water used
	in.	in.	in.	in.
1	0.13	3.87	4.20	8.03
2	0.26	4.00	4.18	8.18
3	0.52	4.26	4.18	8.44
4	0.80	4.54	4.15	8.69
5	1.28	5.02	4.11	9.13
6	1.78	5.52	4.09	9.61
7	2.16	5.90	3.70	9.60
8	2.55	6.29	3.33	9.62
9	2.60	6.34	3.70	10.04
10	2.66	6.40	3.89	10.29

3.74 inches of rainfall was added to the water applied

Table 5. Irrigation water and calculated water used by Arabella, Bienvenu, CC-349 and Liradonna winter canola cultivars during the treatment period of 1993.

Treatment	Irrigation	Water applied	Soil water used	Total water used
	in.	in.	in.	in.
1	0.16	1.07	5.14	6.21
2	0.80	1.71	5.37	7.08
3	2.18	3.09	4.25	7.35
4	2.43	3.34	4.41	7.75
5	5.05	5.97	4.26	10.23
6	5.55	6.46	4.34	10.81
7	7.34	8.25	3.95	12.20
8	8.07	8.98	3.84	12.82
9	8.65	9.56	3.51	13.07
10	9.63	10.54	3.32	13.86

0.91 in. of rainfall was added to the water applied

Yield and irrigation efficiency were reported in Table 6 and Figs. 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11 and 12.

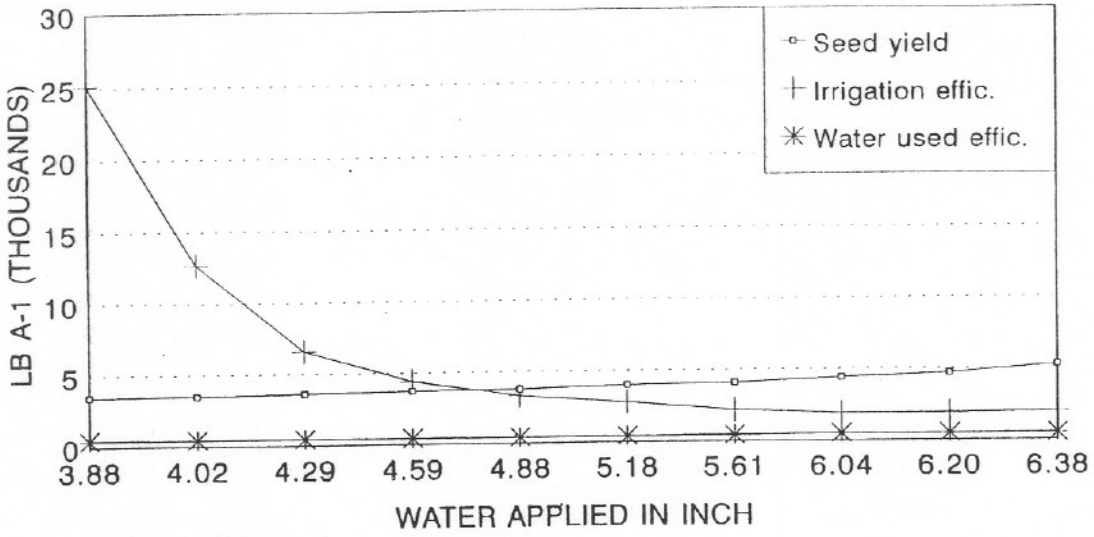
Table 6. seed yield, oil concentration and water used efficiency of winter canola during the 3-year experiment at WSU-Prosser.

Trt.	Seed yield	Oil conc.	Water used eff.	Seed yield	Oil conc.	Water used eff.
	lb a^{-1}	%	lb a^{-1} in^{-1}	lb a^{-1}	%	lb a^{-1} in^{-1}
			1987			
I_0	1467 c	44.2	1497	1235 c	43.2	1260
I_2	3372 b	45.0	966	3442 b	44.9	986
I_3	3458 b	44.8	667	3568 b	44.7	689
I_5	4491 a	43.6	721	4598 a	43.9	738
Mean	3197	44.4		3210	44.2	
Lsd (.05)	820	NS		820	NS	
			1988			
I_0	3899 bc	44.5 a	2931	5147 b	44.7 a	3870
I_1	3858 bc	41.3 c	1507	4789 bc	40.8 b	1871
I_2	4663 a	42.6 bc	1230	7036 a	41.6 b	1856
I_3	4577 ab	39.4 d	912	4201 c	41.0 b	837
I_4	3725 c	43.4 ab	596	4447 bc	43.7 a	711
Mean	4144	42.2		5124	42.4	
Lsd (.05)	487	1.1		487	1.1	
			1989			
I_0	1745 c	38.6 c	3793	3269 bc	40.3 c	7106
I_1	4983 a	43.4 ab	2914	4736 a	44.5 ab	2769
I_2	4191 ab	43.9 ab	1416	4474 ab	45.0 ab	1511
I_3	3232 b	45.4 a	768	2823 c	46.0 a	670
I_4	3807 ab	44.8 a	692	3221 bc	45.6 ab	586
Mean	3592	43.2		3704	44.3	
Lsd(.05)	835	2.8		835	3.1	

Water used efficiency = Seed yield/water applied

Yield and Water Used Efficiency by Cascade Winter Canola

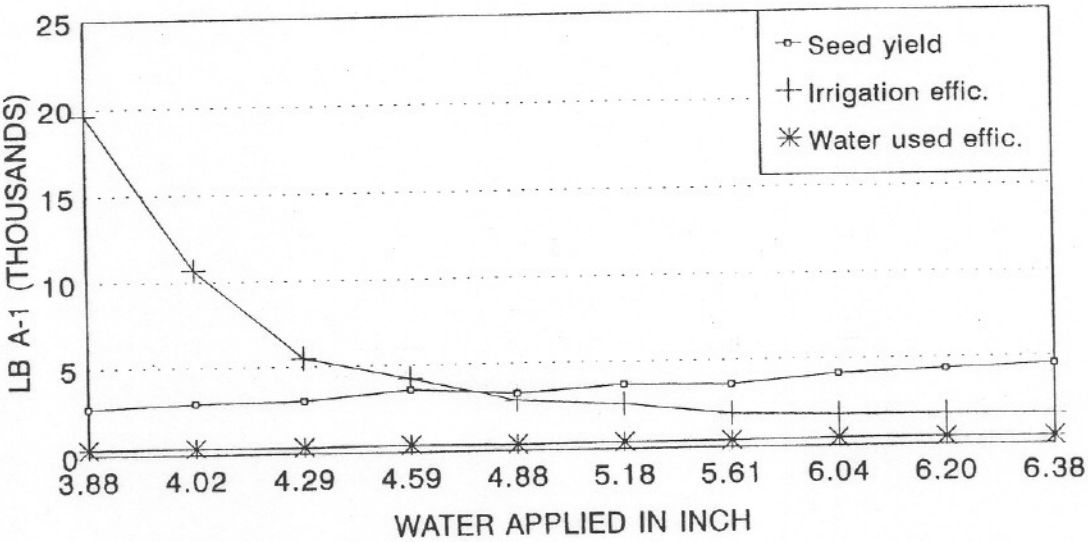
WSU - Prosser. 1990-1991.



Irrigation efficiency = yield/irrigation water (lb a-1 in-1)
Water used efficiency = yield/total water used (lb a-1 in-1)
Water applied = rainfall + irrigation water

Yield and Water Used Efficiency by Norseman Winter Canola

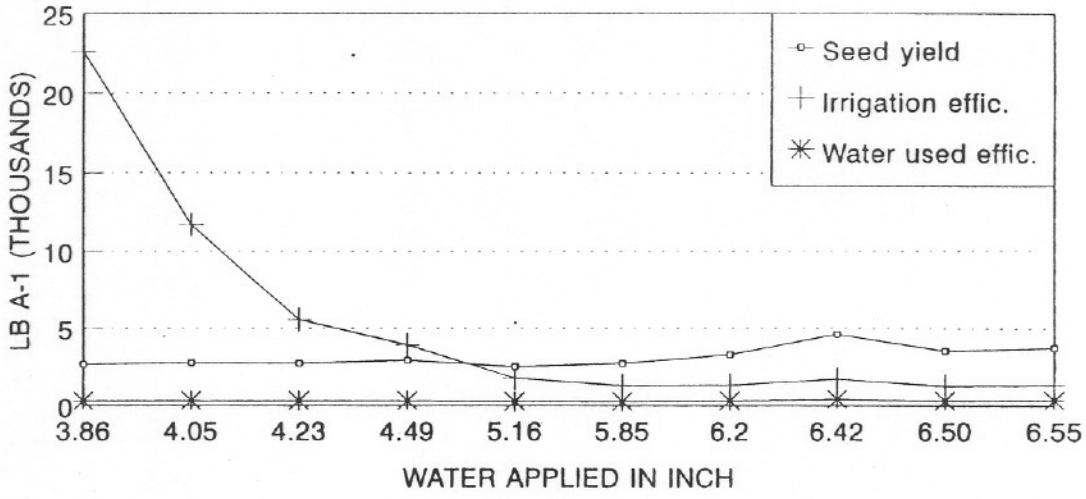
WSU - Prosser. 1990-1991.



Irrigation efficiency = yield/irrigation water (lb a-1 in-1)
Water used efficiency = yield/total water used (lb a-1 in-1)
Water applied = rainfall + irrigation water

Yield and Water Used Efficiency by Liradonna Winter Canola

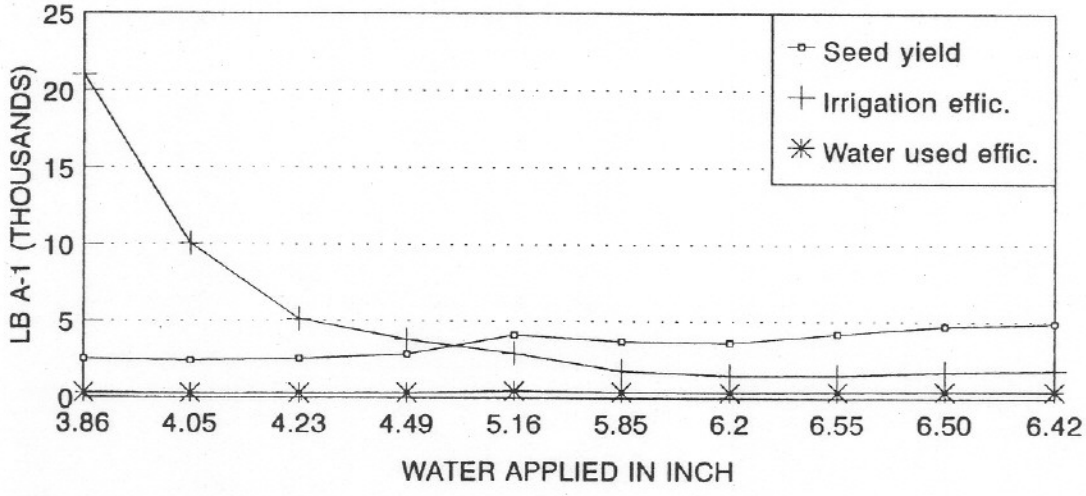
WSU - Prosser. 1990-1991.



Irrigation efficiency = yield/irrigation water (lb a-1 in-1)
Water used efficiency = yield/total water used (lb a-1 in-1)
Water applied = rainfall + irrigation water

Yield and Water Used Efficiency by Santana Winter Canola

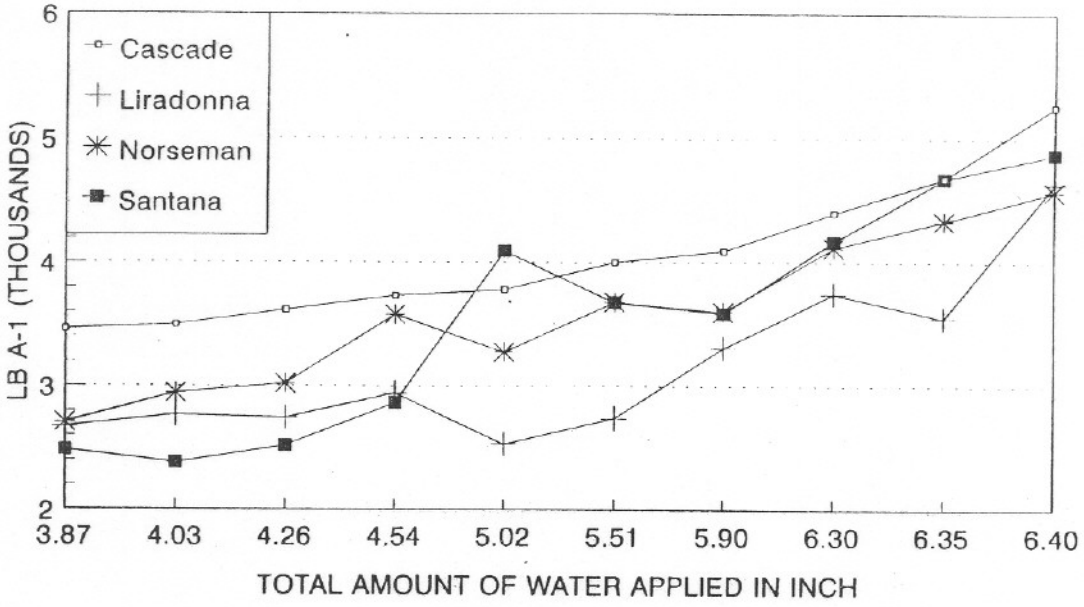
WSU - Prosser. 1990-1991.



Irrigation efficiency = yield/irrigation water (lb a-1 in-1)
Water used efficiency = yield/total water used (lb a-1 in-1)
Water applied = rainfall + irrigation water

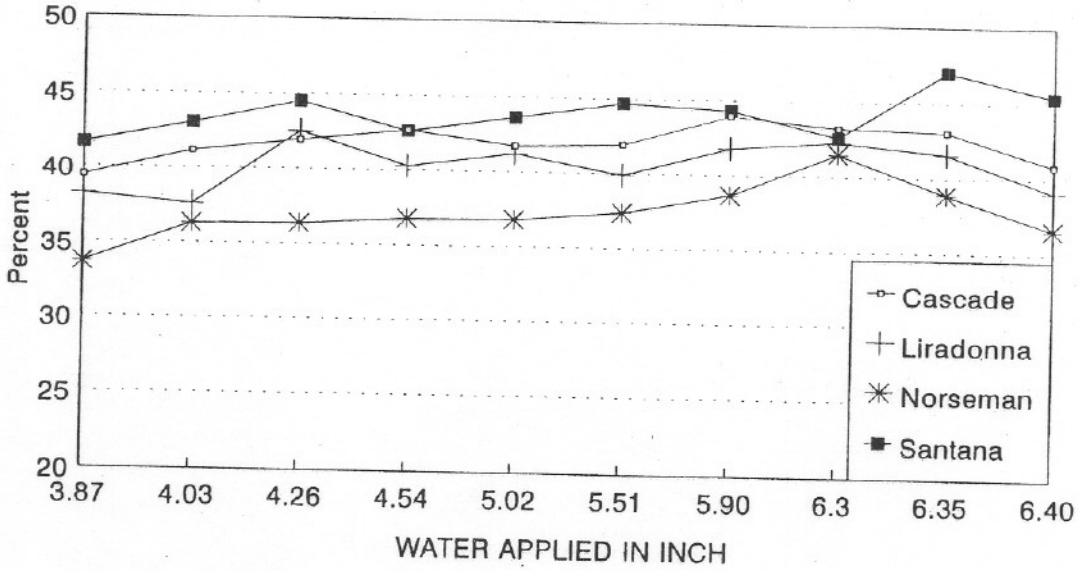
Seed Yield of Cascade, Liradonna, Norseman and Santana Winter Canola

WSU - Prosser 1990-1991



Oil Concentration of Cascade, Liradonna, Norseman and Santana

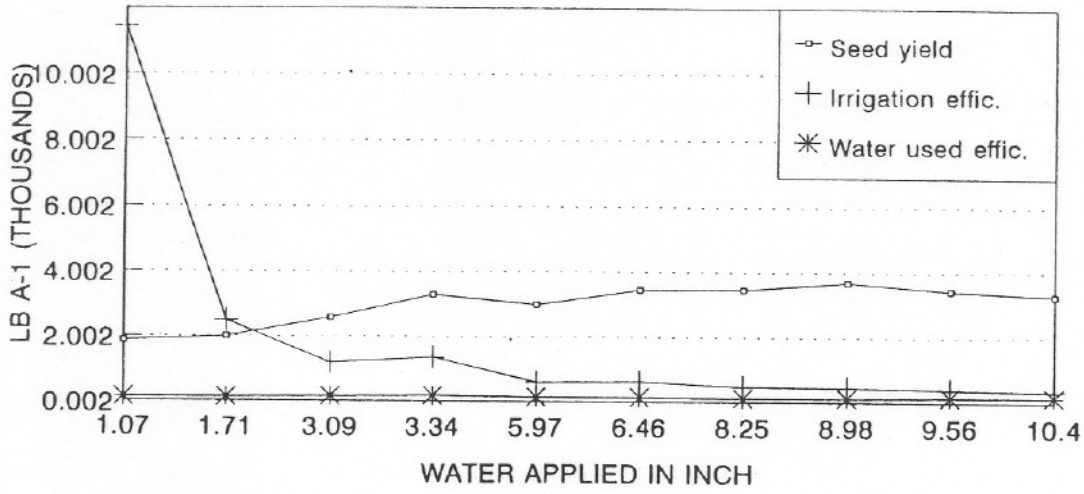
WSU - Prosser. 1990-1991.



Seed was at 4.5 % moisture

Seed Yield and Water Used Efficiency by Arabella Winter Canola

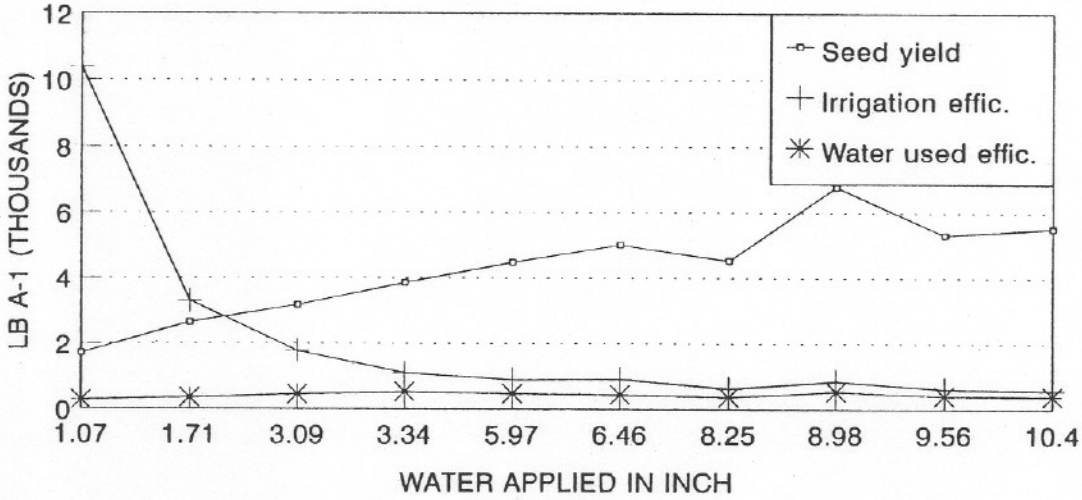
WSU - Prosser 1992-1993



Water applied = rainfall + irrigation water
Irrigation efficiency = yield/irrigation water (lb a-1 in-1)
Water used efficiency = yield/total water used (lb a-1 in-1)

Seed Yield and Water Used Efficiency by Bienvenu Winter Canola

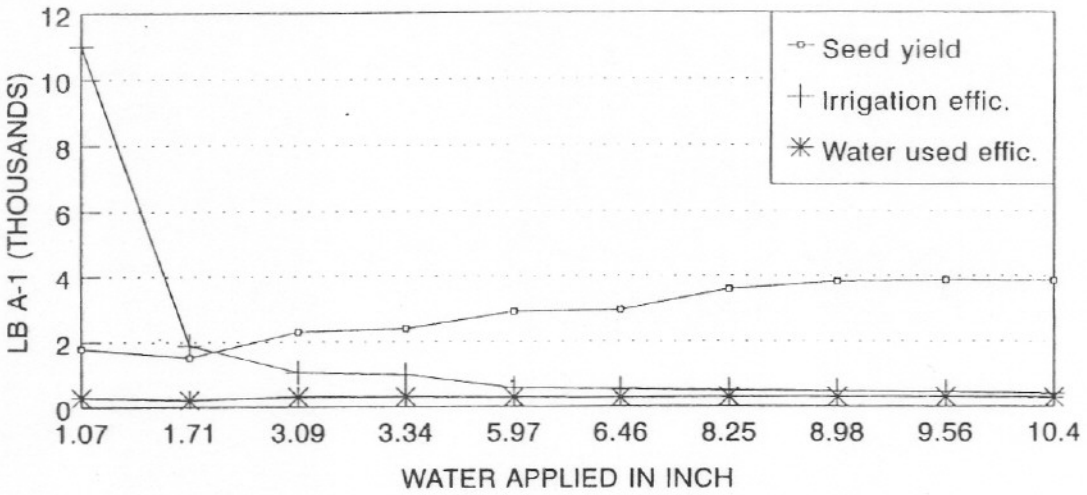
WSU - Prosser 1992-1993



Water applied = rainfall + irrigation water
Irrigation efficiency = yield/irrigation water (lb a-1 in-1)
Water used efficiency = yield/total water used (lb a-1 in-1)

Seed Yield and Water Used Efficiency by CC-349 Winter Canola

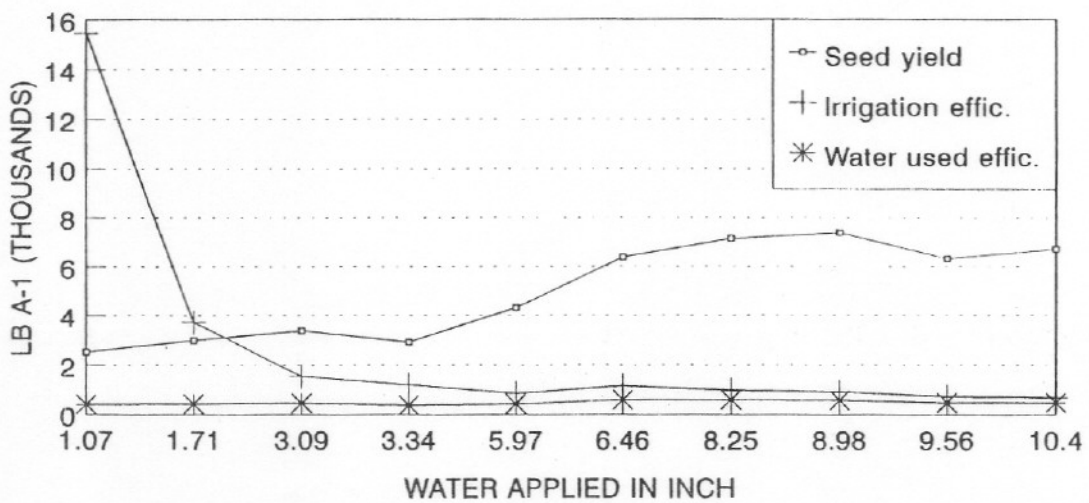
WSU - Prosser 1992-1993



Water applied = rainfall + irrigation water
Irrigation efficiency = yield/irrigation water (lb a-1 in-1)
Water used efficiency = yield/total water used (lb a-1 in-1)

Seed Yield and Water Used Efficiency by Liradonna Winter Canola

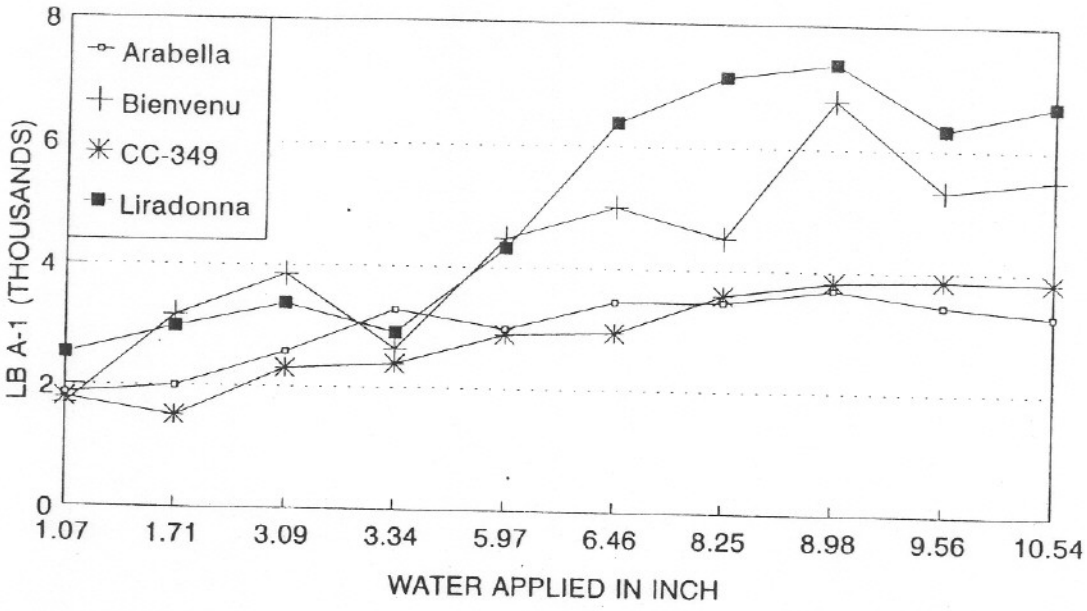
WSU - Prosser 1992-1993



Water applied = rainfall + irrigation water
Irrigation efficiency = yield/irrigation water (lb a-1 in-1)
Water used efficiency = yield/total water used (lb a-1 in-1)

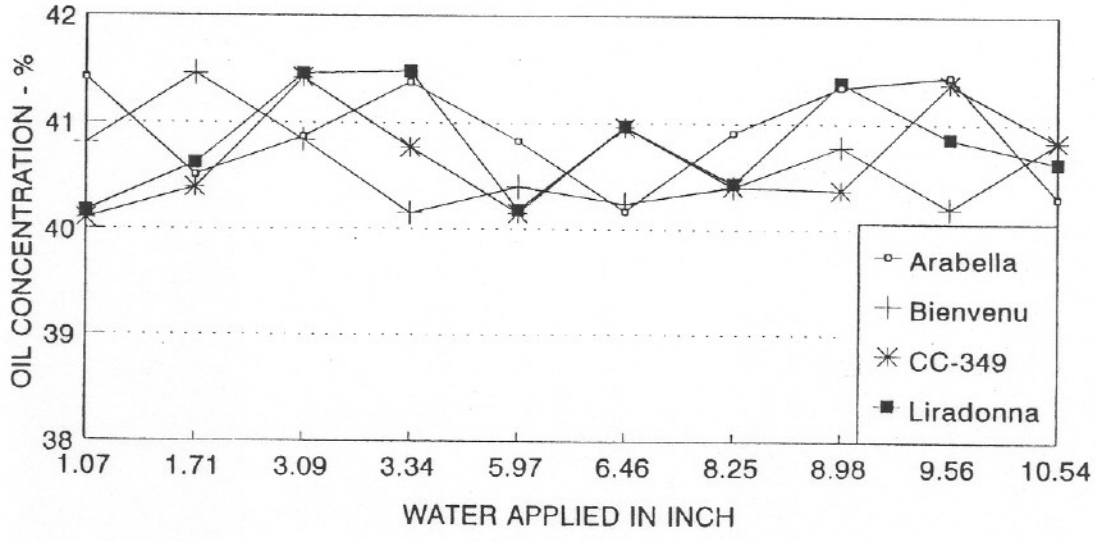
Seed Yield of Arabella, Bienvenu, CC-349 and Liradonna Winter Canola

WSU - Prosser 1992-1993



Oil Concentration of Arabella, Bienvenu, CC-349 and Liradonna Canola

WSU - Prosser 1992-1993



Seed was at 4.5% moisture
Hexane extraction methode

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