Deficit Irrigation of Blackeyes with Alternate Furrow and Reduced Irrigation Frequency, Variable Plant Populations and Impact on Lygus Counts, Yield and Quality

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ABSTRACT

A one year study compared standard furrow irrigation practice for blackeye beans in the San Joaquin Valley, once every seven days during the peak of the season irrigating every furrow (Every) to alternate furrow irrigation every seven days (Alt) and irrigating every furrow every 14 days (Reduced). Planting densities of 2, 4 and 6 inches, varieties CB 46 and CB 50 and the impact of irrigation on lygus populations and final yield/quality were evaluated. The first irrigation after planting was withheld until floral bud initiation. The more frequent, Every row irrigation treatment gave a 48 to 95% yield advantage over the Alt and Reduced irrigation treatments. The 2 inch spacing gave a 26 to 32% yield advantage in CB50 for the most stressed treatment but did not repeat this trend for CB46. Basically, a water savings of about 10 inches (0.83 feet) lost about 1200 lb/ac of blackeyes. Lygus numbers were significantly reduced in the Alternate and Reduced irrigation treatments with wider plant spacing for two weeks during bloom and podset.

Key Words: blackeye beans, irrigation, lygus, grain quality, soil water content, yield

INTRODUCTION

Allocations for Westside water districts have ranged from 0 to 60% at best over the last 3 years. Groundwater levels across the San Joaquin Valley have declined by 50 to 150 feet in some areas. Legal issues are also restricting pumping from the Delta and compound the real drought conditions California faces with interminable "judicial droughts" for an unknown number of years ahead of us. A great deal of land is being fallowed to use what water is available on permanent crops. At the same time, blackeye prices have been very good and growers need to maintain some rotational crops. Add to the uncertain water situation soaring nitrogen fertilizer prices, it may be that a single flush, 15 to 25 sack crop of No. 1 blackeyes requiring only 15 inches of water and no lygus sprays could be profitable.

Earlier work by Tony Hall showed that blackeye yields were unaffected by delaying the first irrigation until floral bud initiation followed by normal irrigation. Alternate furrow irrigation and irrigation of "skip-row" cotton plantings (two rows planted, one skipped, irrigation only in every third furrow) were studied by Sanden in the late 1990's on Westside clay loam soils where water savings was 25 to 50% with yield losses of 20 to 40% compared to every furrow irrigation.

The extra heat from deficit irrigation and exposed soil due to reduce plant size may also act as a deterrent to lygus. Deficit irrigation and the impact on lygus populations has not been studied before to my knowledge. Under reduced irrigation regimes there is also some suggestion that a less dense plant population will allow for better rooting of young plants; translating into an ability to maintain yield under stressed conditions.

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The newly released variety from Jeff Ehlers, CB50, has shown the ability to develop a fuller canopy more quickly than CB46 under fully irrigated conditions, but we have no data on its performance under stress. To answer these questions two trials were initiated in 2009 in the southern San Joaquin Valley incorporating 3 different irrigation regimes, 3 different plant spacings and the two main commercial varieties CB46 and CB50.

PROCEDURES

Single-row 30" beds were listed the beginning of April 2009. A split-split plot design was used (Figure 1). with Irrigation (described below) as the main treatment, Variety (CB46 and CB50) as the main split and plant spacings at 2, 4 and 6" for the second split treatment. Plots were 16 rows wide by 150 feet long (placed in two tiers for a total field length of 300 feet) with irrigation treatments running the length of the field and the two varieties, CB46 and CB50, planted as subplots 8 rows wide, side by side. This design provided 6 replicated blocks.

The field was pre-irrigated April 20. Three separate sets of gated pipe were installed, each with their own flowmeter, to apply water to each of the three irrigation treatments. A normal, every furrow pre-irrigation was applied to the control (Every) and Reduced irrigation treatments, and only alternate furrows were irrigated for the Alternate irrigation treatment. The pipe was removed after pre-irrigation and beans were planted to stand May 4 using an air planter at the 2 inch spacing and hand-thinned May 18-19 using either a three inch or five inch wide hoe to achieve the 4 and 6 inch spacings after emergence. Spacing subplots were 50 feet long by 8 rows wide. Five foot wide alleys were cut between spacing subplots May 26 to leave 45 foot long plots. Pipe was reinstalled in the field and the first irrigation applied June 11 at floral bud initiation. Irrigation treatments during the season were as follows:

1. **Every** furrow every 7 days (industry standard for Shafter) – estimated water use 22-25 inches.
2. **Alternate** furrow irrigation at the same frequency; irrigating the same furrow all season. Target water use 15-18 inches.
3. **Reduced** irrigation frequency in every furrow every 14 days. Target water use 10-12 inches.

Irrigation sets were only 3 to 6 hours in duration due to short runs and applied about 2 inches per irrigation in the **Every**/Control treatment. Irrigation was terminated August 5th.

Soil water content was measured weekly after planting in 6 neutron probe access tubes installed to a depth of 6 feet in the bed and adjacent irrigation furrow of each treatment in one replication near the middle of the field. Measured soil water content depletion was added to applied depth of irrigation to estimate crop evapotranspiration (ET).

Lygus counts for each plot/subplot were determined every one to two weeks using a standard sweep net and 10 sweeps per subplot from bloom through maturation of first flush pods by Pete Goodell's staff.

Harvest was accomplished using a small 2-row cutter September 3 and threshing beans September 10 using a small CB Hays Harvester.

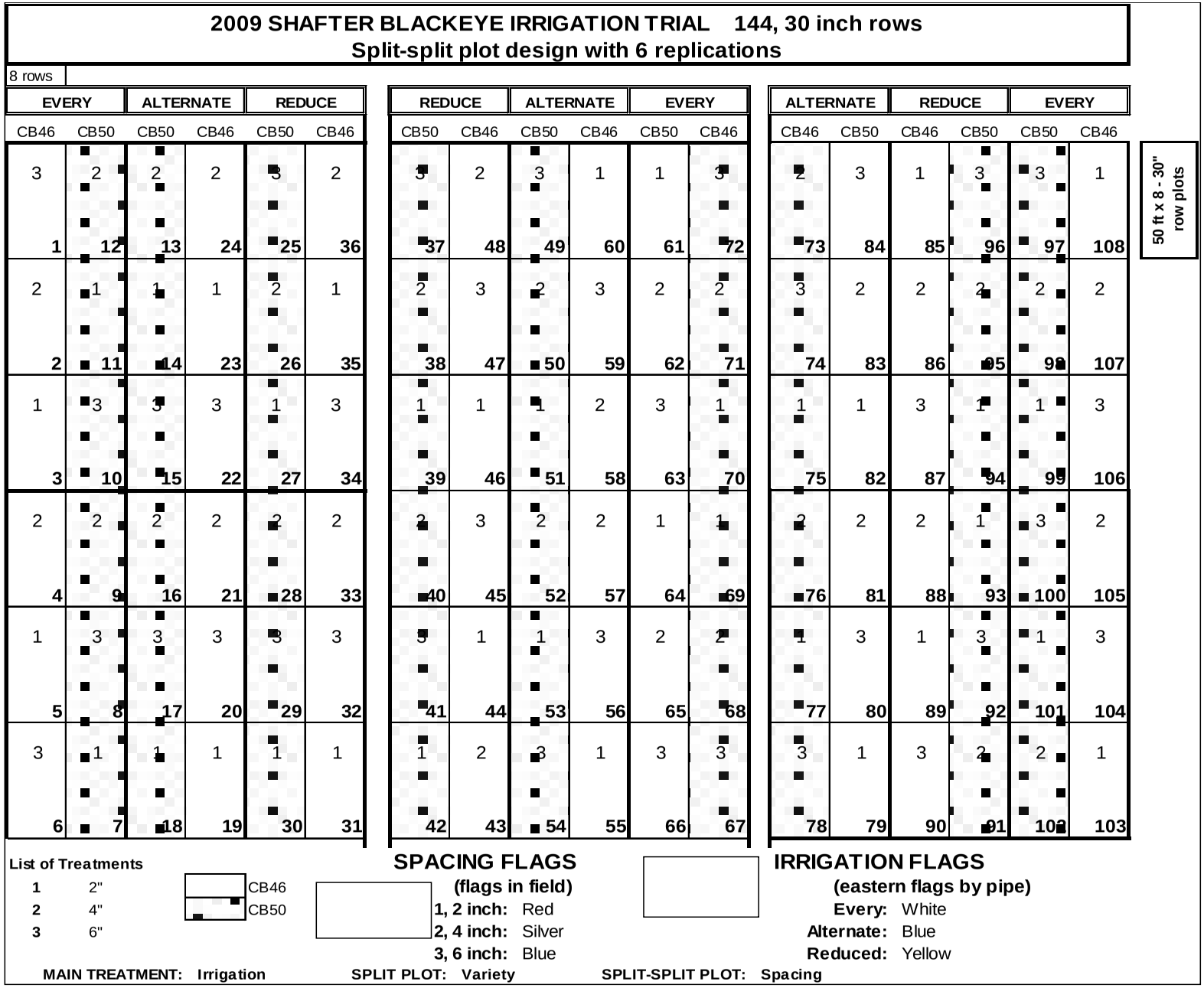

Fig. 1. Irrigation trial design.

RESULTS

IRRIGATION: Figure 2 charts cumulative irrigation over the season for all treatments; with the **Every**/Control irrigation treatment at the upper end of our application target at 25 inches of water. The **Alternate** treatment also achieved the project target of 16 inches, but due to the extra dry down time between irrigations and minor cracking in the **Reduced** treatment in this Wasco sandy loam, the net plot infiltration rate for this treatment was almost double the **Alternate** treatment – resulting in 15.7 inches of applied water instead of the target 10 to 12 inches.Figure 3 shows the change in soil water content for the 1, 3 and 5 foot depths in the **Every** furrow treatment over the season. Neutron probe measurements were usually taken right before an irrigation and therefore the only irrigation "peaks" that show are those for pre-irrigation, first irrigation and one irrigation in late July. The 3 and 5 foot depths just continue a slow decline all season as this Wasco sandy loam soil is notorious for "sealing over" and limiting infiltration. A similar pattern is seen for the **Alternate** furrow treatment (Fig. 4) except that the drying is more severe as moisture is not replenished by more frequent irrigation. Figure 5 shows the summed (total) soil water content to 6 feet. Average available soil moisture for the full irrigation was about 75% during the critical podset and fill stage while in the stressed treatments it was about 50%. Only in the **Reduced** irrigation frequency treatment did plants appear visually stressed in July. Figure 6 shows the up and down swings of weekly ET for all treatments as estimated with soil water content depletion and applied irrigation water. The erratic curves are an artifact of irrigation events between readings and greatly increased *evaporation* (E) as opposed to *transpiration* (T) for that period. The thin blue line is the calculated blackeye ET using "normal year" weather data and blackeye crop coefficients – close to the measured ET of the **Every** treatment.

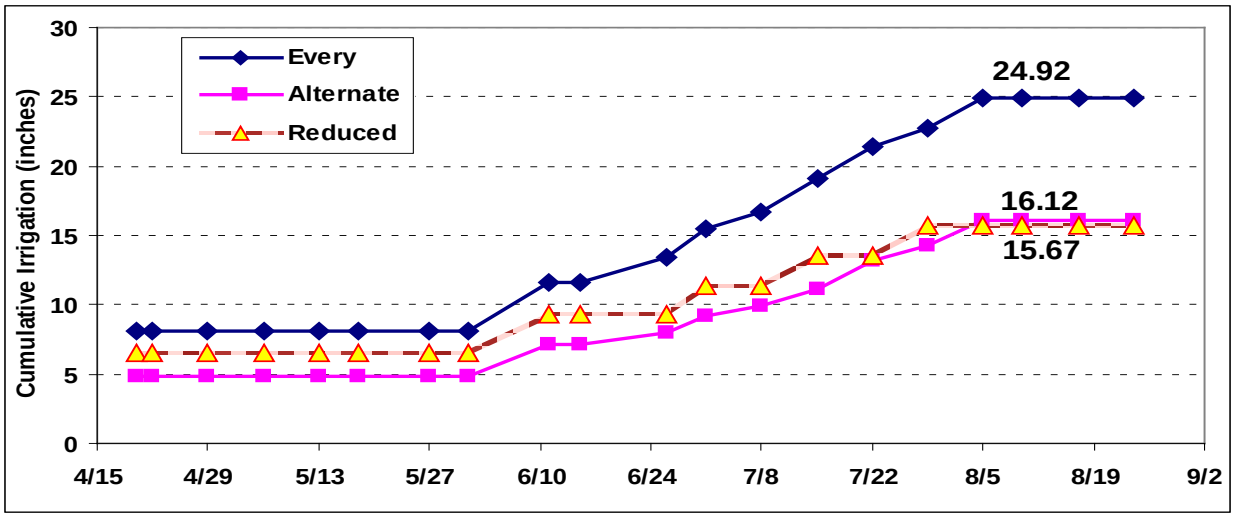

Fig. 2. Cumulative irrigation over the season for all irrigation treatments.

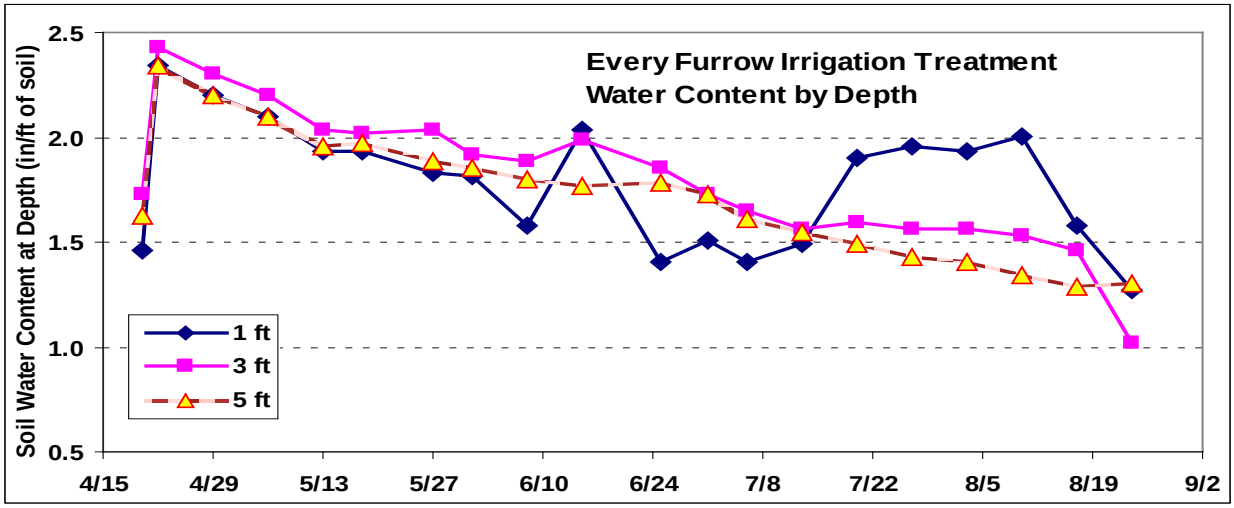

Fig. 3. Seasonal soil water content for the 1, 3 and 5 foot depths for the Every furrow treatment.

The final calculated ET for the **Alternate** furrow treatment is actually more than the applied water as the plants extracted an additional 2.1 inches of stored moisture from the previous season.

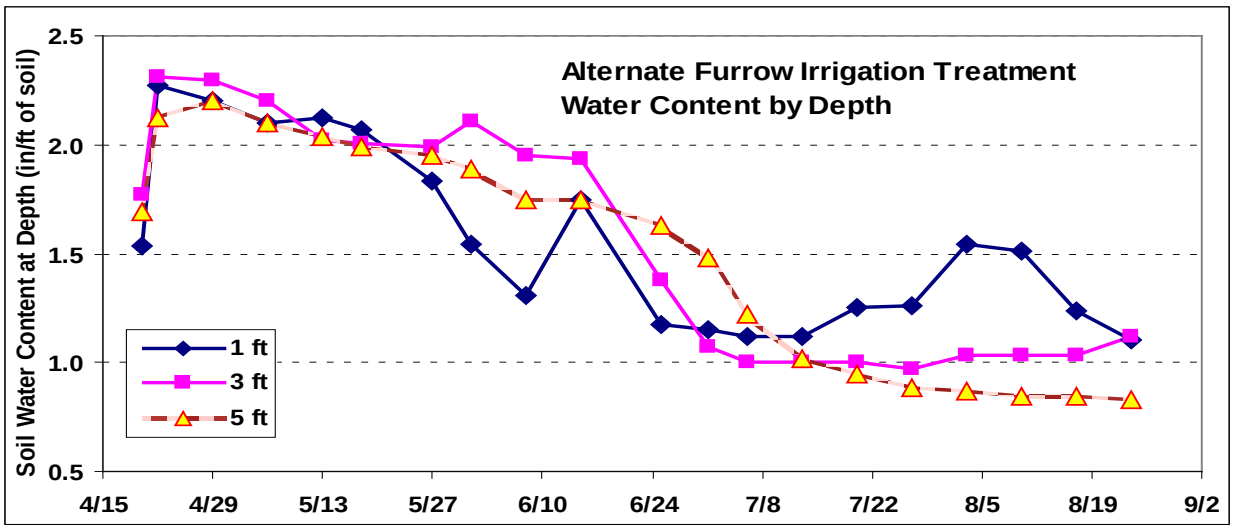

Fig. 4. Seasonal soil water content for the 1, 3 and 5 foot depths for the Alternate furrow treatment.

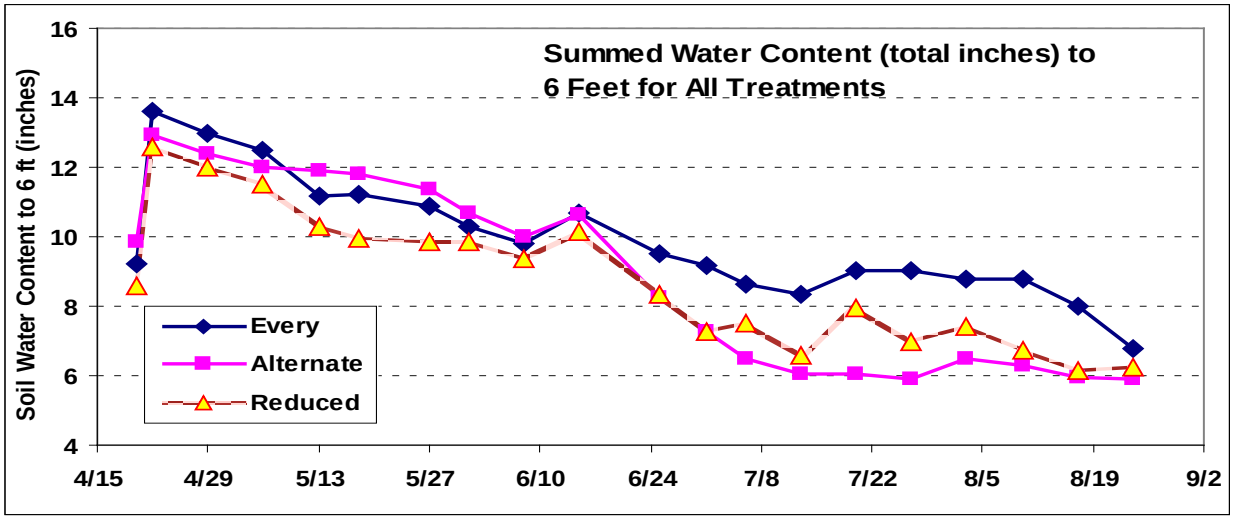

Fig. 5. Total seasonal soil water content for all irrigation treatments to a 6 foot depth.

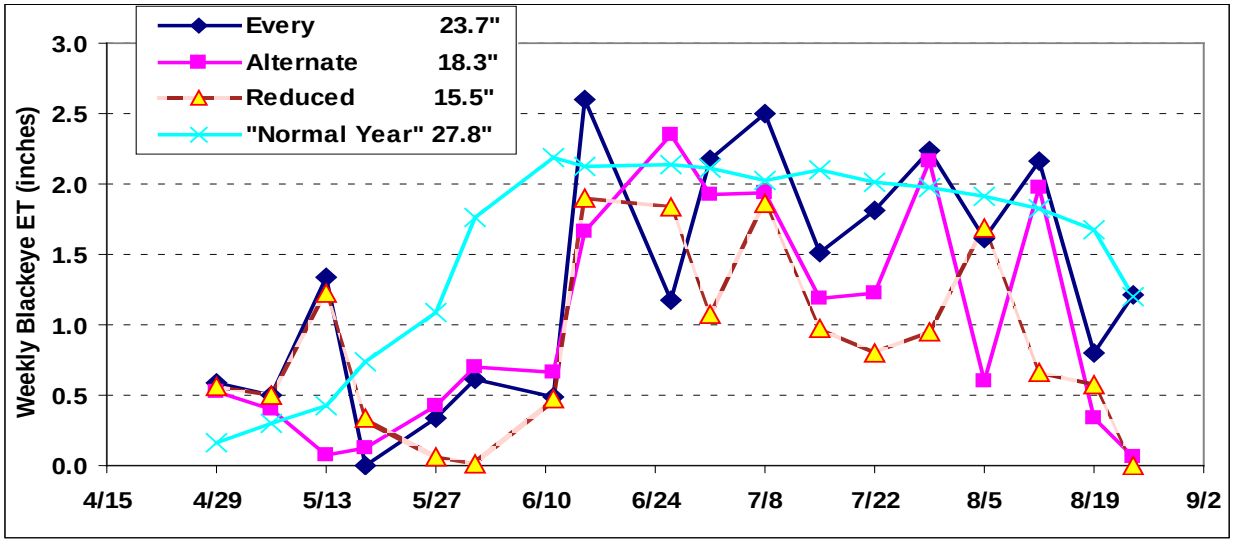

Fig. 6. Total seasonal soil water content for all irrigation treatments to a 6 foot depth.

DISEASE: In the middle of June there appeared to be a number of plants collapsing in the 4 and 6 inch spaced plots. Closer inspection and a pathological analysis indicated charcoal rot (Macrophomena phaseolina) was the cause. The 2 inch spacing was virtually unaffected. We believe the infestation occurred during thinning as young roots of adjacent plants to those removed were severed and laid vulnerable to infection. This may also be a causal organism responsible for plant collapse after a cultivation.

INSECTS: Lygus counts in the 2 inch spacing subplots reached 0.7 per sweep as of July 7. Lygus were significantly reduced in the **Alternate** and **Reduced** irrigation treatments compared to the **Every** furrow irrigation during the first two weeks of July during peak bloom @ 0.36 and 0.57 lygus/sweep, respectively. The field was sprayed with Dimethoate 4EC @ 1 pt/acre on July 13. By the end of July a significant amount of damage had been done by leafminer. The final irrigation was applied August 5. See P. Goodell's report for results on lygus number and impact on bean quality.

YIELD: Sub samples from harvested plots were analyzed for turnout and lygus damage. The dirt weight turnout averaged 10.7%. The **Every** furrow, standard irrigation practice, produced a much higher yield than the other two irrigation treatments (Table 1).

Table 1. Yield summary for all treatments, spacings and varieties. (Clean weight yields below adjusted by an average turnout of 10.7% and for 8% moisture content.)

Irrigation Treatment	*Every Row (7 days)	Alternate Row (7 days)	Reduced (14 days)
[1]Irrigation (in)	24.9	16.1	15.7
[2]Estimated ET (in)	23.7	18.3	15.5
CB46-2"	*3656 a	2464 a	2109
4"	2951 b	2113 ab	1948
6"	2766 b	1839 b	2015
CB50-2"	*3630 a	2447 a	2396 a
4"	2814 b	1896 b	2020 b
6"	2733 b	1895 b	1658 b

RATIO OF CB50 TO CB46			
	Every	Alternate	Reduced
2"	0.99	0.99	1.14
4"	0.95	0.90	1.04
6"	0.99	1.03	0.82

*Significantly different (P<0.002). Numbers without * followed by a different letter are significantly different (P<0.05)

[1]Includes preirrigation.

[2]As measured by soil water content depletion using the neutron probe plus applied irrigation. "Normal Year" ET calculated at 27.8 inches.

There was no significant difference between varieties for any spacing or any irrigation treatment. A 13 sack yield loss (for CB50) @ $38 to save 10 inches of water equals $593/ac-ft. So reducing irrigation in blackeyes makes no economic sense unless you cannot get the water at all or it will cost you more than $400/ac-ft. Fifteen inches of water still yielded 20 +/- sacks using alternate furrow irrigation.

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