Evaluating Deficit Irrigation of Blackeye Cowpeas Under Variable Plant Densities

C.A. Frate[1], S.C. Mueller[1], L.J. Schwankl[2], B. Sanden[1], P.B. Goodell[1], J. Ehlers[3], S.R. Temple[2]

[1]University of California Cooperative Extension Tulare, Fresno and Kern Counties and UC Kearney Agricultural Center

[2]University of California Davis, Land Air & Water Resources and Department of Plant Sciences; [3]University of California Riverside, Botany and Plant Sciences

INTRODUCTION

Blackeye cowpeas (*Vigna unguiculata*) are the main dry bean type grown in the southern portion of California's San Joaquin Valley. Acreage ranges from 4,000 to 12,000 acres. Although a minor crop compared to cotton, corn, alfalfa, and winter cereals, blackeye cowpeas are important for rotation. Almost all of the acreage is produced under furrow irrigation using groundwater and/or surface water. The cost and, in some years, the availability of water are issues facing growers. CB 46 has been the standard variety for the past 20 years, most commonly planted on 30-inch beds with 4-6 plants/ft. CB 50, released in 2008, was selected for larger seed size, which is desired for export markets. Given limited experience with the new variety, two trials conducted in 2009 evaluated the impact of deficit irrigation regimes on the yield and quality of CB 46 and CB 50, planted at three densities.

OBJECTIVE

Evaluate the impact of deficit irrigation on CB 46 and CB 50 at different plant densities in terms of yield and seed size.

METHODS

Two trials were located at the UC Shafter and Kearney Research & Extension Centers in California's San Joaquin Valley (Figure 1). Location specific management details are listed in Table 1. The design was a randomized complete block with split-split plots.

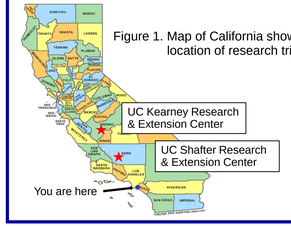


Figure 1. Map of California showing location of research trials.

METHODS

Main plot: Irrigation
- **Conventional** (every 7-10 days, every furrow)
- **Alternate Furrow** (every 7-10 days, every other furrow)
- **Extended Interval** (every other irrigation, every furrow)

Split-plot: Variety
- **CB 46**
- **CB 50**

Split-split plot: Plant density
- **High** density (6 plants per ft)
- **Medium** density (3 plants per ft)
- **Low** density (2 plants per ft)

Table 1. Location-specific management details.

	Shafter	Kearney
Number of reps	6	5
Plot size	8 30-in rows x 45 ft	8 30-in rows x 40 ft
Planting date	May 4, 2009	May 21, 2009
Stand Establishment	Uniform seeding rate, thinned to desired densities	Seeding rate adjusted to achieve desired densities
1st irrigation	June 11, 2009	June 15, 2009
Cutting date	Sept. 3, 2009	Sept. 15, 2009
Threshing date	Sept. 10, 2009	Oct. 6, 2009
Soil type	Wasco fine sandy loam	Hanford fine sandy loam
Moisture Monitoring	Flow meters in gated pipe; Neutron probes at 1-ft intervals to 6 ft	Soil moisture blocks (Watermark sensors) at 1-ft intervals to 5 ft

Four interior rows of each plot were harvested for data. Beans were cleaned and a 100-gram sample was counted to assess seed size. Commercially, CB 50 has 400-420 beans/100 g while CB 46 ranges from 460-520 beans/100 g. Smaller beans (>450/100 g) are marketed domestically while larger beans (<450/100 g) are desirable for the export market. Results from the ANOVA are in Table 2.

Conventional Irrigation Treatment

Alternate Furrow Irrigation Treatment

RESULTS

Fig. 2. Shafter neutron probe readings (in/ft of soil).

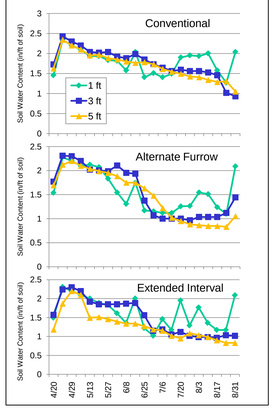
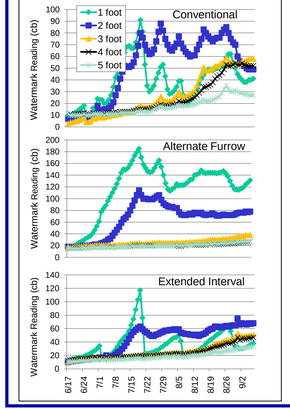


Fig.3. Kearney moisture sensor readings (cb).



In both trials, water content in the 2 ft zone and below declined through the season (Figures 2 and 3). Root zones below 1 ft were not fully recharged regardless of treatment. At Shafter, applied water in the **Conventional** treatment was 25 inches and 16 inches in the deficit treatments. Average available soil moisture was 75% during pod fill in the **Conventional** treatment and 50% for the stressed treatments. At Kearney, moisture sensors at the1 ft level in the **Alternate** treatment often exceeded 120 cb, while in the **Extended** treatment sensors recorded values higher than 120 cb only once.

Table 2. Probabilities from ANOVA for Yield and Seed Count.

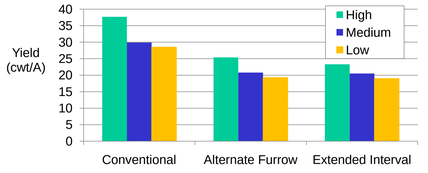
	Shafter		Kearney	
	Yield	Seed Count	Yield	Seed Count
Irrigation	0.0000	0.0020	0.0001	0.0194
Variety	0.0108	0.0000	NS	0.0000
Irrigation x Variety	0.1209	0.0002	NS	NS
Density	0.0000	0.2172	0.0037	0.0016
Irrigation x Density	0.0328	NS	NS	NS
Variety x Density	0.0022	NS	NS	NS
Irrig x Variety x Density	NS	NS	0.0045	NS
CV(%)	*12.12*	*2.95*	*22.38*	*2.81*

Table 3. Bean Yield and Seed Count.

	Yield (cwt/acre)		Number of Beans/100 g	
	Shafter	Kearney	Shafter	Kearney
Irrigation				
Conventional	32.0 a	39.9 a	414.3 b	430.6 a
Alternate	21.8 b	26.1 b	401.8 a	441.0 b
Extended	21.0 b	25.7 b	401.6 a	446.1 b
LSD	*1.90*	*4.62*	*6.53*	*9.94*
Variety				
CB 46	26.6 a	31.1	451.4 b	487.8 b
CB 50	23.3 b	30.0	360.4 a	390.6 a
LSD	*2.42*	*NS*	*5.43*	*9.33*
Plant Density				
High	28.8 a	33.3 a	403.1	432.6 a
Medium	23.7 b	31.2 a	407.7	440.5 b
Low	22.3 b	27.2 b	406.9	444.6 b
LSD	*1.43*	*3.55*	*ns*	*6.40*
CV(%)	*12.1*	*22.4*	*2.95*	*2.81*

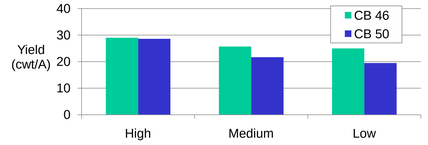
At Shafter, the **Conventional** treatment produced significantly more beans than the other irrigation treatments, which were not significantly different from each other. CB 46 produced 3.3 more cwt/acre than CB 50 (Table 3). There were significant interactions between irrigation treatment and plant density (Table 2, Figure 4). There was no difference in response within the deficit irrigation strategies, but in the **Conventional** treatment, all 3 densities produced more beans than the deficit irrigation treatments.

Fig. 4. Irrigation x Density Yield Interaction at Shafter.



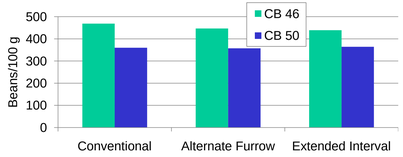
There was also a significant interaction between variety and plant density (Table 2, Figure 5). CB 46 and CB 50 produced similar yields in the high density planting, but at the lower density plantings, CB 46 out-produced CB 50.

Fig. 5. Variety x Density Yield Interaction at Shafter.



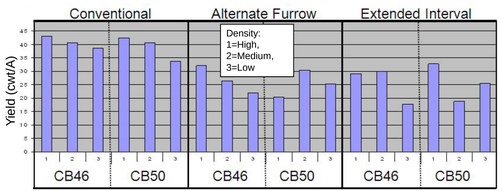
At Shafter, seed size was larger in the two deficit treatments, but there was an interaction between irrigation and variety (Table 2, Fig. 6). Seed size of CB 50 remained relatively constant across the irrigation treatments while seed size of CB 46 increased in the deficit irrigation treatments.

Fig. 6. Irrigation x Variety Seed Count Interaction at Shafter.



At Kearney, there was a significant interaction between irrigation, variety, and plant density on yield, indicating the two varieties responded differently to the irrigation strategies based on planting density (Table 2, Fig. 7). Yields were higher in the **Conventional** treatment (40 cwt/A vs. about 26 cwt/A in either of the deficit irrigation treatments) and yields were also generally higher in the more densely planted plots (Table 3). There was no difference in yield between the two varieties when averaged over all treatments.

Fig. 7. Irrigation x Variety x Density Yield Interaction at Kearney.



At Kearney, seed size was larger in the **Conventional** irrigation treatment compared to either of the deficit irrigation treatments, which were not significantly different from each other (Table 3). Unlike at Shafter, seed size responded to plant density with larger beans produced in the high density plantings.

SUMMARY

- Reducing the amount of applied water for blackeye production had consequences in terms of yield in both locations. **Alternate Furrow** and **Extended Interval** treatments reduced yields by an average of 34% compared to the **Conventional** irrigation treatment.
- Sixteen inches of water yielded 26 cwt/A at Shafter using either deficit irrigation strategy. In the case of a limited but not expensive water supply, alternate furrow or extended interval practices may be an option for growers.
- Reducing the applied water by 9 acre-inches in the deficit irrigation treatments decreased yields by 11 cwt/acre at Shafter. Assuming a blackeye cowpea price of $32/cwt, water costs would have to be $469/acre-ft or more in order for growers to consider reducing applied water as was done in these trials.
- There appeared to be an advantage in yield and size with higher density plantings.
- Seed size response to reductions in applied water was inconsistent between locations.
- Future studies could help resolve the differences in results between the locations, but funding is limited for this relatively small acreage crop.