Irrigation and Other Management Effects on Soybean Yield

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Introduction

With occasionally dry conditions, including the widespread drought across much of the U.S. Corn Belt in 2012, the response of soybean [*Glycine max* L. (Merr.)] to irrigation, and whether or not irrigation affects responses to other management inputs, are of considerable interest. The evaluation of irrigation under normal precipitation would be of value as well, as researchers and producers look for ways to maximize soybean yield potential.

Objective

We undertook these studies to evaluate the effect of supplemental irrigation on soybean yield across seven sites at four Illinois locations, and to assess the effect of irrigation on the response of soybean yields to other management inputs, including foliar fungicides and in-season N fertilizer application.

Figure 1. Irrigated and non-irrigated soybeans during late September at Brownstown, IL

Study Design and Sites

- Designed as a split-plot design, with irrigation (with and without) assigned to main plots
- Randomized complete block arrangement of management inputs with four replications
- Sites and years:
  - Brownstown in south-central Illinois, 2009
  - Carbondale in south-southwestern Illinois, 2009
  - Dixon Springs in south-southeastern Illinois, 2008 and 2009
  - Urbana in east central Illinois, 2008, 2009, and 2010
- Experimental Units consisted of plots 7, 38-cm rows 8 to 12 m long, depending on site

Materials and Methods

- Irrigation was applied to supplement rainfall (Table 1), with rainfall plus irrigation generally totaling 100 to 125 mm per month in July, August, and early September
- Fungicide: Headline (pyraclostrobin) fungicide was applied as its labeled rate at R3 and again R5/R6
- Nitrogen: Dixon Springs and Brownstown had 156 kg ha^{-1} of Polyon® (43% N) slow release nitrogen applied early in the growing season. In 2008 at Urbana 112 kg ha^{-1} of urea (45% N) was applied at R3, R5, and at R6. At Carbondale and at Urbana in 2009 and 2010, 112 kg ha^{-1} of dry urea and 8.3 kg ha^{-1} of CoRoN® (slow-release N) as foliar spray were applied at both R2 and again at R5.
- The center 1.5 m (4 rows) of each plot was harvested using a plot combine and yield corrected to 87% dry weight.

Table 1. Monthly rainfall by environment

	Brownstown		Dixon Springs		
Month	2009	Avg†	2008	2009	Avg
	mm				
May	174	138	112	156	141
June	123	105	55	92	103
July	113	101	165	241	98
August	42	76	61	72	84
September	27	81	63	115	90

	Carbondale		Urbana			
Month	2009	Avg	2008	2009	2010	Ave
	mm					
May	177	136	149	130	78	124
June	104	115	133	108	199	110
July	189	93	202	156	91	119
August	149	83	17	137	40	100
September	72	80	202	16	77	80

† 30 Year Averages from 1981 to 2010 (Illinois State Water Survey)

Results

Table 2. ANOVA by environment of soybean yield for main effects and interactions. Management includes in-season N and foliar fungicide.

	Brownstown	Dixon Springs	
Fixed Effect	2009	2008	2009
Irrigation	*	NS	NS
Management	*	NS	NS
Irr*Mgt	NS†	NS	NS

	Urbana			Carbondale
Fixed Effect	2008	2009	2010	2009
Irrigation	*	NS	NS	*
Management	NS	*	*	*
Irr*Mgt	NS	NS	NS	NS

* Significant at the $P = 0.1$ probability level
† NS = not significant at $P = 0.1$

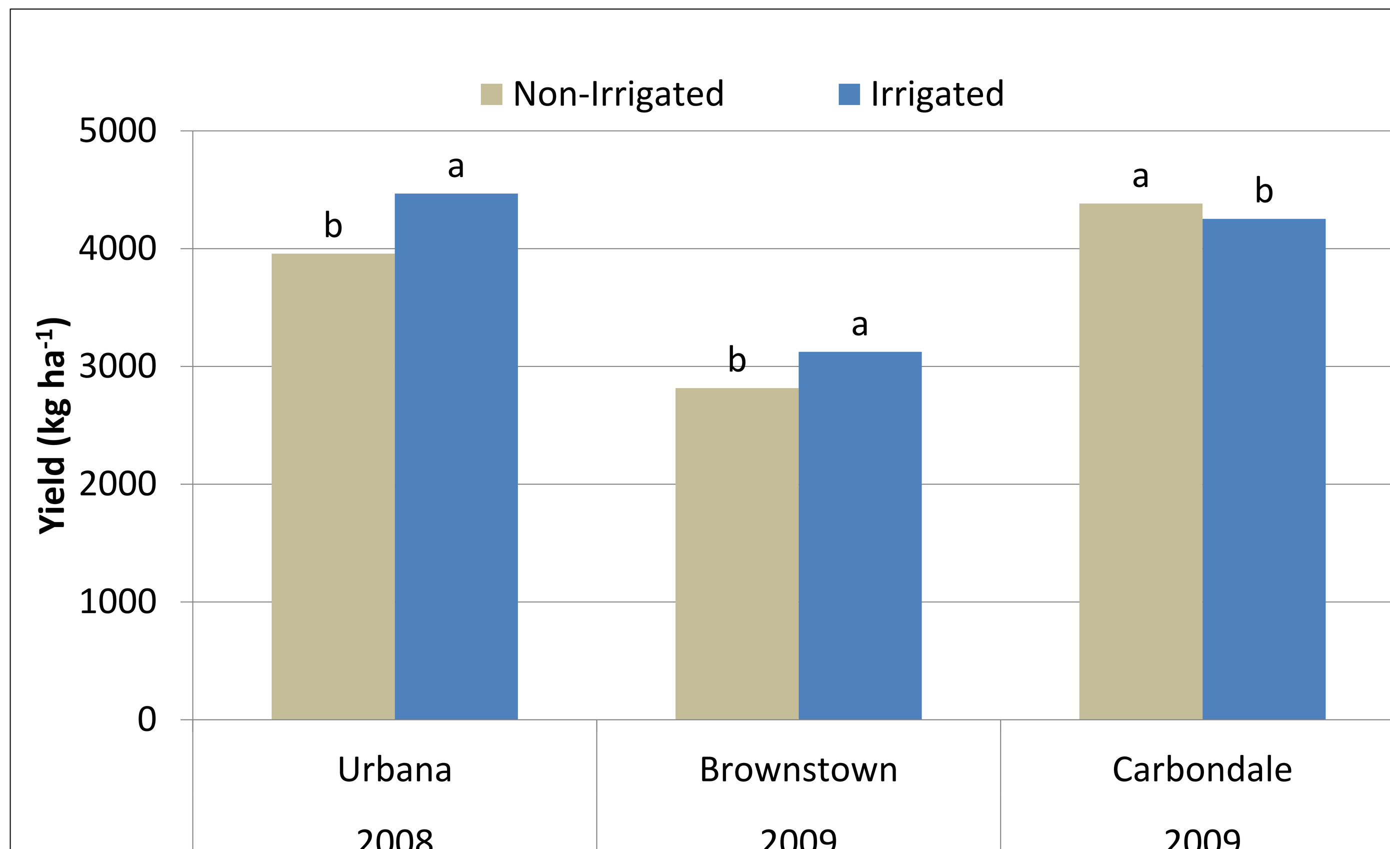

Figure 2. Soybean yield response to irrigation in the three (of seven) environments in which yield responded significantly (α = 0.10) to irrigation, averaged across management inputs.

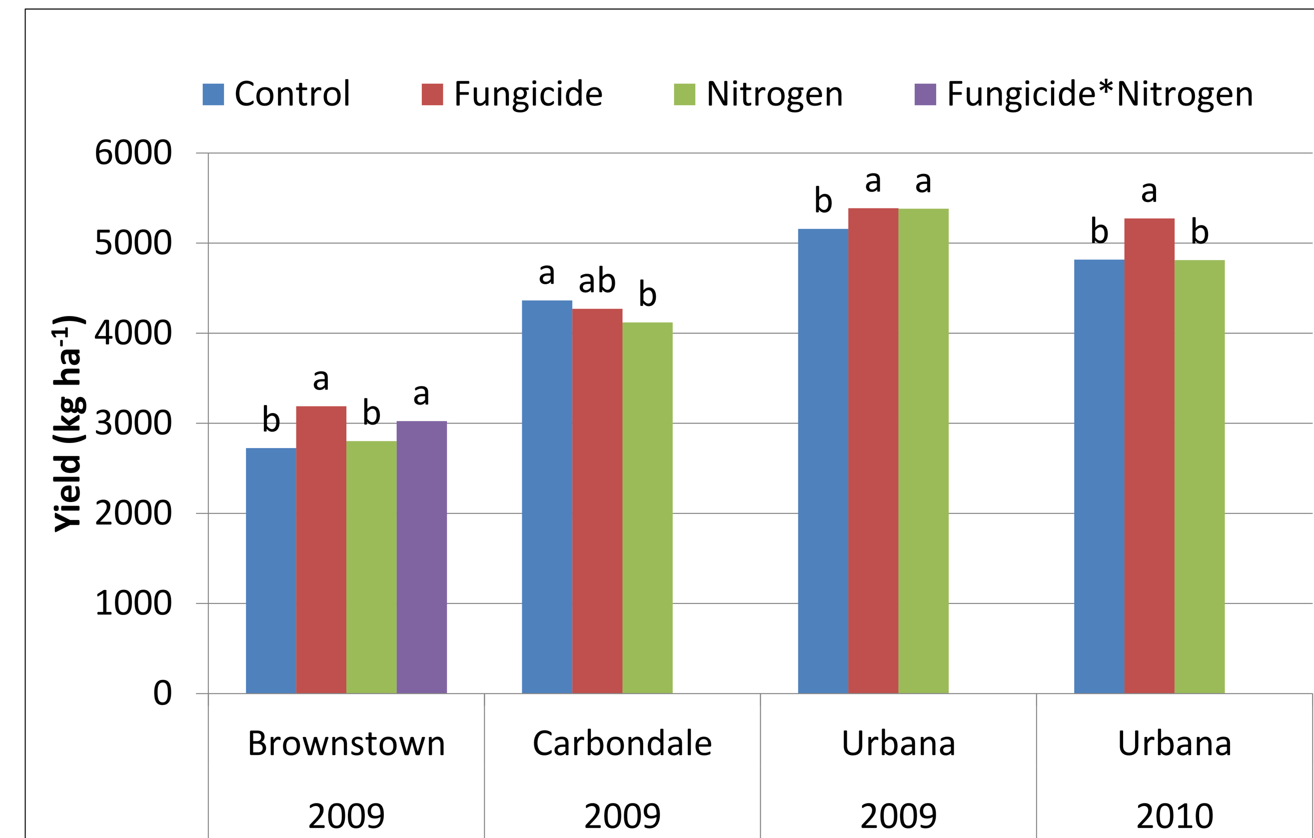

Figure 3. Soybean yield response to management inputs in the four (of seven) environments in which yields responded significantly (α = 0.10) to management inputs, averaged across irrigation treatments. Different letters indicate that treatments yielded different at α=0.10 within that environment.

Summary and Conclusions

- The yield response to irrigation ranged from +510 to - 321 kg ha^{-1}, with Urbana in 2008 and Brownstown in 2009 showing 12.9 and 10.9% higher yield with irrigation (Figure 2), respectively, and with Carbondale in 2009 showing a 131 kg ha^{-1} (3.0%) lower yield in irrigated plots. Over all sites, irrigation increased yields by only 60 kg ha^{-1}, or 1.4%.
- Irrigation was most effective in increasing yields during years when August rainfall was well below normal (Table 1) and in soils with lower water-holding capacity.
- Averaged across irrigation treatments, foliar fungicide significantly increased yields in three of seven environments (Figure 3), with an average increase across all seven environments of 244 kg ha^{-1}, or 5.9%.
- Across irrigation treatments, in-season N increased yield in two environments and decreased yield in one environment (Figure 3). Over all trials, adding N increased yield by an average of only 46 kg ha^{-1}, 1.1%.
- Both in-season N and fungicide (NF) were included as a treatment in four environments, and influenced yield at only one of these. At Brownstown (2009), the NF treatment was statistically equal to the fungicide treatment and greater than both the control and the in-season N treatments. In other environments that included NF, this treatment produced yields between those from the fungicide and N treatments alone.
- Irrigation and management inputs did not interact in their effect on yield in any environment (Table 2).
- These trials have shown that, while irrigation can increase yield modestly in certain environments, it appears that stress due to lack of water has to be fairly severe during seed filling (August) for this effect to be consistent.
- The lack of interaction amount irrigation, N, and fungicide in these trials suggests that reducing yield limitations due to water through irrigation does not consistently move foliar disease or plant N supply into the position of most-limiting factor.

Acknowledgements

We thank the Illinois Soybean Association for funding this work. We acknowledge with gratitude the willing and able assistance in plot establishment, care, and harvest provided by Darin Joos, Nathan Mellendorf, Brian Henry, Lindell Deal, Dr. Steve Ebelhar, Dr. Bryan Young (SIU at Carbondale), and personnel of the UI South Farm and of the other Centers.