EFFICIENT MANAGEMENT OF ILLINOIS WATER AND NUTRIENT RESOURCES: ASSESSING THE POTENTIAL FOR DRIP IRRIGATION AND FERTIGATION

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EXECUTIVE SUMMARY

The industry-wide initiative of doubling corn grain yields by 2030 is required to feed a growing world population, while still meeting needs for biorenewable energy. The use of precision irrigation and fertilizer application technology may serve as a promising opportunity for producers to increase yields sustainably. Therefore, our primary objectives were to, 1) investigate drip irrigation as a possible strategy to improve the efficiency of nutrient uptake and use when liquid nutrients are applied at key growth stages, and 2) understand how drip irrigation and fertigation can be optimized in a high yield agronomic system with complementary agronomic management practices including hybrid and variety selection and crop protection. Across all corn hybrids and planting populations, yield improvements by as much as 18 to 22 bu Ac^{-1} were measured due to the season-long fertigation of N, K, and S. Fertigation increased total nutrient accumulation over a base fertilizer application for N (+19%), K (+27%), and S (+16%) leading to nutrient recovery efficiencies of over 40% for N and K. Nutrients were also fertigated in soybean (N, K, and S) and improved grain yield by as much as 6.1 bu Ac^{-1}. Varietal differences in response to fertigated nutrients clearly suggest that this tool may be used to classify soybean varieties for their responsiveness to agronomic management which, to our knowledge, has never been demonstrated. The 2014 findings highlight significant yield improvements associated with adequate nutrient availability in corn and soybean, and how innovative liquid nutrient sources and delivery methods (i.e., SDI) were used as a strategy to increase nutrient recovery efficiencies beyond those frequently experienced by producers.

JUSTIFICATION AND BACKGROUND

While irrigated crop acreage in Illinois is limited in scope (435,000 acres or approximately 2% of total crop acres as of a 2005 survey), it has experienced a 48-fold increase compared to the first estimate of irrigated Illinois crop production in 1950 (Roberts, 1951; USGS, 2005). The current distribution of irrigated corn and soybean production is mainly located in the Havana Lowlands (Mason and Tazewell Counties), the Green River floodplain (Lee and Whiteside Counties), and areas along the Wabash River (Bowman and Collins, 1987). These regions are characterized by light-textured soils with reduced water holding capacity; however, there has also been continued expansion of irrigation in areas with heavier soils such as northern Champaign County. Although irrigation is often a necessity in areas with sandy soil textures (e.g., Mason County), use of irrigation in other areas may become attractive to crop producers as a strategy to reduce annual yield variability associated with insufficient precipitation or for high-value crops such as seed corn production. As such, irrigated crop acres in Illinois are anticipated to expand by an additional 40% by the year 2025 (Dziegielewski et al., 2005). It is likely, however, that other factors may accelerate the prevalence of irrigation in Illinois and other traditionally non-irrigated parts of the Corn Belt. These include 1) high commodity and input prices, 2) catastrophic weather events such as the 2012 drought, and 3) the demand for increased agricultural productivity in response to world population growth. Use of irrigation cannot be approached without considering regional impacts on water resources. Thus, current irrigation technologies such as center-pivot irrigation could be replaced in favor of more efficient innovations such as sub-surface drip irrigation.

Sub-surface drip irrigation (SDI) is not a new technology and has been used for many years in the production of high-value vegetable and fruit crops such as tomato. More recently, it has been adopted for commodity rows crops such as corn and cotton as an alternative to center-pivot or flood irrigation. The benefits of a SDI system relative to other traditional irrigation forms include reduced water use brought about a reduction in evaporation losses (by up to 50%; Lamm and Trooien, 2003), and the ability to adapt to any field size, geometry, or topography (Netafim, 2010). Additionally, SDI provides the opportunity to increase the efficiency of nutrient application through the practice of fertigation (i.e., liquid fertilizer sources supplied with irrigation water). Fertigation of nutrients directly into the root microenvironment, particularly during periods of rapid uptake, can minimize nutrient losses associated with immobilization, volatilization, or surface run-off (Hartz and Hochmuth, 1996). The ability to precisely apply plant nutrients at the right place, in the right amount, and at the right time, however, requires an understanding of the seasonal nutrient accumulation patterns in corn and soybean production systems.

A series of studies conducted over the past three years by the University of Illinois Crop Physiology Laboratory have identified the fertility requirements for high-yielding corn (Bender et al., 2013) and soybean (Bender et al., 2015; Table 1). Total nutrient requirements for soybean are similar to those of corn, despite the misconception among farmers that nutrient management in soybean is less critical because of N-fixation as well as the notion that fertilizer supplied to a corn crop will also meet subsequent soybean fertility requirements. Nutrient harvest index values (i.e., the portion of total nutrient uptake represented in grain tissues) of N, P, S, and Zn in both corn and soybean are generally between 60-80%; which suggests that soil test levels will quickly decline if provided inadequate crop nutrition. This may partially explain the decreases in P, K, S, and Zn levels reported by a recent IPNI summary of soil fertility levels (Fixen et al., 2010). Achieving maximum yields while also sustaining the productivity of Illinois soils will require a comprehensive season-long fertility plan designed to meet the uptake needs of well-managed corn and soybean crops.

Table 1. Mineral nutrition required to produce 230 bu acre^{-1} corn (adapted from Bender et al., 2013) and 60 bu acre^{-1} soybean (adapted from Bender et al., 2015). 'Maximum Uptake' (total nutrient uptake), 'Removal with Grain' (nutrient content of grain), and 'Harvest Index' (portion of total nutrient uptake represented in grain tissue) are three key measures used to estimate nutritional needs in a cropping system.

Nutrient	**Maximum Uptake**		**Removal With Grain**		**Harvest Index**	
	Corn	Soybean	Corn	Soybean	Corn	Soybean
	—— lb ac^{-1} ——		—— lb ac^{-1} ——		—— % ——	
N	256	245	148	179	58	73
P_2O_5	101	43	80	35	79	81
K_2O	180	170	59	70	32	41
S	23	17	13	10	57	61
Zn (oz ac^{-1})	7.1	4.8	4.4	2.0	62	44

Macronutrient accumulation varies considerably among crop and mineral nutrient. In corn, the majority of N and K accumulation occurs before flowering compared to uptake of P, S, and Zn, which primarily occurs during grain-filling (Bender et al., 2013). Because nutrient applications for corn production primarily supply nutrients in a bulk, dry granular form prior to planting, most nutrients are prone to chemical conversion or are fixed into unavailable forms before plant uptake. The potential for nutrient fixation or environmental pollution occurs for soybean as well, with an estimated 118, 19, and 48 lb ac^{-1}, respectively, of N, P_2O_5, and K_2O uptake required after the initiation of pod-filling (Bender et al., 2015).

We believe that drip irrigation may become a component of the future agricultural landscape in Illinois, but perhaps more importantly, that improved fertilizer application might be achieved with subsurface drip irrigation and liquid fertilizer sources. The importance of supplying nutrients at key growth stages may be more crucial for intensively managed corn and soybean production systems where other factors such as germplasm, pest control, plant density, and row spacing have been optimized. This project is designed to be forward-looking and assess how drip irrigation and fertigation might be used in the future to increase Illinois corn and soybean yields while also improving nutrient use efficiency.

WORK PLAN

Site characteristics and cultural practices

Experiments were conducted at the Crop Sciences Research and Education Center in Champaign, IL using adjacent plots maintained in a corn-soybean rotation. This site has been established by the University of Illinois Crop Physiology Laboratory as a long-term study site on a tile-drained silt loam. Plots were planted on 15 June 2014 to a Drummer Flanagan soil (silt loam, 3.6% organic matter; 21.1 meq/100g CEC, 5.8 pH, 22 ppm P, 99 ppm K, and 9.5 ppm S using Mehlich-3 extraction). Corn and soybean experiments were maintained weed- and disease-free and were well-suited to provide evenly distributed soil fertility, pH, soil organic matter, and water availability. Currently available corn and soybean varieties that have been previously identified as having high yield potential and responsiveness to management were used. Plots were 37.5 feet (corn) or 36 feet (soybean) in length with 30-inch row spacing.

In 2012 and 2013, we completed four preliminary experiments using a surface drip irrigation system provided in part by Netafim USA. Based on this initial experience and success, we installed a permanent subsurface drip irrigation system equipped with programmable controllers and fertilizer injection equipment during fall 2013/spring 2014. Dripper lines were placed 14 to 16 inches beneath the soil surface with 30-inch spacing between lines. A total of 48 independently controlled zones were included; 24 for corn plots and 24 for soybean plots. Water and nutrient applications were varied according to each zone.

Research approach

Two studies were conducted during 2014 to adapt drip irrigation and fertigation to modern management practices in a corn-soybean rotation. Experiment one used a nutrient application schedule based on the patterns of nutrient acquisition and timing for corn as described by Bender et al. (2013). This study utilizes a split-block experimental design to evaluate the responsiveness of various hybrids to fertigation and was compared to an unfertilized control.

Experiment two used a nutrient application schedule designed using nutrient uptake patterns for soybean (Bender et al., 2015). The study was similarly designed as a means to understand the varietal response to fertigation with a tailored nutrient application schedule. Both studies were balanced with water regimes across all treatments.

Nutrient application scheduling

Nutrient uptake patterns describing the quantity and timing of nutrient accumulation were used for corn (Bender et al., 2013) and soybean (Bender et al., 2015) to estimate seasonal nutrient application rates. Total nutritional requirements needed to produce 230 bu acre^{-1} of corn were measured, but in a non-irrigated environment. Using these values and the timing at which nutrients were acquired, a seasonal fertigation design was used to supply 80 lbs N, 70 lbs K_2O, and 14 lbs S during seven fertigation periods between V6 to R2 in addition to a standard application of 180 lbs N Ac^{-1} as urea at V4.

The schedule for soybean nutrient fertigation was based largely upon soybean nutrient uptake curves (Bender et al., 2015) and recommendations for soybean fertigation by Bar (2004). A total of 50 lb N, 76 lb K_2O, and 16 lb S were applied during six fertigation periods between V4 and R7.

Measured Parameters

Cumulative rainfall, irrigation events, and temperature were collected season-long and are reported below. The center two rows of each plot were mechanically harvested for grain yield and measurement of yield components (corn only). At physiological maturity, whole plant biomass and nutrient accumulation was measured for each corn hybrid and select soybean varieties as to estimate the recovery efficiency of applied nutrients.

RESULTS

Weather and Supplemental Irrigation

Environmental conditions during 2014 generally consisted of above-average precipitation with below-average temperatures with little weather induced stress (Figure 1). As a result, record yields were recorded for soybean and corn at the local, state, regional, and national level. Limited in-season irrigation was necessary because of above-average rainfall during 2014 and as a result, irrigation was primarily used as a medium for fertigation in the current studies. Despite the delayed planting of corn and soybean trials due to the construction of the SDI system, measured yield responses to fertigation and agronomic management provided critical insight for maximum yields.

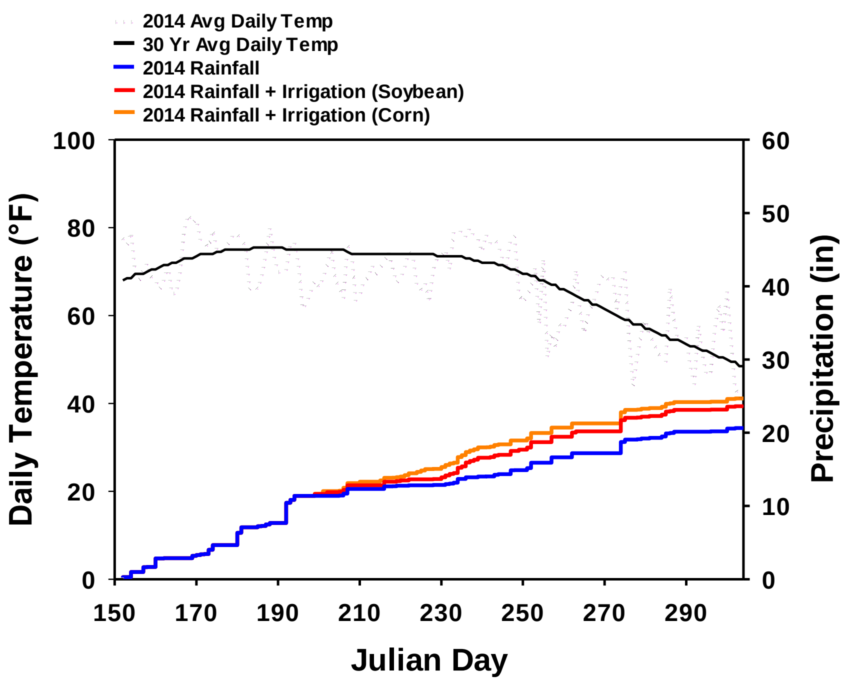

Figure 1. Actual and 30 Yr averages for daily average temperature, cumulative precipitation, and cumulative precipitation + irrigation measured at Champaign, IL during 2014. The total volume of water supplied in the fertigated corn and soybean trials totaled 4.04 and 2.94 inches, respectively.

Corn Fertigation Trial: Yield and Yield Components

Hybrid, population, and fertigation served as significant sources of variation for grain yield (Table 2). Although planting populations and hybrids responded differently to fertigation (Table 3 and Table 4), an overall yield improvement by an average of 18 bu Ac^{-1} occurred due to fertigation. Fertigation significantly increased yield by an average of 18 to 22 bu Ac^{-1} across hybrids except for N79Z-3000GT, which only realized a 10 bu Ac^{-1} yield increase (Table 3). Measured yield gains between hybrids occurred via contrasting yield component responses, suggesting that the time of nutrient availability may be especially critical for some hybrids. When introduced to fertigation, the yield improvement associated with DKC62-08 and DKC63-33 was primarily associated with increased kernel number (+9 to 11%; Table 6). By contrast, greater yields observed with hybrids N63R-3000GT and N79Z-3000GT were primarily derived from improved kernel weight (+5 to 7%; Table 6).

The authors hypothesized that complementary agronomic practices necessary to maximize yield in a fertigated environment would also include greater planting densities. Data reported in table 4 tend to support this conclusion in which yields peaked at approximately 6,000 plants Ac^{-1} greater than in the irrigated control. Furthermore, the yield response to fertigation across hybrids tended to increase with greater planting densities: +16 bu Ac^{-1} at 24,000 plants Ac^{-1}, +14 bu Ac^{-1} at 30,000 plants Ac^{-1}, +18 bu Ac^{-1} at 36,000 plants Ac^{-1}, +22 bu Ac^{-1} at 42,000 plants Ac^{-1}, and +18 bu Ac^{-1} at 48,000 plants Ac^{-1} (Table 4). Consistent yield component responses across all population levels suggest that fertigation improved season-long growth leading to increased kernel number (+3 to 6%) in addition to kernel weight (+4 to 5%; Table 7).

A significant three-way interaction between hybrid, population, and fertigation treatment (Table 2) suggested that individual hybrids had differential responses to fertigation. N63R-3000GT, for example, was selected for its unique tolerance for high population as identified in previous studies. As a result, the improvement in yield associated with fertigation gradually increased from low (+9 bu Ac^{-1}) to high (+26 bu Ac^{-1}) planting densities (Table 5). Hybrids previously characterized as less responsive to population measured the greatest responses to fertigation at more moderate population levels: +36 bu Ac^{-1} at 36,000 plants Ac^{-1} (DKC62-08), +35 bu Ac^{-1} at 42,000 plants Ac^{-1} (DKC63-33), and +21 bu Ac^{-1} at 24,000 plants Ac^{-1} (N79Z-3000GT; See Table 5). Maximizing the utility of SDI as a fertigation tool clearly requires matching in-season nutritional needs and, perhaps even more importantly, selecting appropriate planting densities for each hybrid.

Table 2. Analysis of variance for yield and yield components for the fertigated corn trial conducted at Champaign, IL during 2014. Nutrients including N (80 lbs N Ac^{-1}), K (70 lbs K_2O Ac^{-1}), and S (14 lbs S Ac^{-1}) were supplied in the fertigated treatment as UAN or Potassium Thiosulfate. The entire plot area was balanced for total water applied and received 180 lbs N Ac^{-1} as urea at V4.

Source of Error	Yield	Kernel Number	Kernel Weight
		P < F	
Fertigation (F)	<0.001	0.007	<0.001
Hybrid (H)	<0.001	<0.001	<0.001
F x H	0.013	<0.001	<0.001
Population (P)	0.004	<0.001	<0.001
F x P	0.575	0.613	0.787
H x P	<0.001	<0.001	0.038
F x H x P	0.006	<0.001	0.180

Table 3. Effect of hybrid selection and fertigation treatment on grain yield at Champaign, IL during 2014.

Hybrid	Irrigated	Fertigated	Average
		Yield (Bu Ac^{-1})	
DKC62-08	155	175*	165
DKC63-33	180	202*	191
N63R-3000GT	180	200*	190
N79Z-3000GT	189	199*	194
LSD (α = 0.10)	5	5	3

* Yielded significantly greater than irrigated treatment at α=0.10.

Table 4. Effect of planting population and fertigation treatment on grain yield at Champaign, IL during 2014.

Population	Irrigated	Fertigated	Average
Plants Ac^{-1}		Yield (Bu Ac^{-1})	
24,000	172	188 *	180
30,000	181	195 *	188
36,000	179	197 *	189
42,000	174	196 *	185
48,000	175	193 *	184
LSD (α = 0.10)	5	5	4

* Yielded significantly greater than irrigated treatment at α=0.10.

Table 5. Effect of planting population, hybrid selection, and fertigation treatment on grain yield at Champaign, IL during 2014.

Population	Irrigated	Fertigated	Average
Plants Ac^{-1}		Yield (Bu Ac^{-1})	
DKC62-08			
24,000	165	175	170
30,000	163	181*	172
36,000	148	184*	166
42,000	149	165*	157
48,000	148	172*	160
DKC63-33			
24,000	175	200*	188
30,000	191	203*	197
36,000	183	203*	193
42,000	173	208*	191
48,000	179	197*	188
N63R-3000GT			
24,000	170	179	175
30,000	185	199*	192
36,000	184	205*	194
42,000	182	209*	196
48,000	181	207*	194
N79Z-3000GT			
24,000	179	200*	190
30,000	183	198*	190
36,000	201	197	199
42,000	192	203	197
48,000	190	194	192
LSD (α = 0.10)	11	11	7

* Yielded significantly greater than irrigated treatment at α=0.10.

Table 6. Effect of hybrid selection on yield components at Champaign, IL during 2014. The means shown are for fertigated plots only and values in parentheses indicate the difference relative to the irrigated control.

Hybrid	Kernel Number	Kernel Weight
	kernel number m^{-2}	mg $seed^{-1}$
DKC62-08	3252 (+266)*	276.0 (+12.2)*
DKC63-33	4054 (+410)*	256.7 (+2.6)
N63R-3000GT	3374 (+72)	302.7 (+19.8)*
N79Z-3000GT	3817 (-26)	266.5 (+12.9)*

* Significantly greater than irrigated treatment at α=0.10.

Table 7. Effect of planting density on yield components at Champaign, IL during 2014. The means shown are for fertigated plots only and values in parentheses indicate the difference relative to the irrigated control.

Population	Kernel Number	Kernel Weight
Plants Ac^{-1}	kernel number m^{-2}	mg $seed^{-1}$
24,000	3243 (+156)*	295.3 (+10.4)*
30,000	3534 (+109)	282.6 (+13.2)*
36,000	3741 (+180)*	271.5 (+13.2)*
42,000	3773 (+245)*	267.5 (+13.0)*
48,000	3829 (+212)*	260.4 (+9.6)*

* Significantly greater than irrigated treatment at α=0.10.

Corn Fertigation Trial: Nutrient Accumulation Measurements

At physiological maturity (R6), nutrient accumulation was measured in the above-ground stover and grain and combined for total nutrient accumulation. Statistical analysis was conducted on this parameter and is reported for select nutrients in table 8. Although hybrid selection and population influenced total nutrient accumulation, the primary source of error for applied nutrients (i.e., N, K, and S) was the fertigation treatment (Table 8). Fertigation increased total nutrient accumulation by 16%, 19%, and 27% for S, N, and K respectively (Table 9). Even for non-fertigated nutrients such as phosphorus, an increase in total nutrient accumulation occurred (+7%, Table 9) and was likely a consequence of a greater yield potential as reported in Tables 2 to 4.

The fertilizer industry and sustainability efforts promote increased nutrient use efficiency of applied fertilizers through the 4R Nutrient Stewardship approach. Although Franzen and Gerwing (1997) suggest that as much as 50 to 75% of N and 35 to 60% of K are recovered during the year of application, anecdotal reports suggest that these values are nearly two-fold greater than typically observed. In the current study which also included a standard application of 180 lbs N Ac^{-1} to all plots, nearly 43% of supplemental fertigated N and K was recovered in aboveground biomass (Table 9). We believe that the values presented in table 9 represent significant improvements compared to traditional fertilization practices. Furthermore, the authors believe that future cultural practices which permit a more timely planting date and the use of a full complement of nutrients (i.e., including phosphorus and other micronutrients) will further improve crop yield potential and recovery efficiency of applied nutrients.

Table 8. Analysis of variance for R6 nutrient accumulation of N, P, K, and S for the fertigated corn trial conducted at Champaign, IL during 2014.

Source of Error	N	P	K	S
		$P < F$		
Fertigation (F)	<0.001	0.036	<0.001	<0.001
Hybrid (H)	<0.001	<0.001	<0.001	<0.001
F x H	0.242	0.036	0.114	0.040
Population (P)	0.156	<0.001	<0.001	0.138
F x P	0.016	0.819	0.755	0.102
H x P	0.657	0.558	0.085	0.439
F x H x P	0.034	0.756	0.867	0.109

Table 9. R6 nutrient uptake of N, P, K, and S for the fertigated corn trial conducted at Champaign, IL during 2014. Nutrients including N (80 lbs N Ac^{-1}), K (70 lbs K_2O Ac^{-1}), and S (14 lbs S Ac^{-1}) were supplied in the fertigated treatment as UAN or Potassium Thiosulfate. Recovery efficiency was calculated using the equation: (($Uptake_{Fertigated}$ – $Uptake_{Irrigated}$) / Nutrients Applied).

Treatment, Parameter	N	P_2O_5	K_2O	S
		lbs Ac^{-1}		
Irrigation	176	54.6	113	14.1
Fertigation	210*	58.6*	144*	16.4*
Recovery Efficiency (%)	42.8%	-	43.2%	16.5%

Soybean Fertigation Trial: Yield

Fertigated nutrients in the soybean trial were comprised of N (50 lbs N Ac^{-1}; R5 to R7), K (76 lbs K_2O Ac^{-1}; V4 to R4), and S (16 lbs Ac^{-1}; V4 to R4). The main effects and interaction between fertigation and variety selection (n = 15), were significant sources of variation for grain yield (Table 10). Each of the 15 varieties ranged in RM from 2.7 to 4.2 which presumably bracket the ideal maturity of 3.2 to 3.8 for Champaign, IL.

Fertigated soybean yields ranged from 60.2 to 68.2 bu Ac^{-1} (Table 11) with an average response of +2.3 bu Ac^{-1} (P = 0.001). The effect of relative maturity as a function of variety selection did not appear to influence the response to fertigation, though we believe the highest soybean yield potential requires a well-managed, full-season RM variety which is planted as early as permissible for the region.

Hybrid management evaluations in corn using varying nitrogen fertilization rates and planting densities have been used by the Crop Physiology Laboratory to classify a hybrid's responsiveness to crop management. Further insight allows producers to position specific hybrids in certain environments for optimal crop performance. Because of the indeterminate nature of soybean and its ability to compensate for seasonal biotic and abiotic stresses, classification of soybean varieties for their responsiveness to agronomic management has been especially difficult. Preliminary research at the Crop Physiology Laboratory suggests that responsiveness to supplemental fertilization may be used as a proxy for tolerance of additional agronomic practices. The results in the current study suggested that six of the 15 varieties resulted in significant yield responses to fertigation by nearly 4.8 bu Ac^{-1} (Table 11). Coincidentally, a variety's magnitude of yield response to fertigation in the current study was at least partially predictive of their responsiveness to agronomic management (e.g., fertilization, row spacing, crop protection products, etc.) in supplementary trials. The initial results of this study clearly highlight the importance of proper variety selection and how the SDI system may be used as a tool to further predict responsiveness to agronomic management.

Table 10. Analysis of variance for yield and R8 Biomass for the fertigated soybean trial conducted at Champaign, IL during 2014. Nutrients including N (50 lbs N Ac^{-1}), K (76 lbs K_2O Ac^{-1}), and S (16 lbs S Ac^{-1}) were supplied in the fertigated treatment as UAN or Potassium Thiosulfate. The entire plot area was balanced for total water applied.

Source of Error	Yield	R8 Biomass
	P < F	
Fertigation (F)	0.001	0.290
Variety (V)*	<0.001	<0.001
V x F	0.063	0.723

* A subset of six varieties were measured for biomass accumulation at R8: AG3634, AG3832, R2C3113, R2C3822, S32-L8, S39-U2.

Table 11. Effect of variety selection and fertigation treatment on yield at Champaign, IL during 2014.

Variety	Relative Maturity	Irrigated	Fertigated	Average
		Yield (Bu Ac^{-1})		
S27-J7	2.7	62.5	61.7	62.5
AG2933	2.9	62.1	68.2*	62.1
S29-G4	2.9	63.1	65.6	63.1
31A32	3.1	61.2	66.3*	61.2
R2C3113	3.1	60.7	62.1	60.7
S32-L8	3.2	59.6	60.2	59.6
R2C3323	3.3	66.1	66.3	66.1
AG3432	3.4	66.6	67.1	66.6
AG3634	3.6	60.2	64.6*	60.2
R2C3783	3.7	58.9	62.9*	58.9
AG3832	3.8	57.0	62.5*	57.0
R2C3822	3.8	61.8	61.1	61.8
39A22	3.9	64.4	67.8*	64.4
S39-U2	3.9	59.3	61.3	59.3
42A12	4.2	61.4	62.1	61.4
	LSD (α = 0.10)	3.0	3.0	2.2

* Significantly greater than irrigated treatment at α=0.10.

Soybean Fertigation Trial: Nutrient Accumulation Measurements

A subset of varieties (*n* = 6) were sampled for measurement of biomass and nutrient accumulation. Of the six randomly selected varieties, those which resulted in significant yield improvements due to fertigation (see Table 11) were classified as 'Responsive', and those with no significant yield improvements were grouped into a 'Non-Responsive' category. Although differences in variety influenced total biomass accumulation (Table 10), fertigation treatments only increased total biomass in yield 'responsive' varieties (+401 lbs Ac^{-1}; Table 12). We are currently awaiting nutrient concentration results of grain and stover tissues which will further quantify improved nutrient accumulation, partitioning, and recovery efficiency due to supplemental fertigation.

Table 12. Effect of fertigation treatment on R8 biomass accumulation for six soybean varieties grown at Champaign, IL during 2014. Based on yield results from table 10, each variety was classified as yield 'responsive' or 'non-responsive' to the fertigation regime and corresponding differences in biomass production were compared.

Variety	Irrigated	Fertigated	Difference
'Non-Responsive'	Biomass (lbs Ac^{-1})		
R2C3113	7024	7350	326
R2C3822	8069	7974	-95
S32-L8	7337	7338	1
S32-U2	7948	7882	-66
Average	7595	7636	41
'Responsive'			
AG3634	6987	7299	312
AG3832	7215	7705	490
Average	7101	7502	401*

* Significantly greater than irrigated treatment at α=0.10.

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