Poultry Litter, Potassium Thiosulfate, Foliar Micronutrient, and Fungicide Combinations for Michigan Soybean Production

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Introduction

- Greater soybean (*Glycine Max* (L.) Merr.) grain price relative to other commodities combined with combatting Michigan's year-to-year climatic variability has increased producer interest for intensive soybean management systems.
- Intensive soybean management systems commonly involve prophylactic applications of multiple inputs as a form of risk insurance.
- In contrast to intensive management, traditional management systems justify input applications utilizing university recommended integrated pest management (IPM) strategies.
- Minimal data exists pertaining to which specific inputs(s) result in the greatest yield and economic benefit.
- Commonly marketed agronomic inputs for Michigan soybean production include: poultry litter, potassium thiosulfate, foliar micronutrients, and fungicide.

Objective

Investigate soybean grain yield response and economic profitability to poultry litter, potassium thiosulfate, foliar micronutrients, and fungicide across intensive (i.e. multiple-input) and traditional (individual-input) production systems.

Materials and Methods

- Field trials initiated on 9 May 2016 and 28 Apr. 2017 in Richville, MI and 12 May 2017 in Lansing, MI.
- 'Asgrow 2433' variety was seeded in 0.76 m. rows to a population of 331,120 seeds ha^{-1}
- Omission trial design (Table 1) arranged as a randomized complete block design with four replications with individual plots measuring 4.6 m. x 131.2 m.
- Grain yield harvested from center 1.5 m. on 11 Oct. 2016 and 2 Oct. 2017 and adjusted to 135 g kg^{-1} moisture
- Economic analysis was performed using product cost estimates of \$355.83, \$34.60, \$34.60, \$42.63 ha^{-1} in 2016 and \$331.12, \$34.60, \$31.50, \$42.28 ha^{-1} in 2017 for poultry litter, potassium thiosulfate (KTS), foliar micronutrients, and fungicide, respectively. Application costs of \$18.53 and \$17.30 ha^{-1} in 2016 and 2017, respectively were estimated for poultry litter, foliar micronutrients, and fungicide. Application cost of \$34.60 ha^{-1} was estimated for surface band application of KTS in 2016 and 2017.
- Net returns calculated by total treatment cost ha^{-1} subtracted from gross revenue ha^{-1} (harvest grain price x grain yield).
- Data analyzed using the PROC GLIMMIX procedure of SAS at α=0.1. Factors removed from the intensive management system were compared to the intensive control containing all factors, and conversely, factors added into the traditional management system were compared to the traditional control containing no factors.

Figure 1. Lack of R4 vegetative growth differences observed between intensive (left) and traditional (right) managed soybeans in 2017.

Table 1. Overview of omission trial design including treatment names and inputs applied, 2016 - 2017.

		Agronomic Inputs Applied			
Treatment	Treatment Name	Poultry litter†	KTS‡	Micro§	Fungicide¶
1	Intensive (I)	Yes	Yes	Yes	Yes
2	I without Litter	No	Yes	Yes	Yes
3	I without KTS	Yes	No	Yes	Yes
4	I without Micro	Yes	Yes	No	Yes
5	I without Fungicide	Yes	Yes	Yes	No
6	Traditional (T)	No	No	No	No
7	T with Litter	Yes	No	No	No
8	T with KTS	No	Yes	No	No
9	T with Micro	No	No	Yes	No
10	T with Fungicide	No	No	No	Yes

† Poultry litter pre-plant incorporated at a rate of 0.9 Mg ha^{-1}
‡ Potassium thiosulfate (KTS) surface-banded at a rate of 11.4 L ha^{-1} at R1
§ Foliar micronutrients applied at a rate of 1.9 L ha^{-1} at R1
¶ Fungicide applied at a rate of 0.14 L ha^{-1} at R3

Table 2. Research locations, soil descriptions, chemical properties, and site mean nutrient concentrations obtained from pre-plant soil test data (sample depth 0 – 15 cm).

			Soil Test						
Year	Location	Soil Description	P	K	S	B	Mn	Zn	pH
			---------------- Mg kg^{-1} ------------------						
2016	Richville	Tappan-Londo Loam	48	182	8	1.6	44	6	7.1
2017	Richville	Tappan-Londo Loam	30	191	7	1.7	40	5.8	7.7
2017	Lansing	Capac Loam	39	117	7	0.6	34	2.9	6.5

Table 3. Monthly cumulative precipitation totals for Richville and Lansing, MI in 2016 and 2017.

Year	Location	May	June	July	Aug	Sept	Total
		--------------------------------- cm ---------------------------------					
2016	Richville	1.59	4.04	8.81	13.08	5.16	32.68
2017	Richville	5.00	12.27	2.79	5.71	3.96	29.73
30-yr avg.	Richville	8.68	10.01	9.32	8.55	9.75	46.31
2017	Lansing	6.58	8.36	6.73	3.48	3.28	28.43
30-yr avg.	Lansing	8.45	8.89	8.28	8.38	9.22	43.22

Table 4. Soybean grain yield values for 2016 and 2017. Mean grain yield of intensive and traditional control treatments displayed with remaining treatments showing change in grain yield from respective intensive or traditional control.

Treatment	2016 Richville	2017 Richville	2017 Lansing
	------------------------------Mg ha^{-1}------------------------------		
Intensive (I)	**4.31**	**3.73**	**3.92**
I w/o Litter†	+0.25	-0.31	-0.45
I w/o KTS	+0.28	-0.21	-0.29
I w/o Micro	+0.04	-0.16	-0.11
I w/o Fungicide	+0.10	+0.11	-0.05
Traditional (T)	**4.46**	**3.58**	**3.59**
T w/ Litter‡	-0.25	-0.01	+0.14
T w/ KTS	-0.19	+0.07	-0.12
T w/ Micro	-0.01	+0.14	-0.07
T w/ Fungicide	+0.05	+0.27	-0.06
I vs. T	ns§	ns	ns

* Significantly different at α=0.1 using single degree of freedom contrasts.
† Values in I w/o input rows indicate a yield (Mg ha^{-1}) change from respective intensive (I) treatment.
‡ Values in T w/ input rows indicate a yield (Mg ha^{-1}) change from respective traditional (T) treatment.
§ Non-significant

Table 5. Economic net return, 2016 - 2017. Mean net return of intensive and traditional control treatments displayed with remaining treatments showing change in net return from respective intensive or traditional control.

Treatment	2016 Richville	2017 Richville	2017 Lansing
	-----------------------US\$ ha^{-1}-----------------------		
Intensive (I)	**924.45**	**675.39**	**745.19**
I w/o Litter†	+458.60*	+247.22*	+200.21*
I w/o KTS	+165.55*	+1.54	-23.44
I w/o Micro	-65.82	-3.69	+14.48
I w/o Fungicide	-98.66	+96.38	+43.78
Traditional (T)	**1531.33**	**1152.67**	**1165.35**
T w/ Litter‡	-460.34*	-348.96*	-303.62*
T w/ KTS	-134.97*	-46.46	-108.30
T w/ Micro	-56.01	-3.89	-72.12
T w/ Fungicide	-44.43	+27.01	-78.53
I vs. T	*	*	*

* Significantly different at α=0.1 using single degree of freedom contrasts.
† Values in I w/o input rows indicate a net return (US\$ ha^{-1}) change from respective intensive (I) treatment.
‡ Values in T w/ input rows indicate a net return (US\$ ha^{-1}) change from respective traditional (T) treatment.
§ Non-significant

Results and Discussion

- No single input added generated a significant grain yield increase or positive return on investment during any of the 3 site-years (Table 4).
- Intensive soybean management containing all applied agronomic inputs did not significantly increase grain yield when compared to traditional soybean management containing no agronomic inputs (Table 4).
- Traditional management on average significantly increased producer return on investment by \$501 ha^{-1} across all 3 site-years (Table 5).
- Richville and Lansing locations produced no crop-responsive nutrient deficiencies during the 2016 and 2017 growing seasons (Table 2) which likely contributed to the lack of grain yield response to poultry litter, potassium thiosulfate, and foliar Zn, Mn, and B.
- At or below average July 2016 and 2017 rainfall during soybean reproductive growth stages (Table 3) and trial row spacing of 0.76 m. likely contributed to an overall lack of disease presence resulting in no significant fungicide response across site-years.
- Without the presence of nutrient deficiencies and/or adverse climatic conditions, results suggest minimal potential for grain yield and economic benefit from intensive soybean management.
- Trial results further demonstrate the importance of incorporating university recommended IPM programs to validate input applications rather than applying multiple inputs as risk insurance.

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