Management Effects on Corn, Soybean and Wheat Yields in Agricultural Fields with Diverse Topography

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Background:

Crop yields are influenced by many factors*:

Research Objective:

- The main objective of this study is to examine how field topography and precipitation influence performance of row crop system under different management practices in undulated terrain of southwest Michigan.

Research Questions:

- Are differences in crop yields between the studied management practices consistent across topographically diverse agricultural fields?
- Are there particular topographical settings where differences among the management practices are enhanced or reduced?
- Do topographical settings and precipitation interact in affecting the magnitude of the differences among the management practices?

Materials & Methods

Management practices:

- followed organic management recommended practices and included the same

Study period:

Study sites:

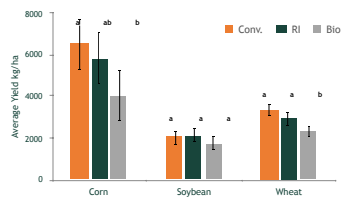
Topographical features measured:

Crops and Precipitation:

Results:

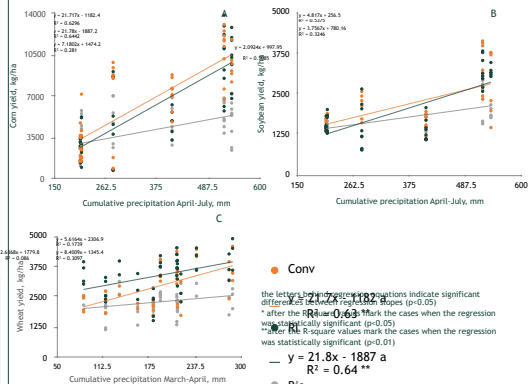
Average Yield:

Across the whole study period yields of all three studied crops followed Conv>RI>Bio pattern. Note that since only yields collected via yield monitors are studied here, Fig.1 does not include a number of instances of completely failed soybean yields.



Error bars represent standard errors. Different letters within each crop mark statistically significant differences among the management practices significant at P<0.05

Fig1. Average yield-monitor recorded yields of corn, soybean, and wheat in the three different management practices, Conv, RI, and Bio, of Farm-scale KBS-LTER experiment during 2007-2012. The zero yield data from the fields/years that experienced complete crop failure are not included.



the letters beside regression equations indicate significant differences between regression slopes (p<0.05)
* after the R-square values mark the cases when the regression was statistically significant (p<0.05)
** after the R-square values mark the cases when the regression was statistically significant (p<0.01)

Figure 2. Relationships between average yields of A) corn and cumulative precipitation from April through July, of B) soybean and cumulative precipitation from April through July, and of C) wheat and cumulative precipitation from March through April in the three studied management practices of Farm-scale KBS-LTER experiment, during 2007-2012.

Corn and soybean yields were positively correlated with precipitation of April-June and wheat yield was positively correlated with March-April precipitation. However, the strength of the correlation depended on the management practice. In all three crops regression slopes relating yields and precipitation were significantly higher in Conv and RI management practices as compared to Bio practice. Thus the greatest contrast in yields between the systems with chemical use (Conv and RI) and biologically-based (Bio) system were present in years with adequate precipitation, while minimal during dry years.

Maximum terrain slope was the topographical feature most consistently related with yields, thus it was used further to model relationships between yields, topography and precipitation (Table 1).

Table1. Multiple regression equations relating crop yield with precipitation and maximum terrain slope values in the three different management practices of Farm-scale KBS-LTER experiment during 2007-2012.

	Management Practice	Corn Estimates	R^2	Soybean Estimates	R^2	Wheat Estimates	R^2
Intercept	Conv	-2717	0.65**	-544	0.57**	4076	0.17*
Maximum slope*Treatment	Conv	266		138		-470	
Rain*Treatment	Conv	27.4		7.2		-3.2	
Maximum slope*Rain*Treatment	Conv	-1.21		-0.40		2.33	
Intercept	RI	109	0.69**	-1185	0.55**	1013	0.45**
Maximum slope*Treatment	RI	-836		363		90	
rain*Treatment	RI	20.8		9.2		14.3	
Maximum slope*Rain*Treatment	RI	1.10		-1.15		-1.46	
Intercept	Bio	521	0.36**	977	0.34**	1781	0.10
Maximum slope*Treatment	Bio	335		-26		47	
rain*Treatment	Bio	14.5		2.9		4.9	
Maximum slope*Rain*Treatment	Bio	-1.88		-0.13		-0.72	

* Significance P<0.05 ** Significance P<0.01 Bold numbers are significant at P<0.05 and P<0.1

Yield differences:

Fig.3 shows plots of the differences between yields of the studied crop in the three studied management practices plotted as a function of maximum terrain slope and precipitation. The differences were calculated from crop predictions via regression models reported in Table 1. P values overlaying the difference maps reflect statistical significance in comparing the management practices.

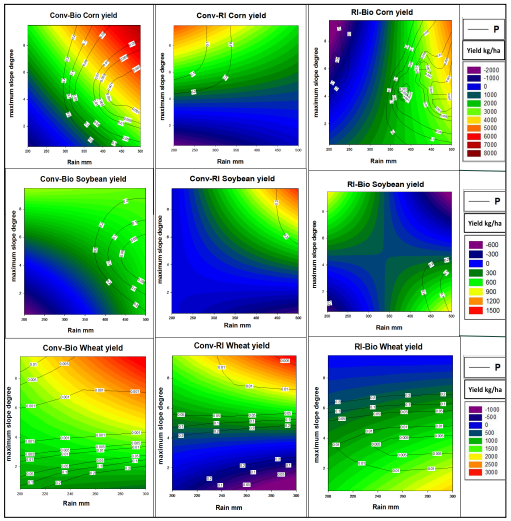


Fig.3 Yield differences in treatments due to rain and maximum values of terrain slope

Differences between Conv and Bio practices:
Corn: Conv>Bio, when precipitation>300mm, across entire slope terrain
Soybean: Conv>Bio, when precipitation>450mm, across entire terrain, no differences when precipitation<450mm
Wheat: Conv>Bio, when high and medium slope terrain, Conv=Bio in flat (slope<3°)

Differences between Conv and RI practices:
Corn: Conv>RI, when precipitation<250 mm, at higher slopes (slope>6°)
Soybean: no differences
Wheat: Conv>RI under all precipitation, and high-medium slope terrain, Conv=RI under medium-low precipitation and flat (slope<3°), but RI>Conv in wet spring.

Differences between RI and Bio practices:
Corn: RI>Bio when precipitation>450 mm across entire slope terrain.
Soybean: RI>Bio when precipitation>450 mm in flat slope terrain. Bio>RI Under low precipitation(<250 mm) and high slope (slope>6°).
Wheat: RI>Bio under all precipitation and flat and medium slope terrain (slope<6°). RI=Bio under high terrain (slope>6°).

Conclusions

Our answers to the research questions so far:

- Differences in crop yields between the studied management practices are not consistent across topographically diverse agricultural fields and vary in response to combined influences of terrain and precipitation.
- The biggest differences among the management practices were observed in terrain with medium-high range of slope values (>3°).
- The greatest differences between Bio and Conv/RI practices were observed in years with adequate precipitation, however, magnitude of the differences varied depending on the terrain.
- The biggest yield disadvantages of biologically based (Bio) management appeared when adequate water availability brought yields from sufficiently fertilized and pest controlled Conv and RI practices to their full potential. The disadvantages were smaller when water related stresses, either deficit or excess, reduced Conv and RI yields.

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