New Experimental Design to Quantify the Value of Management Factors Contributing to High Corn Yield

Matías Ruffo[1], Adam Henninger[2], and Fred Below[2]

1-Mosaic Fertilizer; 2-University of Illinois at Urbana-Champaign

Introduction

- Efficient high yield corn production systems must be developed to meet the demand of the increasing human population.
- Agronomic studies typically focus on few factors at a time and fail to analyze the value of a combined cropping system.
- Previous studies identified genetics, crop nutrition, fungicide and plant population as key management factors.
- We propose an Extended Omission Plot Design as a tool to develop a high corn yield production system and concomitantly determine the value of different inputs and management factors.

Objectives

- Determine the yield gap between a Traditional production system and a High Technology one.
- Quantify the contribution of each management factor under both production systems

Materials and Methods

The experiments were planted on May 26th 2009 in Champaign (CMI; 40°N), and on June 8th 2009 in Dixon Springs (DS; 37°N). Soybean was the previous crop at both sites.

The factors studied were: Genetics (RoundUp Ready vs RoundUp Ready+Bt Corn Borer+Bt Corn Rootworm), Plant Population (80 vs 110 thousand plants/ha), Nitrogen (200 kg N/ha as UAN vs 200 kg N/ha as UAN + 112 kg N/ha as SuperU), Fertility (no P, S, or Zn based on soil test vs 110 kg P_2O_5/ha as MESZ (12-40-0-10S-1Zn) at V4), and Fungicide (no fungicide vs strobilurin applied at VT).

The trial consisted of 12 treatments in a randomized complete block design with six replications (Table 1). Treatment 1 was the High Technology system, and treatment 7 was the Traditiontal Technology system. Our Extended Omission Plot Design consisted of replacing the high technology level of a given factor by its traditional level (treatments 2 to 6), one factor at a time and replacing the traditional technology level of a given factor by its high technology level (treatments 8 to 12).

Soil insecticide was applied with the seed at planting. Plots were overplanted and thinned to the target populations.

Pre-planned contrasts were used to analyze treatment effects.

Table 1. Fertility, nitrogen, genetics, plant population and fungicide levels for the 12 treatments evaluated in Champaign and Dixon Springs, IL in 2009.

#	Treatment	Fertility	Nitrogen	Genetics	Population	Fungicide
1	High Tech.	MESZ	Base + SuperU	RR+CB+CRW	110,000	Strobilurin
2	-MESZ	No PSZn	Base + SuperU	RR+CB+CRW	110,000	Strobilurin
3	-SuperU	MESZ	Base	RR+CB+CRW	110,000	Strobilurin
4	-Genetics	MESZ	Base + SuperU	RR	110,000	Strobilurin
5	-Population	MESZ	Base + SuperU	RR+CB+CRW	80,000	Strobilurin
6	-Fungicide	MESZ	Base + SuperU	RR+CB+CRW	110,000	No
7	Traditional	No PSZn	Base	RR	80,000	No
8	+ MESZ	MESZ	Base	RR	80,000	No
9	+SuperU	No PSZn	Base + SuperU	RR	80,000	No
10	+Genetics	No PSZn	Base	RR+CB+CRW	80,000	No
11	+Population	No PSZn	Base	RR	110,000	No
12	+Fungicide	No PSZn	Base	RR	80,000	Strobilurin

Results

- Fig. 1 shows the response to the different management factors under the Traditional and High Tech. systems at CMI and DS.
- The High Tech. system (treatment 1), maximized corn yield, which reached 17200 kg/ha in CMI and 15400 kg/ha in DS. The lowest yield was obtained with treatment 11 in both locations.
- The yield gain from the Traditional to High Tech. system (treatment 1 vs 7) was 4140 in CMI and 3590 kg/ha in DS.This yield gain was equivalent to 30% of the yield obtained with the Traditional Technology. .

- There was less response to the management factors under the Traditional than under High Tech.
- In CMI, all factors except fungicide, increased corn yield under High Tech system but only SuperU had a positive effect under Traditional.
- In DS, only fungicide and genetics increased corn yield in the High Tech system and no factor had a significant effect under Traditional Tech.
- Incresing plant population under Traditional had a negative effect on corn yield in both locations (significant in CMI).
- No single factor represented more than 25% of the yield gain.

- Under the Traditional Technology the sum of the factors that had a positive effect on yield was1960 kg/ha in CMI and 980 kg/ha in DS, which represented 47% and 27% of the yield gain, respectively.

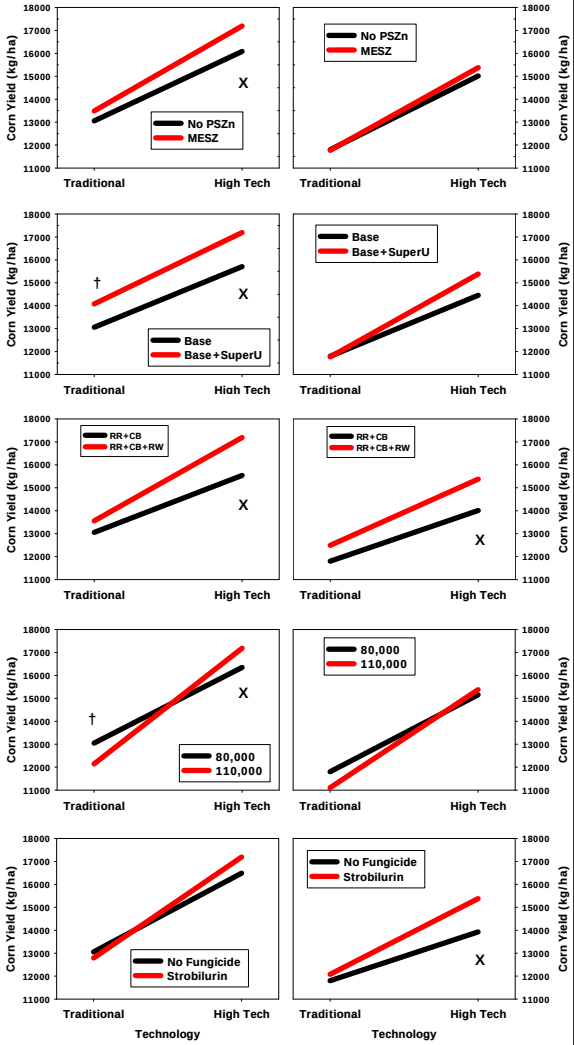

Fig. 1. The impact of removing a factor from a High Tech package or adding it alone to the Traditional package on corn grain yield at Champaign (left) and Dixon springs (right), IL in 2009. Factors from top to bottom include MESZ, SuperU, genetics, plant population and fungicide application. (†=p<0.1; X<0.05).

Conclusions

- The Omission Plot design used in this project allowed us to quantify the yield difference between technology systems, and the value of each management factor under each sytem.
- The yield response to High Technology represented 30% of the yield obtained with the Traditional Technology.
- No single factor contributed more than 25% to the yield increase. The value of each technology was higher under the High Technology System.
- The combined value of the technologies is larger than their sum, indicating positive interactions among these factors.
- There is considerable room to increase corn yield by combining proven technologies and exploiting their synergies.