

Breaking Corn Yield Barriers: A Cropping Systems Approach

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Summary

During 2015, four corn research trials were conducted in dryland and irrigated environments. Two trials were at Scandia, KS and two were in Topeka, KS. The objective of these trials was to study the contribution of different farming management approaches for developing efficient and high-yielding corn production systems. Treatment layout consisted of five combinations: common practices (CP), comprehensive fertilization (CF), production intensity (PI), ecological intensification (CF + PI), and advanced plus (AD). Under dryland and irrigation scenarios, EI and AD treatments presented the highest yields relative to the other combinations. Under irrigation, absolute yield gap was larger in both locations as compared to the dryland scenario. The EI and AP treatments produced better yields than all other treatments at all sites and water conditions.

Introduction

Gaps between potential and actual on-farm yields are primarily defined by crop management practices (such as row spacing, planting date, and fungicide and nutrient application) and their interactions with the environment (weather). Thus, after considering genetics and the environment, on-farm yield is primarily influenced by farmers' decisions, the main components of which are agronomic practices. Crop management practices are often specific to the environment, hybrid/variety, and/or yield level. Row spacing, plant population, nutrient management, and other agronomic practices can modify yields. Selecting appropriate management practices can help farmers increase yields and close yield gaps. Increasing plant population under irrigated conditions is a common intensification practice in high-yielding corn systems.

Procedures

Four corn research trials were conducted; at each of their respective locations one of the experiments was conducted in dryland condition and the other under irrigation. Two trials were conducted at the Scandia Unit of the North Central Kansas (NCK) Experiment Field, and two at Kansas River Valley (KRV) Experimental Field. Corn was planted on April 24 (Scandia) and April 22 (Topeka) during the 2015 growing season. Treatment layout presented five combinations with five replications in a completely randomized block design: (1) common practices (CP), common farming practices (30,000 seeds/a + no nutrient application (P-K) + 30-in. row spacing); (2) comprehensive fertilization (CF), or balancing nutrients (30,000 seeds/a + nutrient application + 30-in. row spacing); (3) production intensity (PI), increasing productivity via narrowing rows and increasing plant population (38,000 seeds/a + no nutrient application +

15-in. row spacing); (4) ecological intensification (CF + PI; 38,000 seeds/a + nutrient application + 15-in. row spacing); and (5) advanced plus (AD), or increasing input applications (38,000 seeds/a + nutrient application + 15-in. row spacing).

Results

Weather Conditions

Weather conditions for the growing season and historical values are shown in Figures 1 and 2 for NCK Scandia and KRV Topeka, respectively. The total amount of rain received during the growing season was 15 inches for Scandia and 16.3 inches for Topeka. The total amount of water provided to the irrigated condition at NCK Scandia was 7.5 inches (7/7, 7/15, 7/23, 8/5, 8/20, and 9/10) and 7.3 inches (06/23, 6/25, 07/02, 07/06, 07/23, 08/01, 08/16, 08/17, 08/24 and 09/03) at KRV Topeka. Temperatures ranged in normal values for the crop registering 6 and 8 days over 95°F (stress) for Scandia and Topeka, respectively during the growing season. Half of those days occurred during the critical period for corn.

Soil Test and Phenological Information

Soil samples were collected before planting to characterize each site. Results of soil tests are shown in Table 2. At the Scandia site, organic matter content was higher but low P values were documented as compared to the Topeka site. The variety planted, the date for phenological stages, and the harvest date are shown in Table 3. Total number of days from emergence to physiological maturity was 136 and 135 for Scandia and Topeka, respectively. Treatments CP and EI for irrigated condition at Scandia location are shown in Figure 5.

Stand Counts

After emergence, stand count for all the treatments was determined. Table 3 portrays the final number of plants emerged per acre for each of the treatments at all sites. Statistical differences in stand counts were detected between treatments CP-CF and PI, EI, and AD.

NCK Scandia, KS, Corn Yields

The average yield for dryland condition at NCK Scandia was 202 bu/a, while in overall the irrigated site yielded 219 bu/a (Figure 3). Maximum yield for dryland condition was 214 bu/a for the EI treatment but without presenting statistical differences relative to the other treatments. The CP treatment was the farming system resulting in the minimum yield (192 bu/a). In absolute terms, the yield gap in dryland was 22 bu/a (EI = 214 bu/a minus CP = 192 bu/acre). Under irrigation, in absolute terms, maximum yield gap was 33 bu/a (CF = 237 bu/a minus PI = 204 bu/a).

KRV Topeka, KS, Corn Yields

The mean overall yield for dryland was 195 bu/a and for irrigated was 199 bu/a. In dryland, the maximum yield was 215 bu/a for AD and the minimum was 180 bu/a for CF, but without presenting statistical differences ($p > 0.05$). In the irrigated condition EI presented maximum yield, 210 bu/a, while CP showed the minimum yield with 191 bu/a, all without documenting a statistical difference among treatments evaluated.

Table 1. Soil characterization before planting time

Corn studies	OM%	pH	P (ppm)
NCK, Scandia irrigated	2.6	6.2	14.0
NCK, Scandia dryland	3.1	6.4	9.2
KRV, Topeka irrigated	1.6	7.3	23.8
KRV, Topeka dryland	2.0	6.8	40.1

Table 2. Phenological data for the 2015 growing season for corn

Phenological data	NCK, Scandia	KRV, Topeka
Corn hybrid	dkc64-69rib	dkc64-69rib
Planting date	04/24/2015	04/22/2015
Emergence date (VE)	05/05/2015	05/01/2015
Flowering (R1)	07/17/2015	07/14/2015
Maturity	09/07/2015	09/04/2015
Harvest time	09/15/2015	10/15/2015

Table 3. Stand counts determined after emergence at all sites during the 2015 growing season

Treatment	Stand Count (plants per acre)			
	NCK, Scandia		KRV, Topeka	
	Dryland	Irrigated	Dryland	Irrigated
CP	23,746 b	29,770 b	17,971 b	23,298 b
CF	23,049 b	30,218 b	19,564 b	21,625 b
PI	28,973 a	38,133 a	27,977 a	36,640 a
EI	28,177 a	37,436 a	36,739 a	35,943 a
AD	27,281 a	37,237 a	32,856 a	36,839 a
P value	0.0001	0.0001	0.025	0.0001

Different letters in each column indicates statistical difference among treatments ($p < 0.05$). CP = common practices, CF = comprehensive fertilization, PI = production intensification, EI = ecological intensification (CF + PI), and AD = advanced plus.

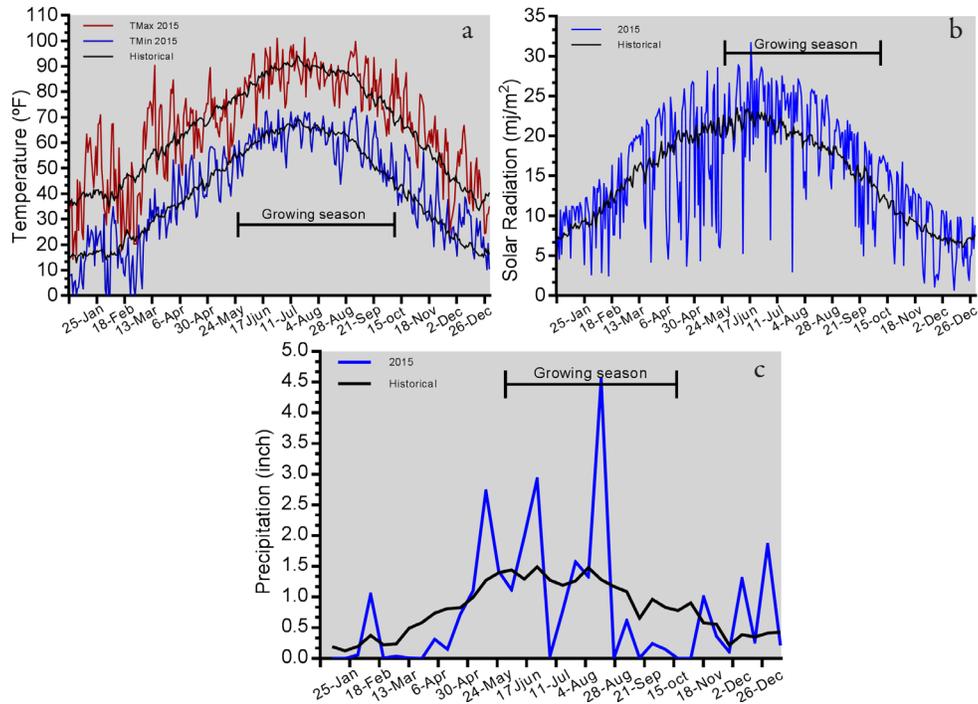


Figure 1. (a) Daily maximum (red lines) and minimum (blue line) temperatures for the 2015 growing season and historical. (b) Daily solar radiation (blue line) for 2015 and historical. (c) Daily precipitation (blue bars) for 2015 and historical. NCK, Scandia.

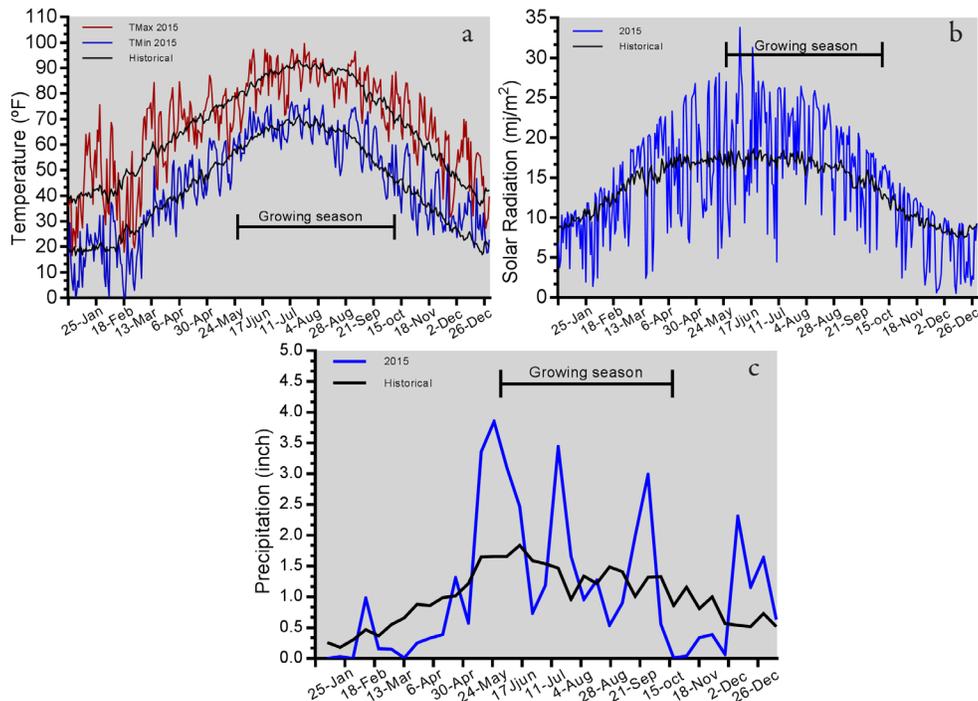


Figure 2. (a) Daily maximum (red lines) and minimum (blue line) temperatures for the 2015 growing season and historical. (b) Daily solar radiation (blue line) for 2015 and historical. (c) Daily precipitation (blue bars) for 2015 and historical. KRV, Topeka.

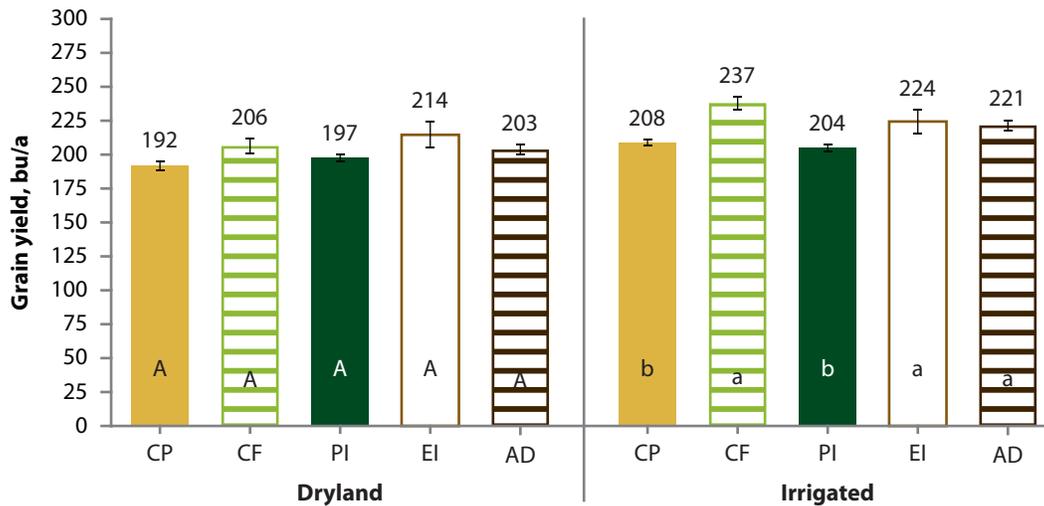


Figure 3. Corn grain yield by treatment for dryland and irrigated conditions during the 2015 growing season, NCK, Scandia. Different letter shows statistical differences ($p < 0.05$). CP = common practices, CF = comprehensive fertilization, PI = production intensification, EI = ecological intensification (CF + PI), and AD = advanced plus.

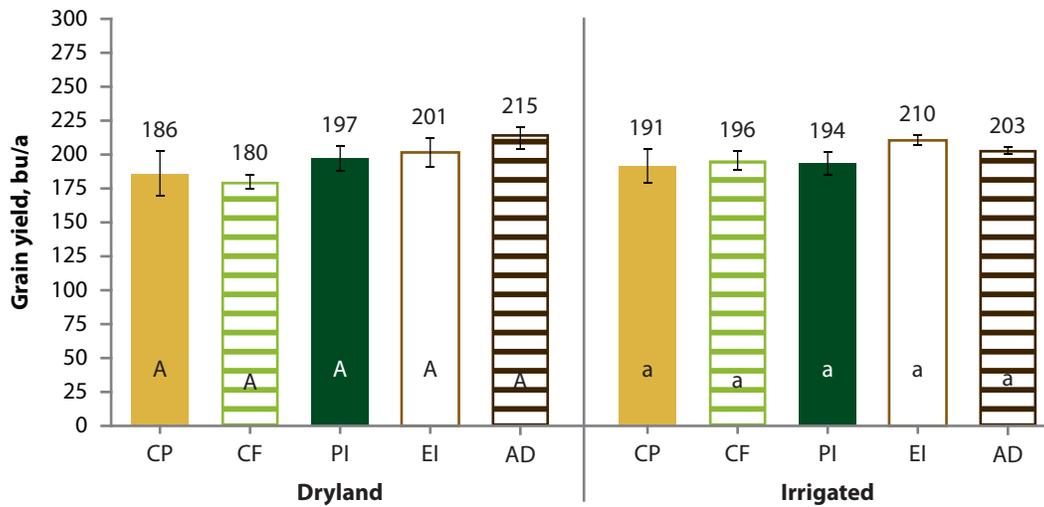


Figure 4. Corn grain yield by treatment for dryland and irrigated conditions during the 2015 growing season, KRV, Topeka. Different letter shows statistical differences ($p < 0.05$). CP = common practices, CF = comprehensive fertilization, PI = production intensification, EI = ecological intensification (CF+PI), and AD = advanced plus.



Figure 5. Scandia irrigated condition, (a) common practice (CP), and (b) ecological intensification (EI). 06-10-2015.