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Closing Corn Yield Gaps via Improved Management: A Systems Approach

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Abstract

Three corn research trials were conducted during the 2016 growing season. Two studies were conducted at Scandia, KS, (dryland and irrigated) and one at Topeka, KS (dryland). The objective of these trials was to investigate the contribution of different farming systems for closing corn yield gaps. Each experiment consisted of five treatments: common practices (CP), comprehensive fertilization (CF), production intensity (PI), ecological intensification (CF + PI), and advanced plus (AD). Across all three experiments and under dryland and irrigation scenarios, CP presented the lowest yield. In environments with yield response, intensifying production without a balanced nutrition program did not increase yields. A balanced nutrition program substantially increased yields in corn with more relative impact in dryland environments. The absolute yield gap was 86 bu/a for dryland and 75 bu/a for irrigated condition.

Keywords

corn, yield gaps, cropping system

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Cover Page Footnote

Thanks to the Kansas State University Crops Production Team for the valuable help in collecting and processing all the field data during 2016 growing season. This study was supported by the International Plant Nutrition Institute (IPNI, Project GBL 62), K-State Research and Extension and the Fulbright Program (partially covering G.R. Balboa's stipend).

Closing Corn Yield Gaps via Improved Management: A Systems Approach

G.R. Balboa and I.A. Ciampitti

Summary

Three corn research trials were conducted during the 2016 growing season. Two studies were conducted at Scandia, KS, (dryland and irrigated) and one at Topeka, KS (dryland). The objective of these trials was to investigate the contribution of different farming systems for closing corn yield gaps. Each experiment consisted of five treatments: common practices (CP), comprehensive fertilization (CF), production intensity (PI), ecological intensification (CF + PI), and advanced plus (AD). Across all three experiments and under dryland and irrigation scenarios, CP presented the lowest yield. In environments with yield response, intensifying production without a balanced nutrition program did not increase yields. A balanced nutrition program substantially increased yields in corn with more relative impact in dryland environments. The absolute yield gap was 86 bu/a for dryland and 75 bu/a for irrigated condition.

Introduction

Crop management practices (such as row spacing, planting date, and nutrient application) and their interactions with the environment (soil + weather) have a direct impact on closing yield gaps. By choosing different combinations of practices, farmers can modify the growing conditions. Thus, after considering the contribution from the 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. Each farmer needs to find the appropriate management practices that can help them increase yields and profits. Increasing seeding rates and narrowing rows are two common intensification practices in high-yielding corn systems.

Procedures

Three corn research trials were conducted during the 2016 growing season. Two studies were located at the North Central Kansas (NCK) experiment fields (Scandia, KS), and one at the Kansas River Valley (KRV) experimental fields (Topeka, KS). At Scandia, one experiment was conducted under dryland and one under irrigated conditions. The corn was planted on May 6 at both locations. Each experiment consists of 5 treatments with five replications in a completely randomized block design: 1) common practices (CP), (30,000 seeds/a + no-nutrient application + 30-in. row spacing); 2) comprehensive fertilization (CF), (30,000 seeds/a + balanced nutrient application + 30-in. row spacing); 3) production intensity (PI), (36,000 seeds/a + no-nutrient application + 15-in. row spacing); 4) ecological intensification (CF + PI; 36,000 seeds/a + balanced

nutrient application + 15-in. row spacing + fungicides and micronutrients); and 5) advanced plus (AD), or increasing input applications (36,000 seeds/a + balanced nutrient application + 15-in. row spacing + double application of fungicides and micronutrients). Mes SZ and Aspire (Mosaic company) rates in lb N-P₂O₅-K₂O-S/a for irrigated were 141 and 133 lb/a, while for dryland fertilizer P and K rates were 105 and 99 lb/a, respectively. Nitrogen rate for the treatments of CF, ecological intensification (EI) (CF+PI), and AD was 175 lb/a of UAN (28%). The EI and AD treatments received an extra 175 lb/a of UAN at flowering. The rates per nutrients in lb/A (N-P₂O₅-K₂O-S-Zn-B) were 73-56-80-14-1.4Zn-0.65B and 68-42-105-11-1Zn-0.85B for irrigated and dryland scenario.

Results

Weather Conditions

Weather conditions for the growing season and historical values are shown in Figure 1 for the NCK site and Figure 2 for the KRV location (Mesonet, Kansas State University). The total amount of precipitation received during the growing season was 17 inches at both locations.

The total amount of water provided to the irrigated condition at NCK site was 6.3 inches (6/23, 7/15, 7/21, 7/29, and 8/10). Temperatures ranged in normal values for the crop, registering only a few days of heat stress.

Soil Test and Phenological Information

Soil samples were collected before planting to characterize each experimental site. Soil test results are shown in Table 1. The previous crop was soybean at all locations. The corn hybrid planted, the date for phenological stages, and the harvest date are shown in Table 2.

North Central Kansas, Scandia, Yields

At the NCK Scandia field experiment, average yield for dryland corn was 159 bu/a; while irrigation yielded on average 190 bu/a (+19%). In both water scenarios there were statistical differences ($P < 0.05$) between treatments, CP and PI recorded the lowest corn yields, and CF the highest values, 199 bu/a for dryland and 226 bu/a for irrigated (Figure 3). Common practices (CP) and intensification without balanced nutrition (PI) treatments obtained the lowest yields under both water scenarios (CP vs. PI, 113 < 122 bu/a for dryland and 164 > 151 bu/a for irrigated). Intensifying management practices with balanced nutrition (EI) treatment yielded more than CP and PI but less than CF (Figure 3). The absolute yield gap was 86 bu/a for dryland and 75 bu/a for irrigated condition (calculated as the maximum yield value, CF treatment, minus lowest yield value, CP treatment for dryland, and PI for irrigation) (Figure 3).

Kansas River Valley, Topeka, Yields

At the KRV Topeka field experiment, average corn yield was 156 bu/a ranging from 150 to 163 bu/a (Figure 4). There were no statistically significant differences between all the treatments ($P > 0.05$) evaluated in this location during the 2016 growing season.

Acknowledgments

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Table 1. Soil characterization before planting time

Corn studies	Organic matter	pH	Phosphorus
	%		ppm
NCK Scandia irrigated	2.1	5.8	6.3
NCK Scandia dryland	2.1	5.3	8.3
KRV Topeka dryland	2.5	6.1	12.3

NCK = North Central Kansas.

KRV = Kansas River Valley.

Table 2. Phenological data for the 2016 growing season for corn

Phenological data	North Central Kansas, Scandia	Kansas River Valley, Topeka
Corn hybrid	DKc64-69rib	DKc64-69rib
Planting date	05/05/2016	05/05/2016
Emergence date (VE)	05/13/2016	05/11/2016
Flowering (R1)	07/21/2016	07/18/2016
Maturity	09/07/2016	08/26/2016
Harvest time	11/04/2016	09/23/2016

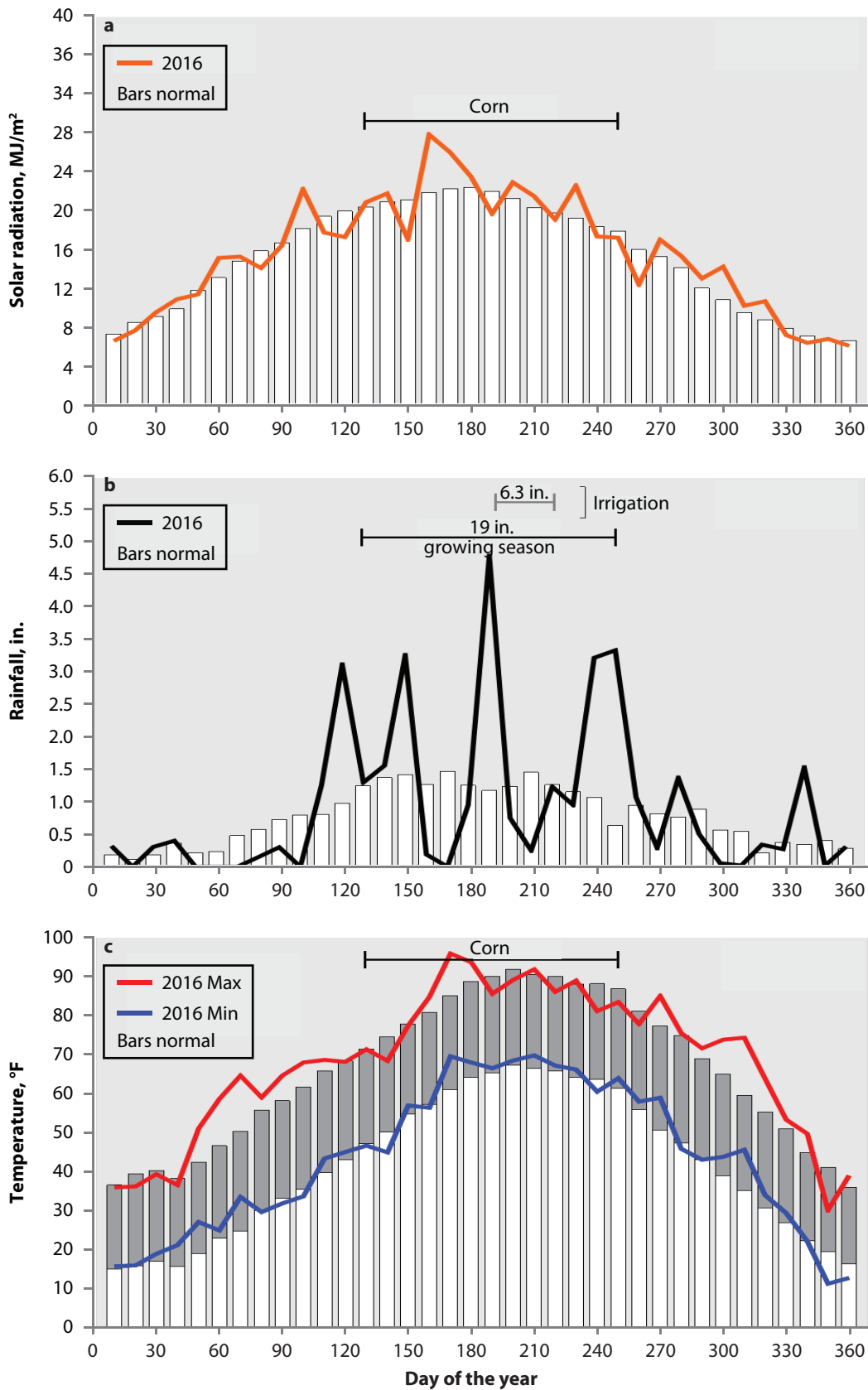


Figure 1. a) Daily solar radiation; b) Daily precipitation; and c) Daily maximum and minimum temperatures all for 2016 season and historical. North Central Kansas, Scandia.

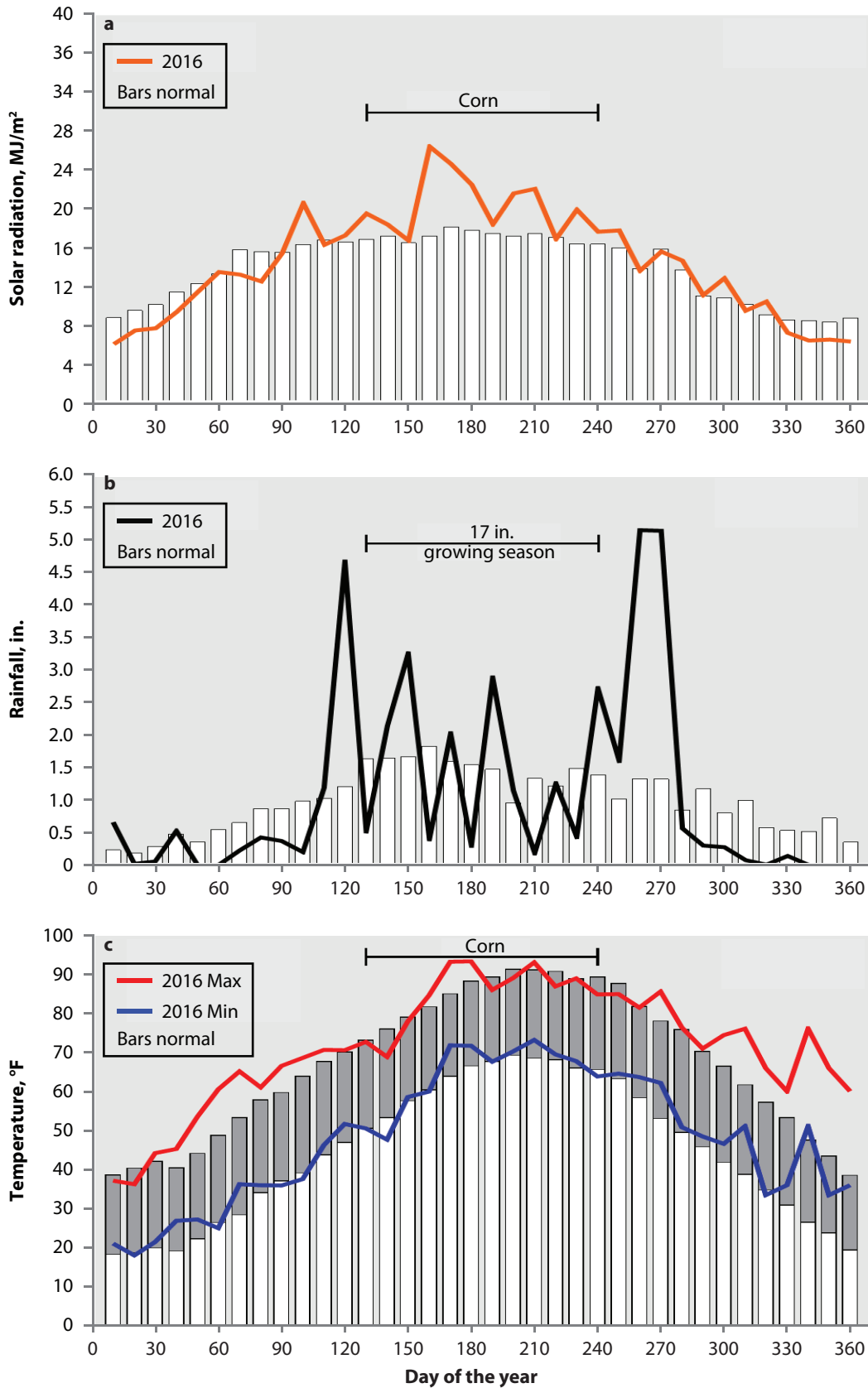


Figure 2. a) Daily solar radiation; b) Daily precipitation; and c) Daily maximum and minimum temperatures all for 2016 season and historical. Kansas River Valley, Topeka.

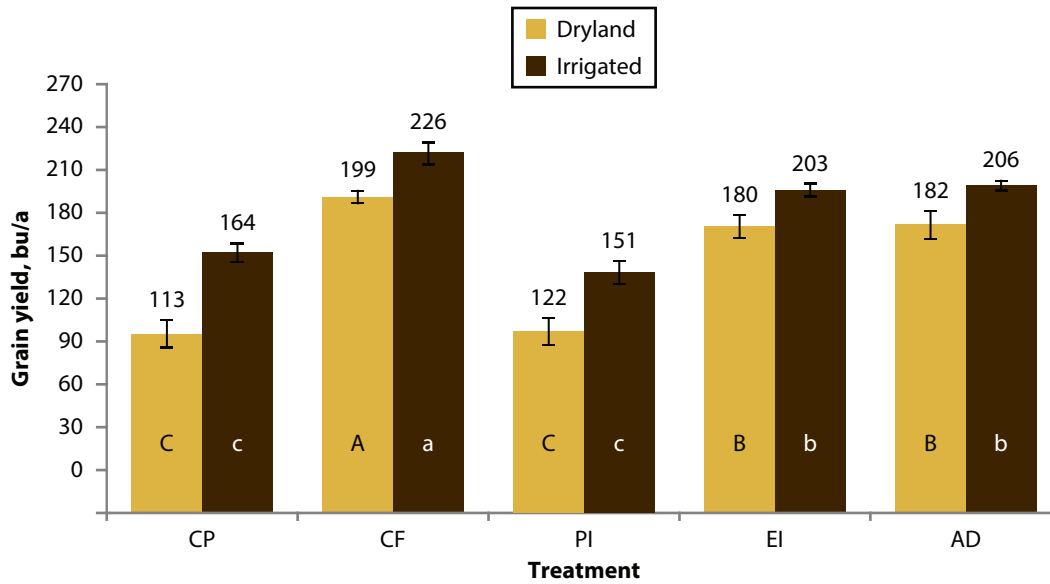


Figure 3. Corn grain yield by treatment for dryland and irrigated conditions during the 2016 growing season, North Central Kansas, Scandia. Different letter shows statistical differences ($P < 0.05$). CP = Common practices, CF = comprehensive fertilization, PI = production intensification, EI = ecological intensification (CF+PI), AD = advanced plus. Lines in bars indicate standard deviation.

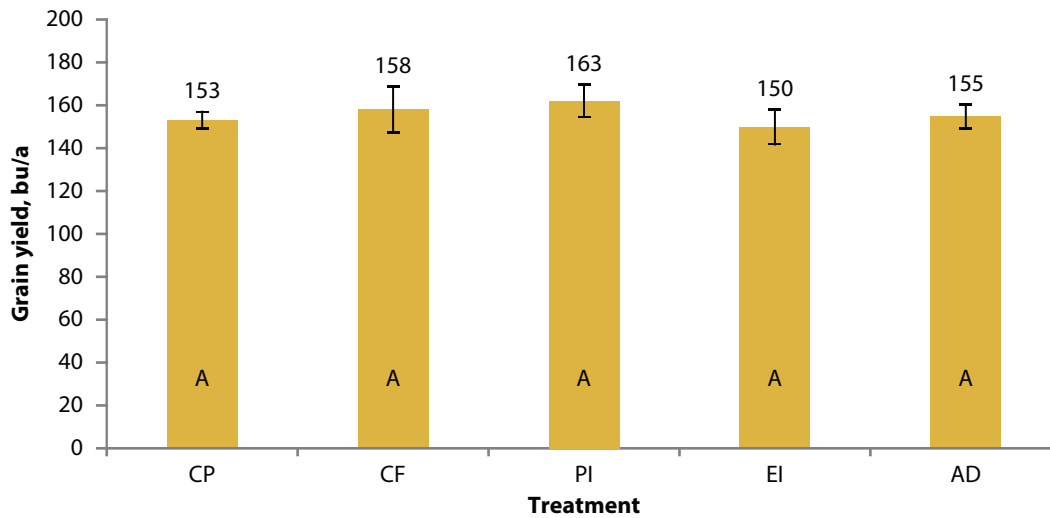


Figure 4. Corn grain yield by treatment during the 2016 growing season, Kansas River Valley, Topeka. Different letter shows statistical differences ($P < 0.05$). CP = Common practices, CF = comprehensive fertilization, PI = production intensification, EI = ecological intensification (CF+PI), AD = advanced plus. Lines in bars indicate standard deviation.