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# Best Management Systems to Intensify Soybean Production

**Abstract**
The aim of this study was to evaluate different management systems to close the yield gap in soybean production. A soybean experiment was established in Scandia, KS, evaluating five management systems under both rainfed and irrigated conditions. For the 2017 season, dryland and irrigated average yields were similar (63–65 bu/a) due to herbicide injury on the irrigated phase. In both water scenarios, intensification (high input) increased yields compared with common practice (low input) systems. Under irrigation, a consistent response to a balanced nutrition program was documented.

**Keywords**
best management systems, soybeans, yield

# Best Management Systems to Intensify Soybean Production

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## Summary
The aim of this study was to evaluate different management systems to close the yield gap in soybean production. A soybean experiment was established in Scandia, KS, evaluating five management systems under both rainfed and irrigated conditions. For the 2017 season, dryland and irrigated average yields were similar (63–65 bu/a) due to herbicide injury on the irrigated phase. In both water scenarios, intensification (high input) increased yields compared with common practice (low input) systems. Under irrigation, a consistent response to a balanced nutrition program was documented.

## Introduction
Yield gap is defined by the difference between potential and actual yield. Management practices such as row spacing, seeding rate, fertilization, pest, and disease control affect the size of the yield gap. A management system is a combination of production practices. The aim of this study was to evaluate the combination of production practices to identify the best management systems (BMSs) for closing soybean yield gaps.

## Procedures
A soybean experiment was established during the 2017 season at Scandia, KS. This experiment is part of a long-term corn-soybean rotation. A total of five treatments were established in a randomized completely block design with five replications (Table 1).

Prior to the experiment, soil samples were collected in both water environments and analyzed for organic matter %, pH, and phosphorus (P) content (Table 2).

The weather for the 2017 growing season was compared with the 30 years of data for the Scandia location (Figure 1). Precipitation and mean temperature were below the mean for the April - October period compared to the historical 30-year average. Black dots in Figure 1 represent the precipitation and temperature recorded for the past soybean growing seasons for this study.

## Results
### *Grain Yield*
The average yield for the dryland condition was 63 bu/a, ranging from 48 to 76 bu/a (Figure 2). The irrigated soybean average yield was 65 bu/a overall, presenting a range

from 48 to 77 bu/a. Seasonal precipitation was 16.3 in. and the irrigated phase received 5.3 in. of water.

Herbicide injury on irrigated plots was assessed on July 27, negatively affecting the final yield (Figure 4). The minimum yield registered for irrigated was 48 bu/a for common practices (CP) and the maximum 77 bu/a for the ecological intensification (EI) treatment. The balanced nutrition program (CF) under irrigated conditions yielded 11 bu/a more over CP. Under both water conditions (dryland and irrigated), treatment EI and advanced plus (AD) showed the greatest yields, without statistically differing between them (Figure 2). The CF and PI treatments yielded more than CP under irrigation (by 11 and 18 bu/a, respectively); while in dryland condition, CF was superior in yield over CP (+3 bu/a) but without statistically differing. Production intensification with balanced nutrition (EI, AD) allowed obtaining 55% and 58% more yield than CP for dryland and irrigated conditions, respectively (Figure 2). After four years of rotation in high yielding environments (irrigated), CP yields statistically differed from the rest of the treatments showing the impact of the lack of a balanced nutrition program.

## *Long-Term Rotation*

To explore the long-term impact of the different treatments under dryland and irrigated conditions, average yields for 2014, 2015, 2016 and 2017 growing seasons were summarized (Figure 3). Narrowing rows and increasing the plant population increased yields (average 62 bu/a). The yield level in the dryland environment did not show response to fertilization over control treatment. For the irrigated scenario, the average of four growing seasons is showing larger yield differences between treatments compared to the 2017 season alone (Figures 2 and 3). For this scenario, a balanced nutrition program (CF) on top of common practices (CP) increased yields over control treatments (+7 bu/a). Ecological intensification and advanced plus were the highest yielding treatments at 81 and 78 bu/a, respectively.

The 4-year summary provides a synthesis on the impact of different management practices and water scenarios on soybean yields, and can help to better understand the interaction of production practices to identify the BMSs to intensify soybean yield environments. Overall, intensified management systems based on seeding rate increase, narrow row spacing and a balanced nutrition program increased yields compared to common practices.

**Table 1. Treatment description, Scandia, KS**

| Treatments | CP | CF | PI | EI | AD |
|---|---|---|---|---|---|
| Seeding rate | 110,000 | 110,000 | 175,000 | 175,000 | 175,000 |
| Row spacing (inch) | 30 | 30 | 15 | 15 | 15 |
| Fertilization | No P-K-S | P-K-S | No P-K | P-K-S-N | P-K-S-N |
| Micronutrients | No | No | No | 1× (Fe, Zn, B) | 2× (Fe, Zn, B) |
| Fungicide/insecticide | No | No | No | 1× | 2× |

CP = Common practices, CF = comprehensive fertilization, PI = production intensification, EI = ecological intensification (CF+PI), AD = advanced plus. P = phosphorus, K = potassium, S = sulfur, N = nitrogen, Fe = iron, Zn = zinc, B = boron.

**Table 2. Soil characterization before planting time**

| Soybean studies | Organic matter % | pH | Phosphorus (ppm) |
|---|---|---|---|
| Irrigated | 2.2 | 6.2 | 11.0 |
| Dryland | 2.3 | 5.4 | 7.4 |

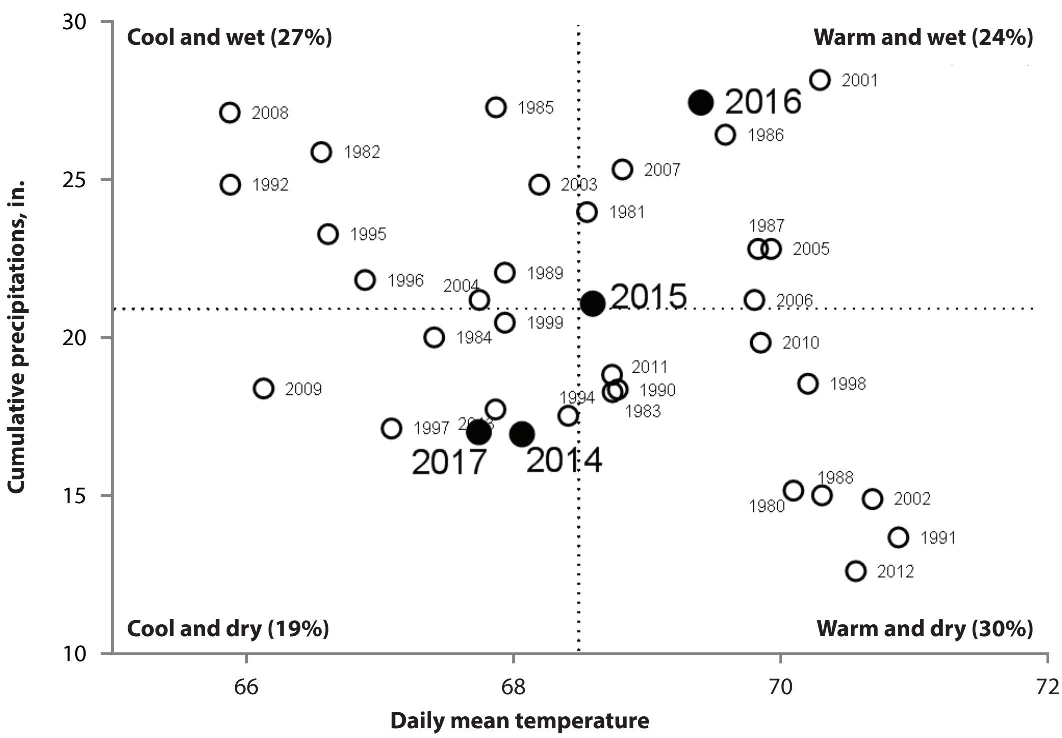


**Figure 1. Yearly (1980 – 2016) mean temperature and mean precipitation for the period April – October. Black circles indicate seasons when experimental data were collected. Empty circles indicate years when experimental data were simulated. Dotted vertical and horizontal lines indicate mean temperature (°F) and mean cumulative precipitation (in.) for the period. Percentage of years in each category are listed in parenthesis.**

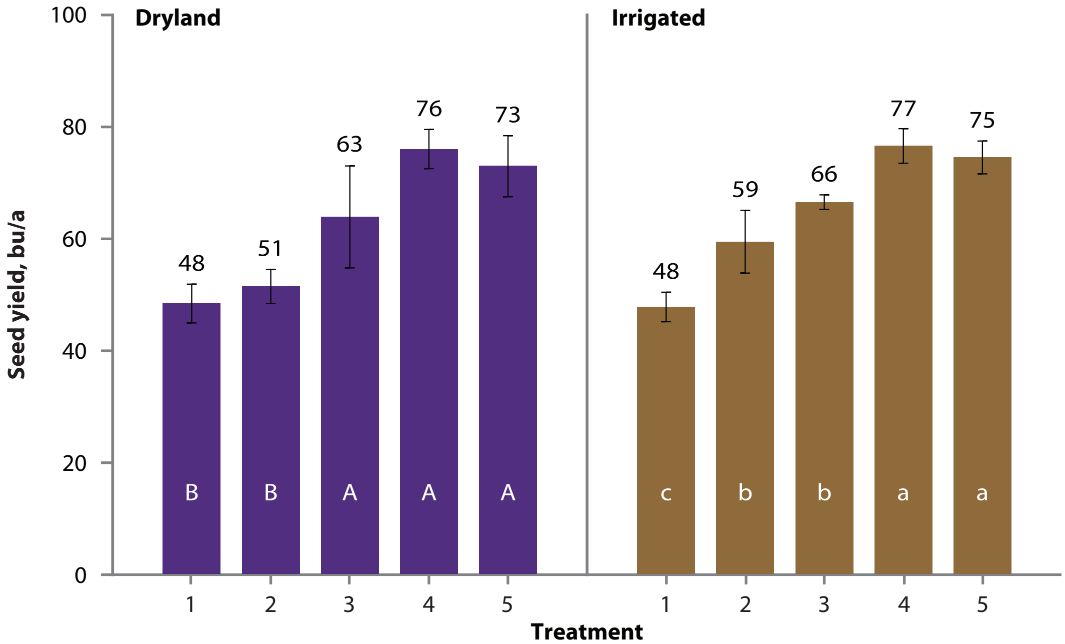


**Figure 2. Soybean grain yield by treatment for dryland and irrigated conditions, Scandia, KS, 2017. Different letter shows statistical differences ($P < 0.05$). (1) CP = Common practices, (2) CF = comprehensive fertilization, (3) PI = production intensification, (4) EI = ecological intensification (CF+PI), (5) AD = advanced plus.**

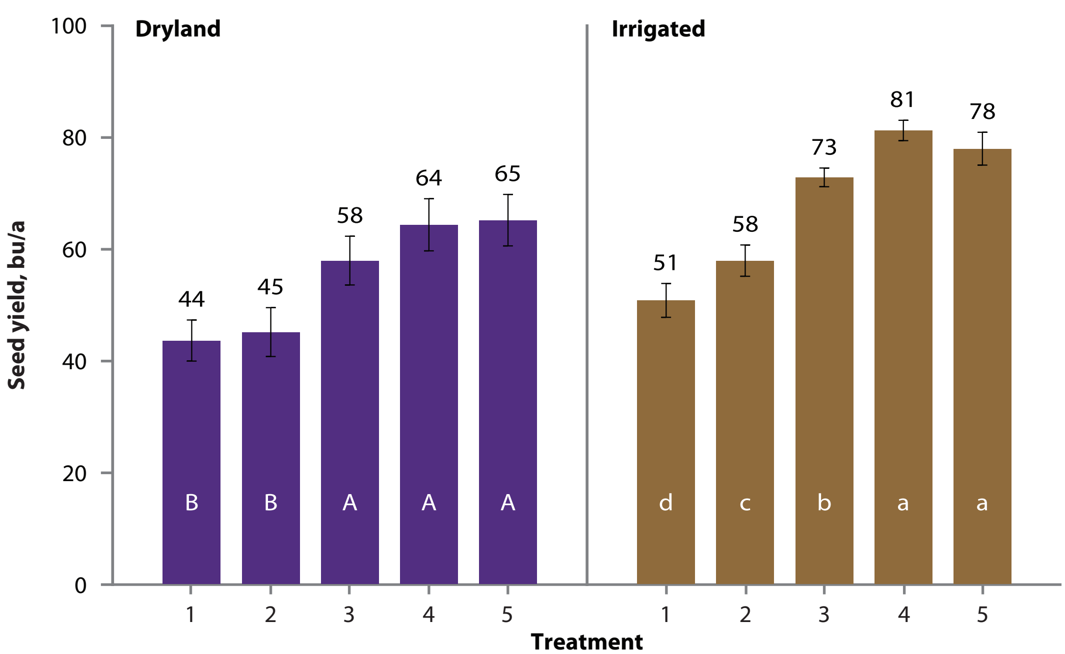


**Figure 3. Soybean grain yield by treatment for dryland and irrigated conditions, Scandia, KS, 2014 – 2017. Different letter shows statistical differences ($P < 0.05$). (1) CP = Common practices, (2) CF = comprehensive fertilization, (3) PI = production intensification, (4) EI = ecological intensification (CF+PI), (5) AD = advanced plus.**

**Figure 4. Crop injury assessed on July 27 with herbicide application on a contiguous soybean field with irrigated plots, Scandia, KS, 2017.**