# Annual Report 2016: KS Soybean Project

**Site:** Scandia, Kansas (US)

**Lat.:** 39°49'52.62"N

**Long.:** 97°50'21.01"W

**Treatment description:** A total of five treatment were planted in a randomized complete block design with five replications. Treatment descriptions are shown in **Table 1**.

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

| | (-) Intensification (+) | | | | |
|---|---|---|---|---|---|
| Treatments | CP | CF | PI | EI | AD |
| Seeding rate | 110k | 110k | 174k | 174k | 174k |
| Row spacing (m) | 30" | 30" | 15" | 15" | 15" |
| Inoculation | No | Yes | Yes | Yes | Yes |
| Fertilization | No P-K | P-K | No P-K | P-K | P-K |
| Micronutrients (Zn-B-Fe) | No | No | No | 1x | 2x |
| Fungicide | No | No | No | 1x | 2x |
| Insecticide | No | No | No | 1x | 2x |

CP=Common practices, CF= comprehensive fertilization, PI= production intensification, EI= ecological intensification (CF+PI), AD= advanced plus. *Fertilizer N only applied in the corn study.

## Phenological information and soil characteristics

Complete information related to planting date and phenology is presented in **Table 2**. Soil characterization before planting can be reviewed in **Table 3**.

**Table 2.** Phenological data for the 2016 growing season for soybean.

| Scandia Phenological Data | **Soybean** |
|---|---|
| Soybean Variety | P39T67R (MG 4.0) |
| Planting Date | 05/06/2016 |
| Emergence Date (VE) | 05/12/2016 |
| Flowering (R1) | 07/12/2016 |
| Maturity | 09/26/2016 |
| Harvest Time | 10/18/2016 |

**Table 3.** Soil characterization before planting time.

| Scandia Soybean Studies | **OM%** | **pH** | **P (ppm)** |
|---|---|---|---|
| Irrigated phase | 2.2 | 6.2 | 11 |
| Dryland phase | 2.3 | 5.4 | 7.4 |

## Irrigation Schedule

The total amount of water provided via irrigation was 6.25 inches (6/23, 7/15, 7/21, 7/29 and 8/10). The total amount of rain registered during the growing season was 22.7 inches.

## Weather conditions

Historic (1980-2015) and 2016 weather conditions are shown in **Figure 1**. Temperature and precipitation in 2016 were within normal ranges for the site.

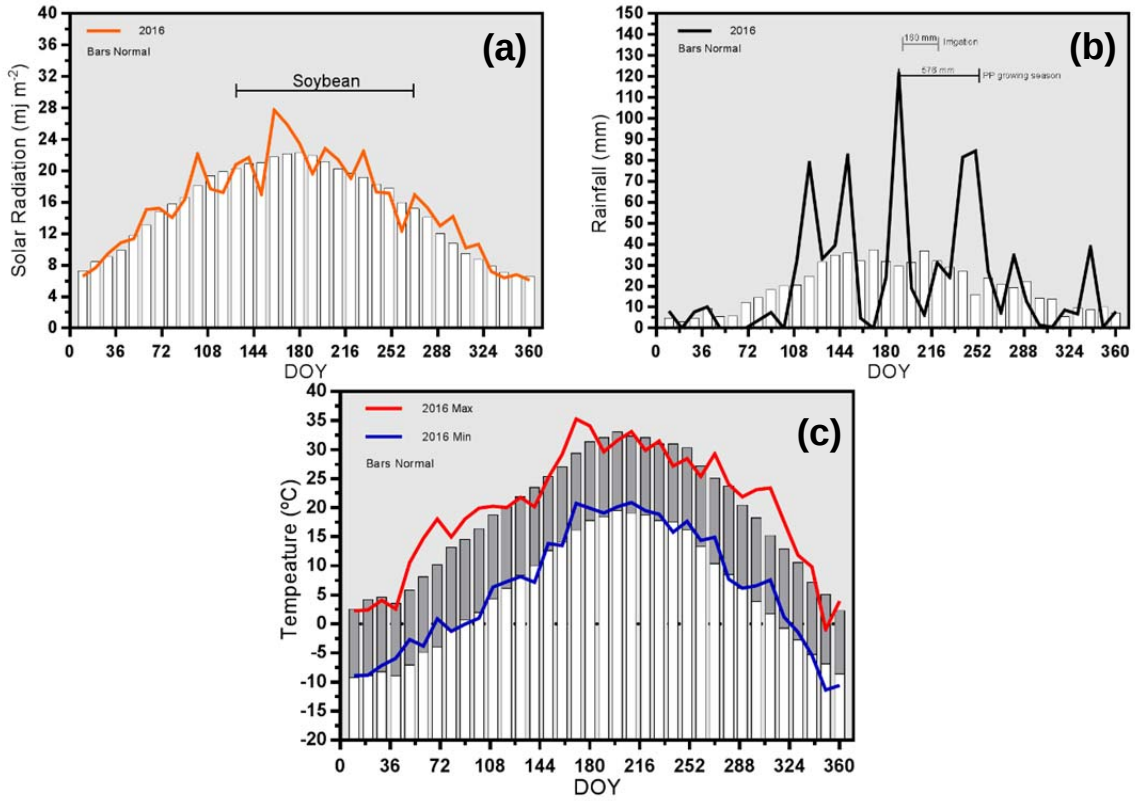


**Figure 1:** (a) Daily solar radiation, (b) rainfall, and (c) maximum and minimum temperatures for 2016 growing season and historical. Scandia KS.

## Results:

*Seed Yield*

The average yield for the dryland condition was 75 bu $ac^{-1}$, ranging from 63 to 85 bu $ac^{-1}$ **(Fig. 2)**. Overall irrigated soybean yield was 74 bu $ac^{-1}$, presenting a range from 56 to 90 bu $ac^{-1}$. Yields across contrasting water supply environments were similar due to the amount of precipitation recorded during the 2016 growing season, total 22.7 inch. The minimum yield observed under irrigation was 56 bu $ac^{-1}$ for CP and the maximum 90 bu $ac^{-1}$ for AD. The balanced nutrition program (CF) under irrigated conditions yielded 10 bu $ac^{-1}$ more than the CP treatment **(Fig. 2).** Under both water conditions (dryland and irrigated) the EI and AD treatments produced the highest yields.

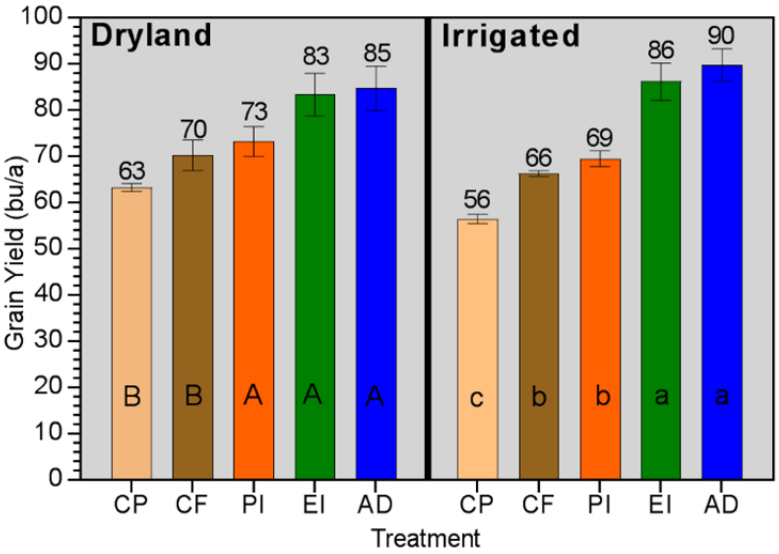


**Figure 2:** Soybean seed yield by treatment for dryland and irrigated conditions, Scandia KS 2016. Different letter shows statistical differences ($p<0.05$). CP=Common practices, CF= comprehensive fertilization, PI= production intensification, EI= ecological intensification (CF+PI), AD= advanced plus.

There were no differences between EI and AD under both water environments. Treatments CF and PI yielded more than CP under irrigation; while in dryland condition, CF was superior in yield than CP (+7 bu $ac^{-1}$) but was not statistically different. After 3 years of rotation, this is the first season with a treatment yield as high as 90 bu $ac^{-1}$. Intensified production systems accompanied by balanced nutrition (EI, AD) produced 60% and 35% more yield than for the low-input treatment (CP) for irrigated and dryland scenarios, respectively **(Fig. 2)**.

*Breaking yield barriers: three seasons and overall outcomes at Kansas, US.*

The "Breaking Soybean Yield Barriers" project has completed the third season at the US (Kansas) site. After three growing seasons (2014, 2015, 2016) following the soybean–corn rotation with the same treatment structure and geo-position in the field (plots located in the same place year-after-year), it is possible to analyze yield trends across years.

Individual season yield by treatments and overall across all 3-years are presented in **Figure 3**.

Across all years of study, under both water environments, the CP treatment presented the lowest yield (42 and 54 bu $acre^{-1}$ for dryland and irrigated). A balanced nutrition program (CF) increased yields over the low-input combination (CP), producing statistically significant yield differences under irrigated (+13%) and dryland (+17%) conditions.

Intensifying production (PI) significantly increased yields (14 bu $acre^{-1}$ for dryland and 21 bu $acre^{-1}$ for irrigated), over low-input (CP). In dryland conditions, PI outyielded CP by 33% and by 40% when irrigation was provided. It is worth noting that these yield increases (PI over CP) resulted in additional mining of soil nutrient resources since this treatment did not receive any fertilizer input. There was a yield penalty observed in the following crop in the rotation (corn) due to the soybean (PI) nutrient mining. For example, during 2016 the corn study that followed the soybean phase under irrigation for the CP treatment yielded 37% less compared to CF.

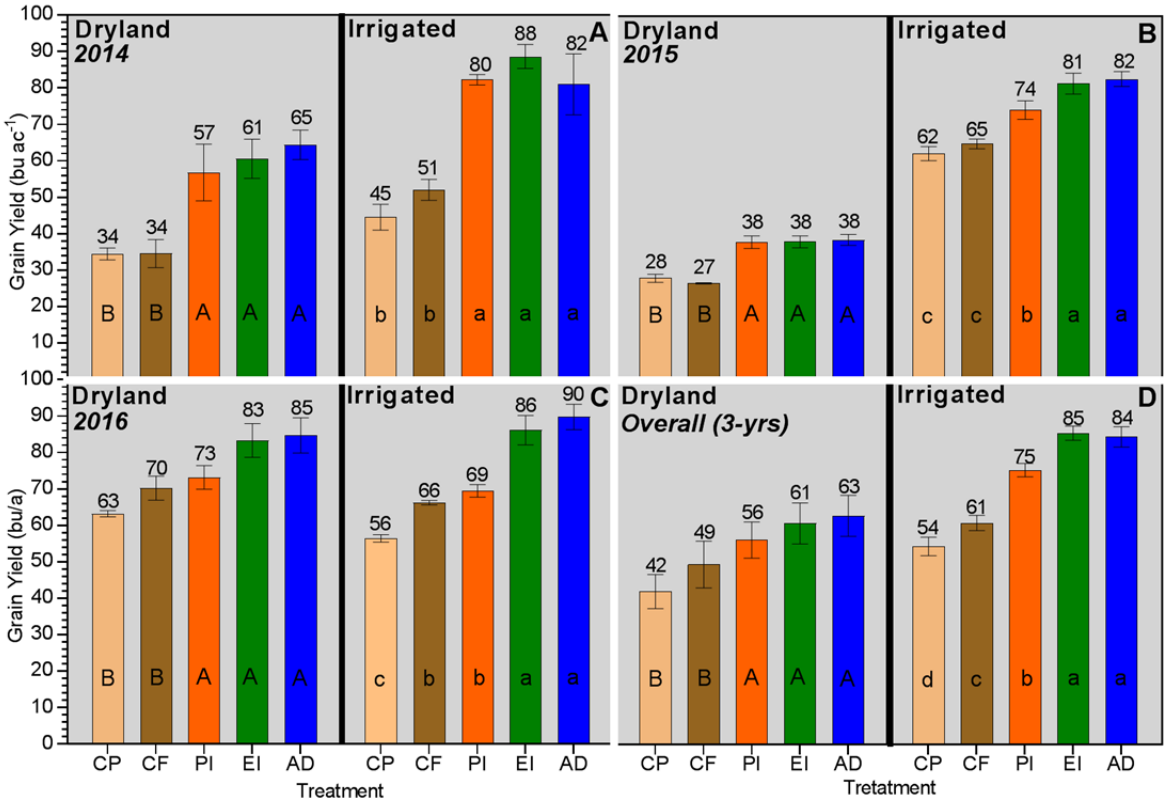


**Figure 3:** Soybean seed yield by treatment for dryland and irrigated conditions for 2014 (A), 2015 (B), 2016 (C) and average for all three seasons (D). Scandia KS. Different letters show statistical differences ($p<0.05$). CP=Common practices, CF= comprehensive fertilization, PI= production intensification, EI= ecological intensification (CF+PI), AD= advanced plus.

A combination of a balanced nutrition program with intensified management (narrower rows and higher seeding rate) had a positive impact in both dryland and irrigated scenarios. The EI treatment resulted in a 3-year average yield of 61 and 85 bu $ac^{-1}$ for dryland and irrigated scenarios, respectively. The overall yield increase of EI over CP was 45% for dryland and 57% for irrigated conditions.

In summary, this study allowed us to identify an overall yield GAP of 21 bu $ac^{-1}$ for dryland and of 31 bu $ac^{-1}$ for irrigated conditions. Analyzing the overall yields (3-yrs) under irrigated conditions the partial factor productivity of the fertilizer (PFPf, seed yield divided by the total quantity of fertilizer applied), was 15 (lb yield/lb fertilizer) for the CF treatment and 17 for the EI treatment. For the dryland environment, PFPf for CF was 17, and for EI it was 18. The PFPf for EI treatment was 16% greater under irrigation, and 8% greater under dryland conditions than the CF treatment. By intensifying production practices (narrow row spacing and increasing seeding rate), each unit of fertilizer added to the system was more efficient in producing seed yield.