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Summary

Two double crop (DC) soybean studies were conducted at Ottawa, KS, during the 2016 growing season. Soybean cultivar Asgrow 4232 (MG 4.2) was planted immediately after two different wheat harvest timings (Study 1: early-wheat harvest 18-20% seed moisture content, and Study 2: conventional-harvest, 13-14% seed moisture content). Seven treatments were evaluated in each of the soybean planting dates: 1) common practice, 2) no seed treatment (without seed fungicide + insecticide treatment), 3) non-stay green (without foliar fungicide + insecticide application), 4) high seeding rate (180,000 seeds per acre), 5) wide rows (30-inch row spacing), 6) nitrogen (N) fixation (without late fertilizer N application), and 7) kitchen sink (includes all management practices). Aboveground biomass, seed harvest index (HI) and yield were evaluated. For the early-planted study, a trade-off was documented between biomass and seed HI, presenting maximum yield also for values with lower HIs. Yield was greatest when planting in wide rows (64.5 bu/a) for the late-planted timing, and for the N-fixation treatment (64.0 bu/a) for the early-planted study. For the early-planted, yield gap (calculated as maximum minus minimum yield) was 6 bu/a, while for late-planted, yield gap was 7.5 bu/a. Best management practices for DC soybean can improve overall productivity via increasing yield with modifications in biomass and HI, and overall yield efficiency. Further testing on the effect of multiple management practices on DC soybean will be performed during the upcoming growing season.

Introduction

Double crop (DC) soybean is cultivated in many regions of the United States. In most double crop systems, soybean is planted immediately after wheat harvest, which increases potential profit where there would otherwise be fallow or a non-cash cover crop. Also, soybean can be managed in no-tillage (NT) systems, reducing costs with less machinery expense after the wheat harvest. Furthermore, NT maintains wheat residue on soil surface, enhancing good soil properties. However, there are many challenges that discourage farmers from planting double crop soybean. The yield gap between full-season and double-crop soybeans is large, with the high risk of crop failure due to heat and drought during the late summer. To improve yields for DC soybean there are some management practices that may increase yield: 1) fertilizer application, promoting stronger plant growth and earlier canopy closure to overcome stresses due to a late planting season; 2) ideal row spacing and seeding rate, allowing more plants in the same unit area, potentially suppressing weed establishment and increasing yield; 3) integrated pest management (due to the late planting, the risk of late summer soil and foliar disease and insects could decrease yield); and 4) earlier planting time to lengthen growing season and allow more time for soybean plants to set pods and seed before the first killing frost.

The main objective of this study was to quantify the yield gap in double crop soybean after wheat harvest and identify the main yield-limiting factors affecting crop productivity from a perspective of environment and management practices.

Procedures

Site Characteristics

Soil type at the Ottawa location was a Woodson silt loam (Mollisols). Soil samples were taken before planting to a total depth of 6 and 12 inches. Soil chemical parameters analyzed were pH, Mehlich P, cation exchange capacity (CEC), organic matter (OM), calcium (Ca), magnesium (Mg), and potassium (K) availability (Table 1).

The studies were arranged in a randomized complete block design with 4 replications. Plot size was 10-ft wide by 60-ft long. The soybean variety used was Asgrow 4232, maturity group 4.2. Soybean was planted immediately after wheat harvest of the cultivar WB Cedar. Study 1 (early wheat harvest) was planted on June 10 and Study 2 (conventional wheat harvest), on June 23. Seven treatments were evaluated: 1) common practice - CP, 2) no seed treatment - NST, 3) non-stay green - NSG, 4) high population (180,000) - HP, 5) wide rows - WR, 6) N fixation - NF, and 7) kitchen sink - KS. The specific management practice included for each treatment is given in Table 2.

The seed treatment was Acceleron Standard® (Monsanto Company), which contains a fungicide + insecticide. For the foliar fungicide + insecticide application, the chemicals used were Aproach Prima + Prevathon (6 + 17 fl oz/a) and applied to soybean at the R3-R4 growth stage. Herbicides and hand weeding were used to maintain no weed interference for the entire season. Fertilizer application was performed on treatments 2 to 7 using the formulation 7-7-7-7S-7Cl. The application rate was 10.93 lb/a of N, phosphorus (P), K, sulfur (S), and chlorine (Cl). In treatments 2 to 6, late N was applied at a rate of 51 lb/a, in the formulation of 32-0-0 (N-P-K). Biomass was collected in a 12.5 ft^2 area, sampled outside the area collected for yield. Dates, degree-days and phenology at sampling were compiled in Table 3.

Results

Despite DC soybean usually yielding significantly less than full-season soybean, the 2016 season was a very good year for summer crops, with weather conditions that created a high-yielding environment.

Precipitation was relatively high after emergence and during the entire growing season. The accumulated seasonal precipitation was 17.6 inches, which was 4 inches greater than the 2015 summer growing season, and was well distributed throughout the growing season (Figure 1).

Biomass, Harvest Index, and Grain Yield

In studies 1 and 2, plant biomass was greater for the wide rows, while lower values were recorded for the non-stay green treatment. Conversely, seed harvest index was greatest for the kitchen sink treatment and least for the wide rows treatment (Figure 2). For seed yield, in Study 1, the N fixation treatment had the greatest yield at 64 bu/a, while the common practice had the lowest level at 58 bu/a (Figure 2). The yield gap between maximum and minimum yield values in this study was approximately 6 bu/a (Figure 2). In Study 2, the common practice yielded the least again, in addition to the no seed treatment, at 57 bu/a. The yield gap from maximum (wide rows treatment) and minimum yielding treatments was 7.5 bu/a (Figure 2).

Conclusions

When planted earlier (Study 1), yield was higher when all inputs were utilized but without the extra late-season N. In the late-planted study (Study 2), yield was maximized also when all inputs were added but with the use of 30-in. rows instead of 15-in. rows.

Size of yield gap, measured in bu/a, was comparable for both planting times but larger for the late-planted situation (25% higher, 7.5 vs. 6.0 bu/a). Best management practices for DC soybean can improve overall productivity, increasing yield via modifications in biomass and HI. Further evaluation and testing should be performed to better understand and predict the effect of management practices on DC soybean systems.

Table 1. Pre-plant soil characterization at 0- to 6-inch depth at Ottawa, KS, location

Soil parameters	Value
pH	5.8
Mehlich P (ppm)	14.5
Cation exchange capacity (meq/100 g)	15.4
Organic matter (%)	2.8
Potassium (ppm)	79.3
Calcium (ppm)	2248.7
Magnesium (ppm)	303.5

Table 2. Management practices for treatments imposed on double crop soybean planted after wheat for the early- and late-planting studies at Ottawa, KS, in 2016

Treatment	Description	Seed treatment	Foliar fung/ins	Fertility	Population	Rows, in.	Late N
1	Common practice (CP)	No	No	No	140,000	30	No
2	No seed TRT (NST)	No	Yes	Yes	140,000	15	Yes
3	Non-stay green (NSG)	Yes	No	Yes	140,000	15	Yes
4	High population (180,000) (HP)	Yes	Yes	Yes	180,000	15	Yes
5	Wide rows (WR)	Yes	Yes	Yes	140,000	30	Yes
6	N fixation (NF)	Yes	Yes	Yes	140,000	15	No
7	Kitchen sink (KS)	Yes	Yes	Yes	140,000	15	Yes

Fung = Fungicide.
Ins = insecticide.
N = nitrogen.
TRT = treatment.

Table 3. Date, degree-days, and phenology at planting date, biomass samplings and harvest for both studies at Ottawa, KS, 2016

	Study 1 (early-planted)			Study 2 (late-planted)		
	Date	Degree days (°F)	Phenology	Date	Degree days (°F)	Phenology
Planting	June 16	35		June 23	33	
Biomass 1	July 27	1,369	R2	August 8	1,442	R2
Biomass 2	August 23	2,179	R3	September 13	2,455	R3
Biomass 3	October 18	3,383	R7	October 18	3,080	R7
Harvest	November 3	3,623	R8	November 3	3,321	R8

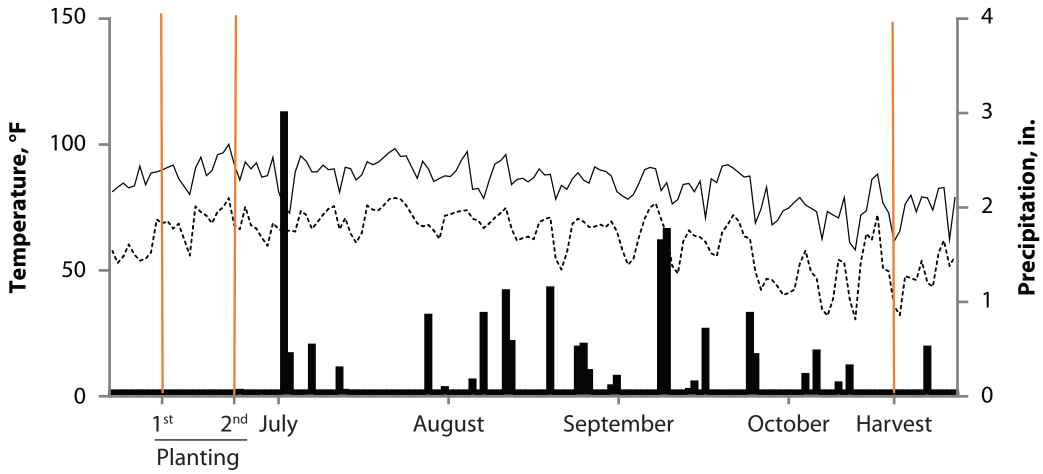

Figure 1. Precipitation and temperature during the growing season at Ottawa, KS, in 2016. Columns correspond to precipitation; continuous horizontal line corresponds to maximum temperature; dash horizontal line corresponds to minimum temperature; and vertical lines represent planting and harvest dates.

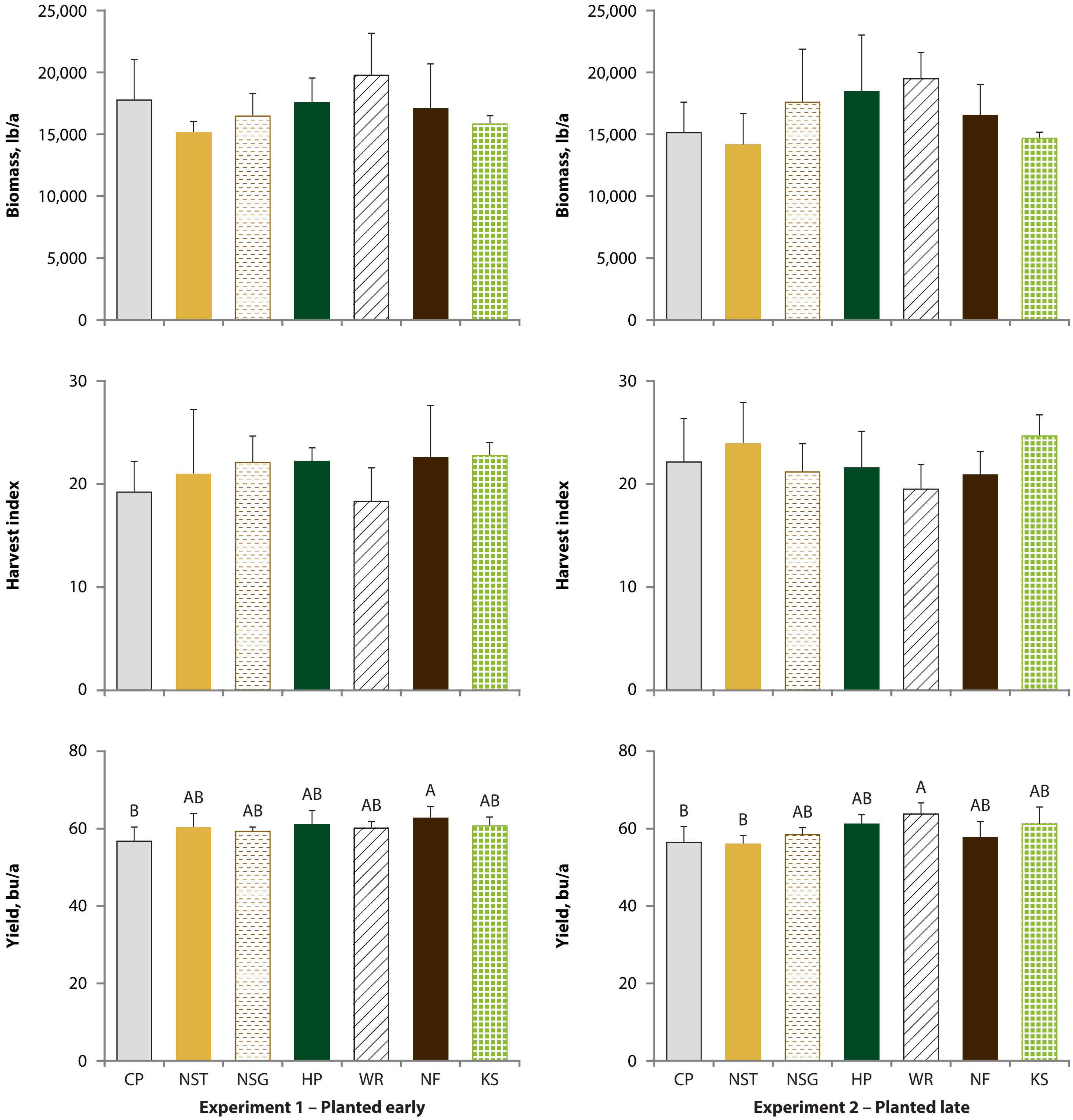

Figure 2. Biomass, harvest index, and yield in experiments 1 and 2. Common practice, CP; no seed treatment, NST; non-stay green, NSG; high population, HP; wide rows, WR; nitrogen fixation, NF; kitchen sink, KS (Table 2), Ottawa, KS, 2016.