Assessing Planting Date Effect on Soybean Yield and Dry Down for Different Maturity Groups and Planting Dates in Eastern Kansas

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Summary

The United States (US) ranks as the second-largest global soybean producer. Especially in Kansas, soybean relevance relates to the double-cropped soybean after winter wheat. While this cropping system allows efficient land use, late planting dates may reduce soybean yields. For this reason, understanding the impact of planting dates on yield is crucial for Kansans farming. Our goals were to: 1) explore the interaction between planting date and soybean maturity group (MG); and 2) characterize the soybean seed filling and dry down processes in Kansas. An experiment was carried out in Topeka, under irrigation during the 2023 growing season. Five genotypes and two planting dates (early and late) were tested. Our results showed that delaying the planting date increased moisture lost per growing degrees days (GDD). Furthermore, late planting date requires less GDD than an early planting date, resulting in a faster dry down, affecting the dry down process. Furthermore, our study showed significant impact of MG for both planting date on seed yield. The highest yields were achieved by MGs 3.4, 3.8, and 4.2, regardless of the planting dates, averaging 84, 81, and 90 bu/a for the early dates, and 80, 77, and 80 bu/a for late planting dates. The shortest and the longest MGs (2.8 and 5.2) presented yield penalties.

Introduction

The United States is the world's second-largest soybean producer. In the 2023 season, the total soybean acreage in the country reached 83.5 million acres, with Kansas State contributing to approximately 5% of the national area (USDA, 2023). The planting window in Kansas spans three months, from early April to early July, with a noticeable reduction in maximum yields of 0.3 bu/a/d, as planting dates progress later in the season (Ciampitti et al., 2022). Moreover, maturity groups 3 and 4 are the most grown throughout central and Eastern Kansas, and 5 and 6 are more prevalent in the southeast region (Ciampitti et al., 2022).

The optimal soybean harvest moisture is ~13%. Seed moisture under the optimum amount can result in mechanical damage and a decline in the seed quality (Elmore and Roeth, 1999), and reduction in sealable volume, thus reducing profits. However, harvesting above the optimum amount of moisture implies incurring additional costs related to drying. Considering these factors, it becomes evident that harvesting around the optimal moisture is essential for seed quality and to boost profitability.

The aims of our study are: 1) assess the soybean maturity group's effect on yield for both early and late planting dates; and 2) explore whether delaying the soybean planting date affects soybean dry down time in Eastern Kansas.

Procedures

A field experiment was carried out in Topeka (39°04'38" N, 95°46'05" W) at the Kansas River Valley Experiment Field area, during the 2023 growing season. Five genotypes and two planting dates were tested (Table 1). The plot size was set at 45 feet long by 20 feet wide with 8 rows per plot and plots were arranged under a randomized complete block design with five replications for each planting date. Irrigation was employed to avoid the crop showing water stress symptoms.

Weather

Weather data were collected from the Mesonet Station (Silver Lake), which is the closest weather station (~ 1.4 miles from the study site). Figure 1 illustrates the weather patterns for the growing season, including maximum and minimum temperature, precipitation, and irrigation. The minimum temperature recorded was 15.1°F and the highest maximum temperature was 105.6°F, highlighting the intense heat experienced throughout the whole season. Total precipitation for the growing season, considering an average crop length among the maturity groups was 13.8 inches from rainfall and 8.6 inches by irrigation for the early planting date. There was 11.2 inches of precipitation and 8.5 by irrigation for the late planting date.

Field Sampling and Laboratorial Process

To assess the seed moisture content, samplings started at the early R5 phenological stage, according to Fehr and Caviness (1971). Pods were collected weekly until the optimum seed moisture to harvest (13 g/100 g). The sampling size was one row × 21 in. with the number of plants varying from 4 to 6. All the pods from the four uppermost and four lowermost nodes of the main stem were collected, and immediately allocated in a Ziploc bag to avoid moisture losses. In the lab, the pods were placed in a humidified chamber with hot water and only the seeds were kept. Individual samples were composed of all seeds collected from the pods. Samples were weighed to obtain the fresh weight and then dried at 165°F until constant weight. After the samples dried, the dry weight was measured. Seed moisture content was calculated as the difference between the seed sample's fresh and dry weights divided by the fresh weight.

$$\text{Moisture} = \frac{\text{Fresh Weight} - \text{Dry Weight}}{\text{Fresh Weight}}$$

We calculated growing degrees days (GDD) by the average of the high and low temperatures minus the base temperature to calculate the daily GDDs. In the sequence, the cumulative GDD was calculated throughout the growing season.

$$\text{Moisture} = \frac{(\text{Tmax} + \text{Tmin}) - \text{Tbase}}{\text{Fresh Weight}}$$

Statistical Analysis

The yield data analysis was performed using analysis of variance (ANOVA) for each planting date. A generalized linear model was fitted considering the MGs as the predictor variable. A gamma distribution was specified to describe yield. If a significant effect was observed ($P < 0.05$), a Tukey test was performed to compare the means. The moisture data were assessed using a non-linear regression with GDD as the predictor variable, and a bootstrap function was performed to generate confidence intervals (CI) of the parameters of the model. A significant difference of the parameters for different planting dates was observed when 0 was not included in the difference between the parameters (CI 95%). All analysis was performed using *stats, car*, and *emmeans* packages in R (R Core Team, 2024).

Results

Soybean Seed Moisture Loss

Our results showed that delaying the planting date increases seed moisture loss rate for all MGs (Figure 2). The average grain moisture losses, in % per GDD, for the dry down period for each cultivar starting from the shortest to the longest MG were: 0.15, 0.18, 0.18, 0.26, and 0.28 for the early planting date; and 0.24, 0.24, 0.23, 0.61, and 0.50 for the late planting date. Therefore, the faster dry down results for the MGs 4.2 and 5.2 in the late planting dates were due to the frost occurrences at the end of the period as low minimum temperatures can be noticed in Figure 1.

Seed Yield

The MGs showed a significant impact on yield for both planting dates ($P < 0.05$; Figure 3). The highest yields were achieved by the MGs 3.4, 3.8 and 4.2, regardless of the planting date, averaging 84, 81, and 90 bu/a for early dates, and 80, 77, and 80 bu/a for the late planting dates. The shortest and the longest MGs (2.8 and 5.2) presented yield penalties, with yields averaging 75 and 70 for early dates, and 61 and 60 bu/a for late planting dates. These results support the most common soybean MGs currently used in Kansas.

Acknowledgments

Kansas Soybean Commission

References

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Table 1. Description of treatments used, including planting date, genotypes, and maturity groups

Factor	n	Treatments
Planting date	2	May 8 (Early)
		June 10 (Late)
Genotypes	5	P28A65E (2.8)
		P34A98E (3.4)
		P38A28E (3.8)
		P42A84E (4.2)
		P52A14SE (5.2)

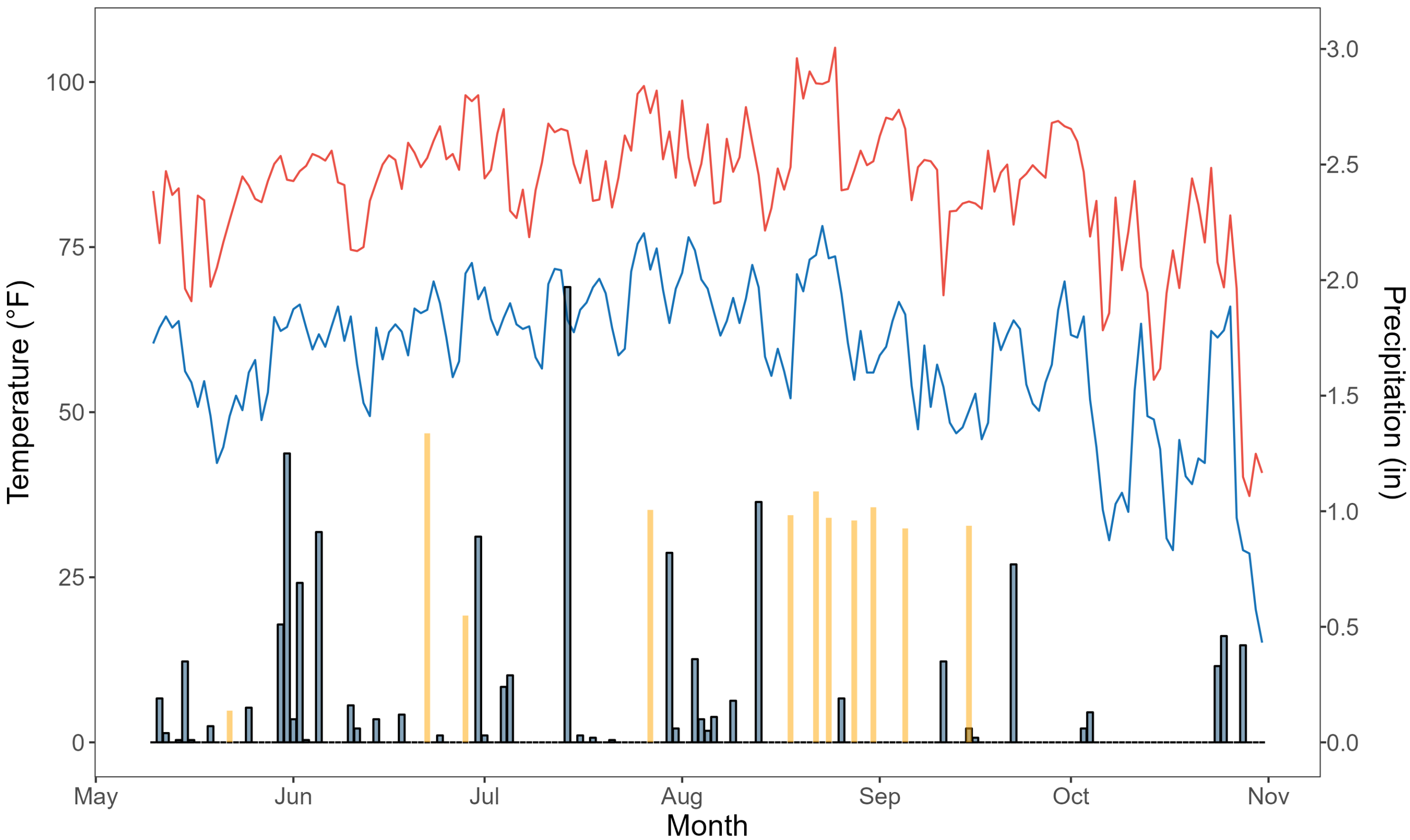

Figure 1. Daily maximum, minimum temperatures, and precipitation for the 2023 soybean growing season at the Mesonet meteorological station (Silver Lake). Blue lines stand for the minimum temperature, red lines stand for the maximum temperature, yellow bars stand for irrigation, blue bars stand for precipitation.

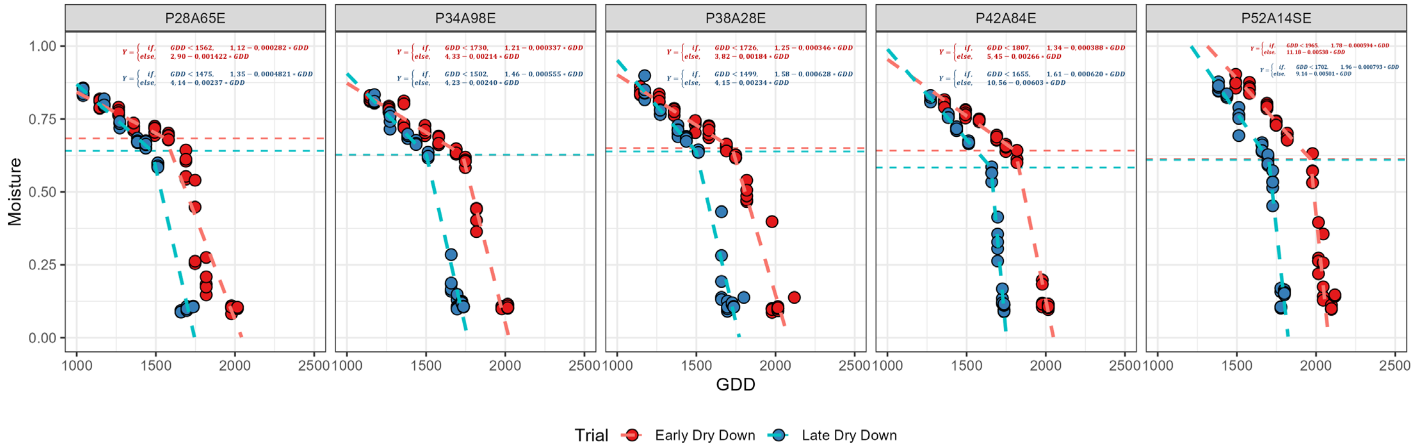

Figure 2. Relationship between moisture loss and accumulated GDD per MG and planting date. Red stands for the early planting date, and blue stands for the late planting date.

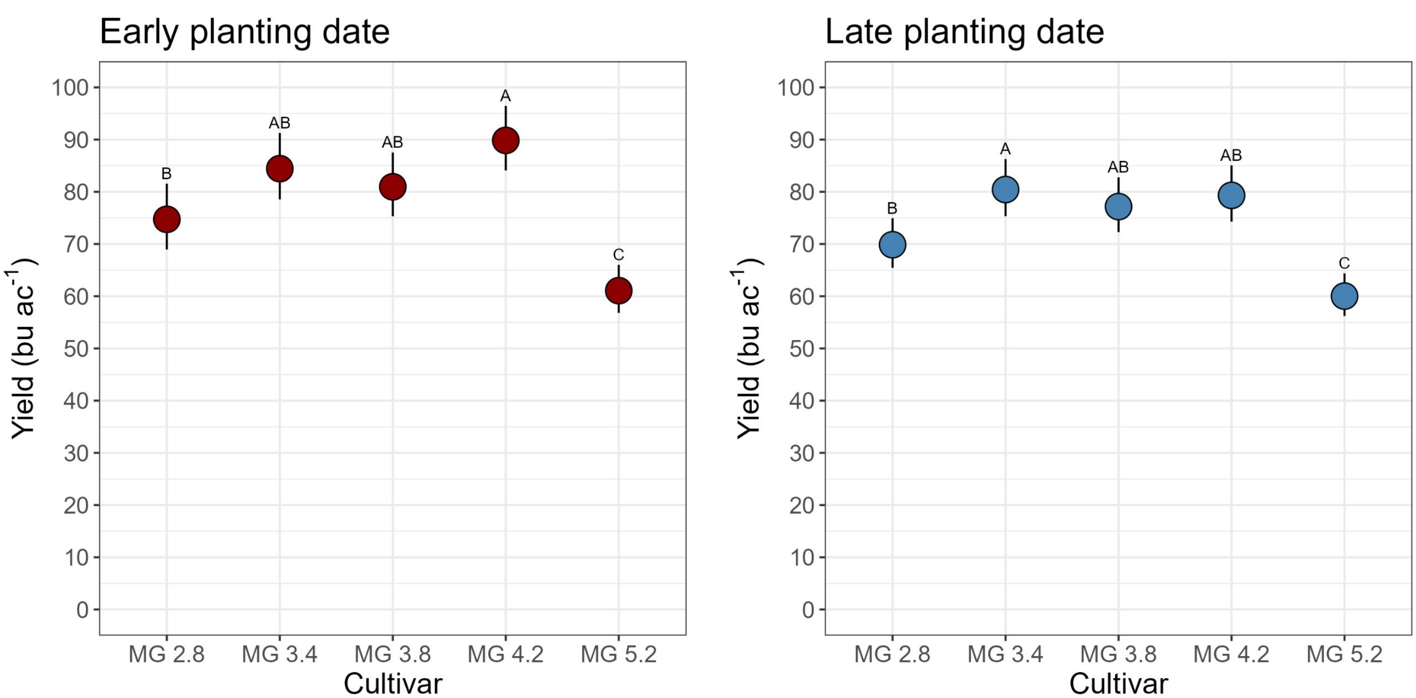

Figure 3. Relationship between yield and cultivars across different maturity groups (MGs) under two planting dates (early, May 8, and late, June 10) during the 2023 soybean growing season.