Switchgrass Harvest Yield is Maximized During an Early Fall Harvest using a Direct Chop and Ensilage Method

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Introduction

Cellulosic ethanol is a popular, renewable, liquid-fuel candidate. Switchgrass is one of the most popular biomass feedstock candidates for cellulosic ethanol production. One of the major components in maximizing ethanol production is maximizing feedstock harvest efficiency. Harvest efficiency is largely determined by the harvest timing and the equipment used in the harvesting process.

- **Objective:** To determine which harvest timing and which harvest method will maximize switchgrass biomass yield.
- **Hypothesis:** An early Fall harvest and the direct chop and ensilage method will yield the highest switchgrass biomass yield.

Description of Treatments

1A Early Harvest Bale	1B Early Harvest Chop	2A Mid Harvest Bale	2B Mid Harvest Chop	3A Late Harvest Bale	3B Late Harvest Chop	4A Over-Winter Harvest Bale	4B Over-Winter Harvest Chop
• Harvest late Sept. • Cut with mower conditioner • Rake • Bale	• Harvest late Sept. • Direct cut chop • Ensile in vacuum pack bag	• Harvest mid-Oct. • Cut with mower conditioner • Rake • Bale	• Harvest mid-Oct. • Direct cut chop • Ensile in vacuum pack bag	• Harvest early Nov. • Cut with mower conditioner • Rake • Bale	• Harvest early Nov. • Direct cut chop • Ensile in vacuum pack bag	• Harvest late March • Cut with mower conditioner • Rake • Bale	• Harvest late March • Direct cut chop • Ensile in vacuum pack bag

plot#	101	102	103	104	105	106	107	108	201	202	203	204	205	206	207	208
trt#	1A	1B	2A	2B	3A	3B	4A	4B	3A	3B	1A	1B	4A	4B	2A	2B
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plot#	301	302	303	304	305	306	307	308	401	402	403	404	405	406	407	408
trt#	2A	2B	4A	4B	1A	1B	3A	3B	4A	4B	2A	2B	1A	1B	3A	3B

Figure 1: Field design with corresponding treatment description for each switchgrass stand. Switchgrass stands are 10'x40'.

Cut-Bale

Chop-Ensile

Harvest Conditions

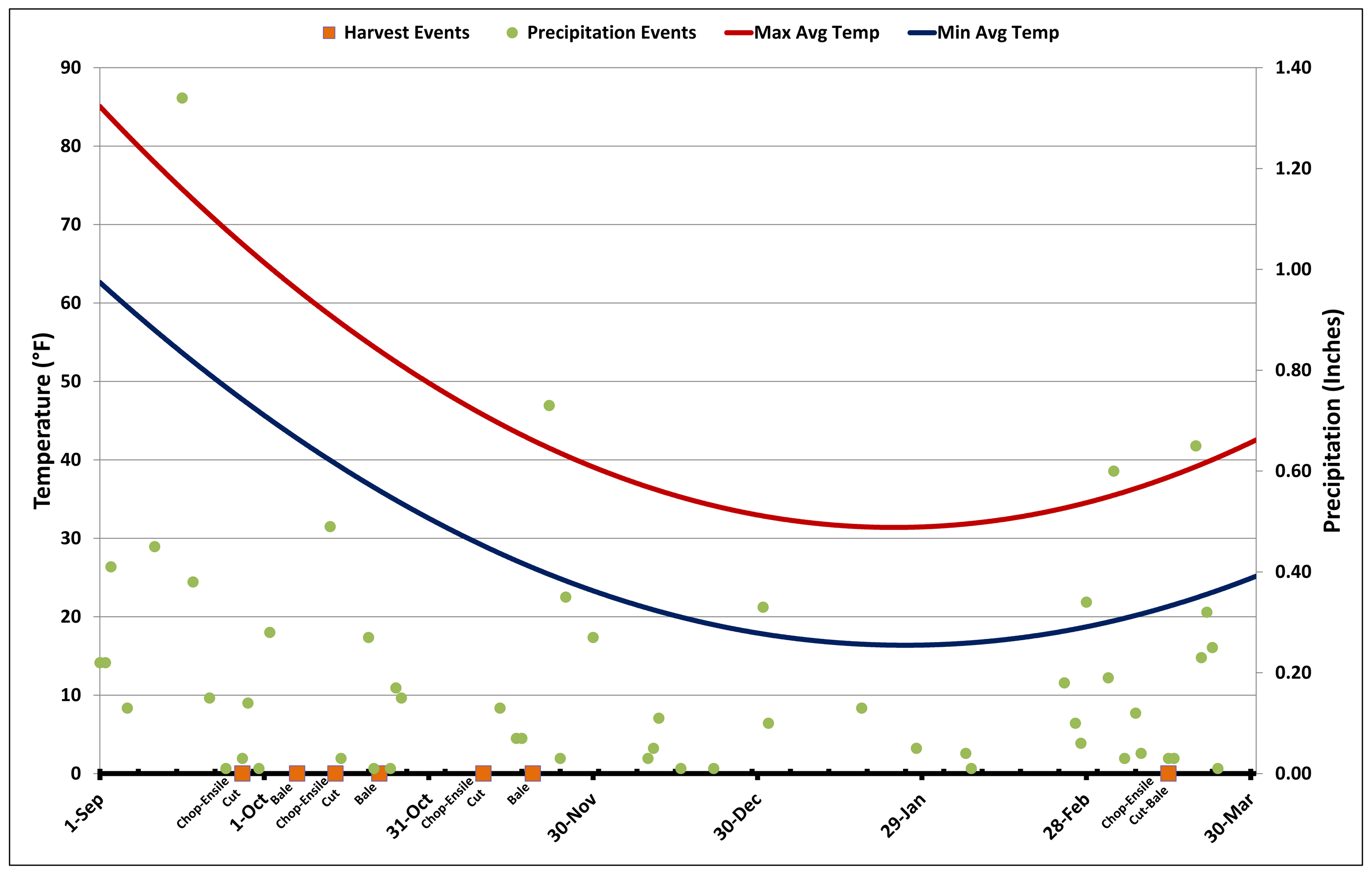

Figure 2: 2010 harvest weather conditions. During the harvest season, there were 39 days where precipitation events occurred and the cumulative precipitation was 5.80 inches.

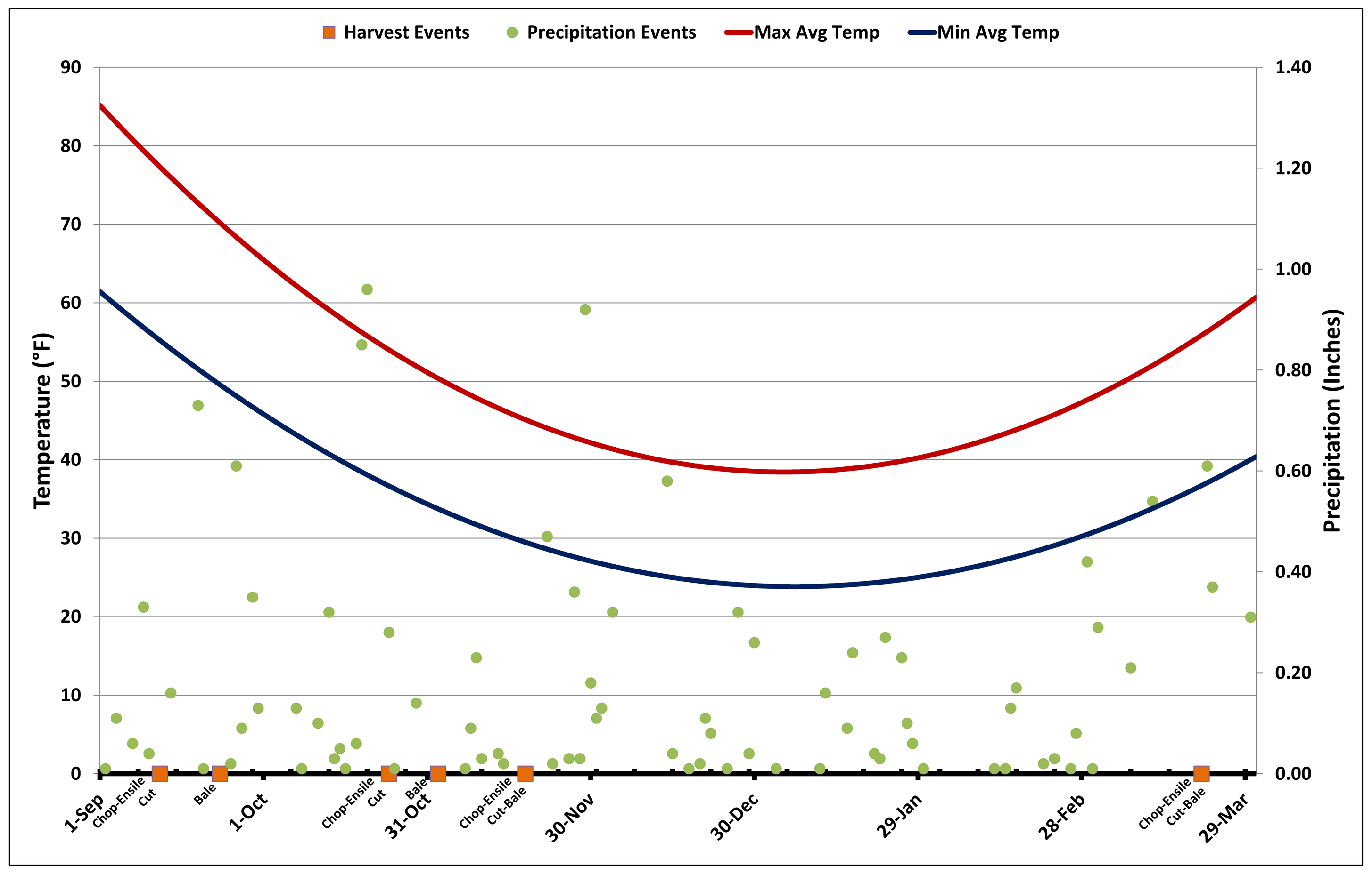

Figure 3: 2011 harvest weather conditions. During the harvest season, there were 72 days where precipitation events occurred and the cumulative precipitation was 12.69 inches.

Statistical Model

$$Yield_{ijk} = \mu + Block_i + HT_j + \varepsilon1_{ij} + HM_k + HT_j{*}HM_k + \varepsilon2_{ijk}$$

$$i = 1,2,3,4 \quad j = 1,2,3,4 \quad k = 1,2$$

- $Yield_{ijk}$ = yield response variable
- μ = grand mean over all studied treatments
- $Block_i$ = random effect of blocking
- HT_j = fixed effect of harvest timing
- $\varepsilon1_{ij}$ = residual due to whole plot variability
- HM_k = fixed effect of harvest method
- $HT_j{*}HM_k$ = fixed effect of interaction b/t harvest timing & method
- $\varepsilon2_{ijk}$ = residual due to sub-plot variability

Results

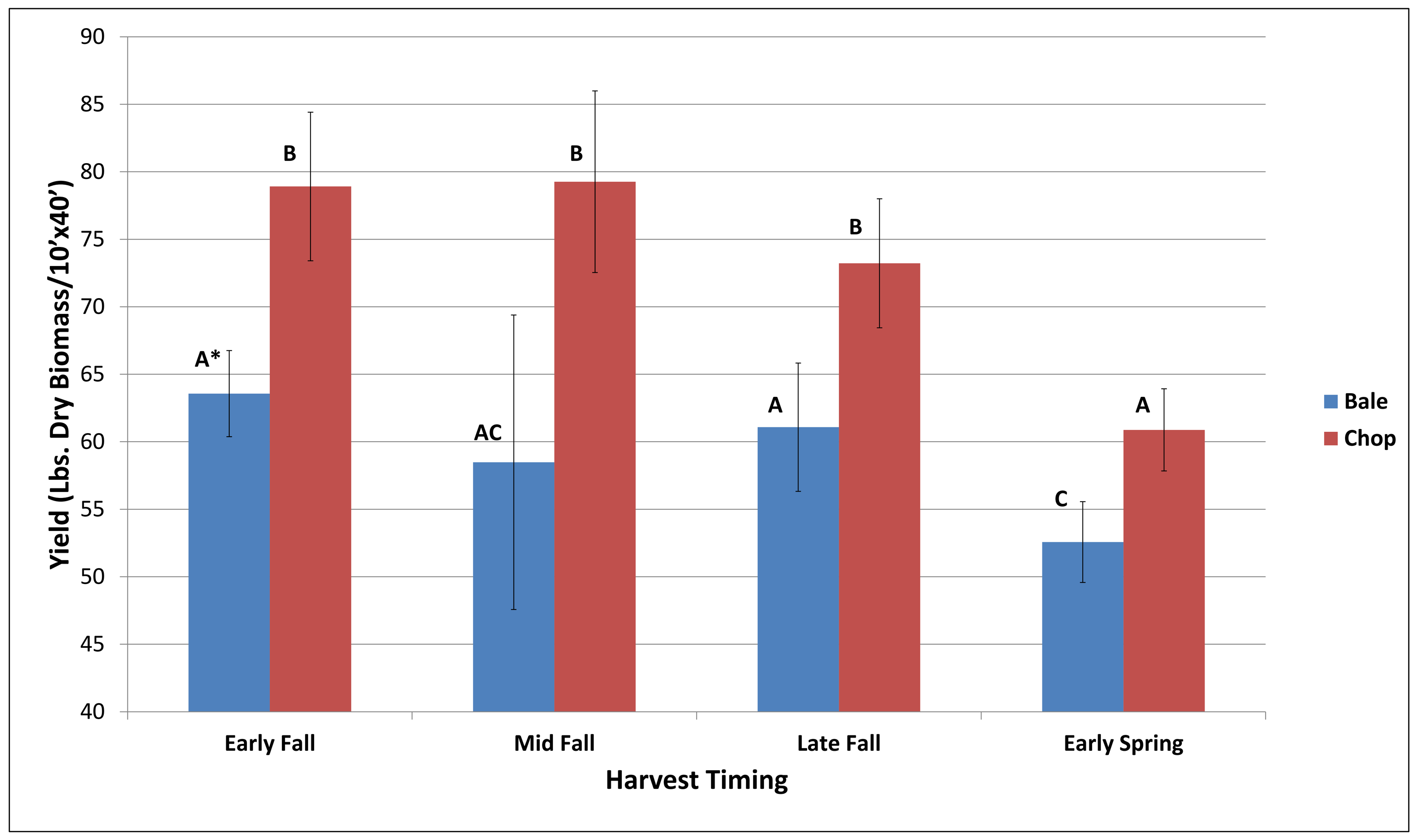

Figure 4: 2010 harvest yield data. For both harvesting methods, spring harvested switchgrass yields were significantly less than all three fall harvested switchgrass yields. The direct chop harvest yields were significantly higher than the bale yields for all harvest timings. *Averages with the same letter are not statistically different from each other (α=0.05).

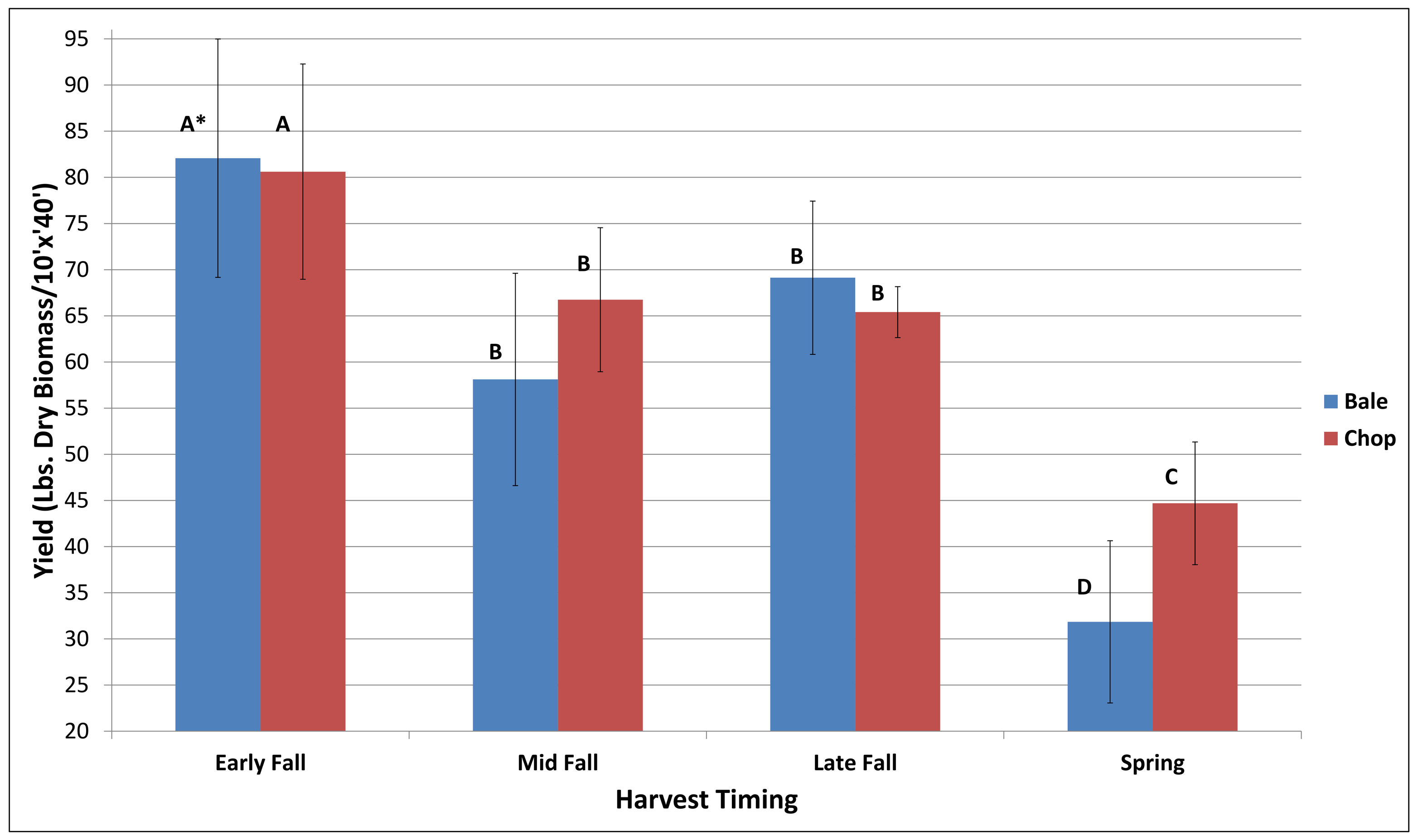

Figure 5: 2011 harvest yield data. Both harvest method yields for the early Fall were significantly higher compared to all the other harvest timings for both harvest methods. There are no significant differences between harvest methods for every harvest timing except for the Spring harvest. *Averages with the same letter are not statistically different from each other (α=0.05).

Conclusion

- 2010 harvest showed a significantly higher harvest yield for the direct chop and ensile method.
- 2010 harvest did not show a significantly higher early Fall harvest yield.
- 2011 harvest did not show a significantly higher harvest yield for the direct chop and ensile method.
- 2011 harvest showed a significantly higher early Fall harvest yield.
- Recommendation: To ensure maximal harvest efficiency, harvest in the early Fall using a direct chop and ensile method.

Acknowledgements

- Todd Martin, Field Technician