Planting Date and Hybrid Selection Decisions for Optimizing Corn Yield and Kernel Dry Down

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Introduction

- Length of the growing season[1] (Fig. 1) is expanding in northern US, allowing corn (*Zea mays* L.) growers to plant early.
- However, variability in spring precipitation (Fig. 2) often delays planting.
- Growers switch to hybrids that requires less growing degree units (GDU) to maturity when planting outside typical window.
- Corn responds to later planting by using less GDU to mature (i.e., GDU compression).

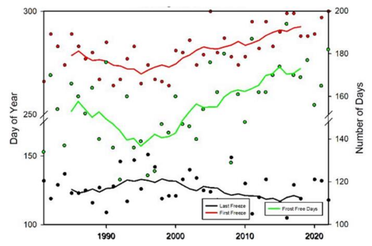

Fig.1. First freeze and last freeze dates, and frost-free days in Lansing, MI (1981-2022)

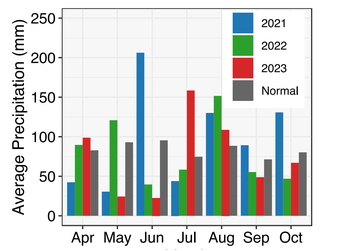

Fig.2. Monthly average precipitation for 2021-2023 vs Normal in Lansing, MI.

- It is important to reassess how to match hybrid maturity with varying planting dates to optimize yield and dry down.

Objectives

- Estimate corn GDU accumulation and compression across planting dates (PD) and relative maturities (RM).
- Quantify planting date and hybrid maturity effect on corn grain yield, test weight, and kernel moisture.
- Evaluate kernel dry down rate across multiple hybrid maturities and planting dates.

RM	GDU
89	2225
94	2330
99	2475
104	2600
109	2725

RM; Relative maturity, GDU; Growing degree units to maturity

Materials and Methods

- Field trials were conducted in 2021 and 2022 with four PD's and five RM's (Fig. 3).

Early planting (April 27) | Typical planting (May 11) | Late planting (May 30) | Very late planting (June 10)

Fig. 3. Corn at different stages of phenological development based on planting date.

- Experimental design was a split plot with four reps. Whole plots: Four PD's; subplots: 5 RM's.
- Physiological maturity (Fig. 4) was monitored and GDU to reach this stage was estimated.
- Growing degree unit compression was estimated as the difference between observed GDU and GDU stated by seed company divided by the number of days in planting after May 1.
- Kernel dry down was monitored (thrice per week) on three RM's and two planting dates.

Data Analysis

- Yield, test weight, and moisture were analyzed in R-studio.
- Response surface models were fitted for the three variables using the "rsm package". Data was pooled across years.
- Kernel moisture was regressed against day of year. The "nlraa" package was used to fit a linear-plateau curve and the "soiltestcorr" package was used to estimate dry down rate and plateau moisture.

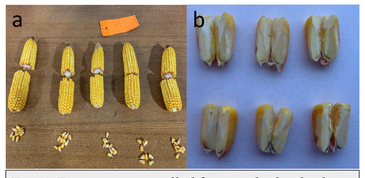

Fig. 4. Five ears were pulled from each plot, broken in middle, and five kernels were selected from each ear (a). Kernels were cut to observe black layer formation (b), physiological maturity was called when black layer was observed in 50% of kernels.

Results and Discussion

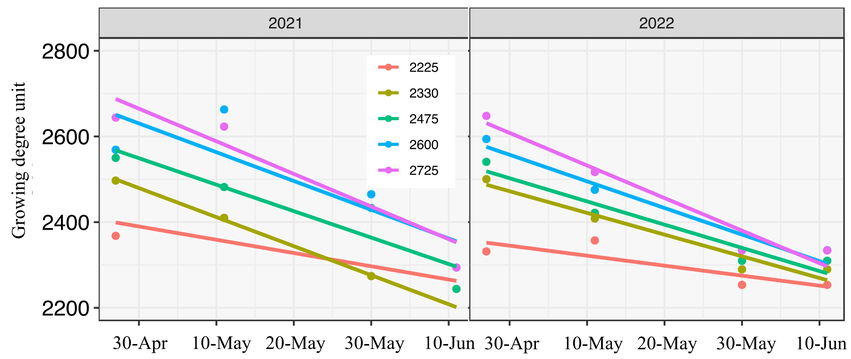

Fig. 5. Growing degree unit (GDU) accumulation and compression with delay in planting for the 2021 and 2022 seasons, for five hybrids with GDUs ranging from 2225 to 2725 GDUs (corresponds to 89 and 109 RM, respectively).

- GDU compression differed in both years.
- Compression averaged 5.6 GDU/day in 2021, higher compression observed in late-maturity hybrids.
- Compression was higher in 2022, averaging 7.2 GDU/day delay, higher compression observed in late-maturity hybrids.
- Compression range was wider in 2022 (1.2-12.6 GDU/day delay) than 2021.

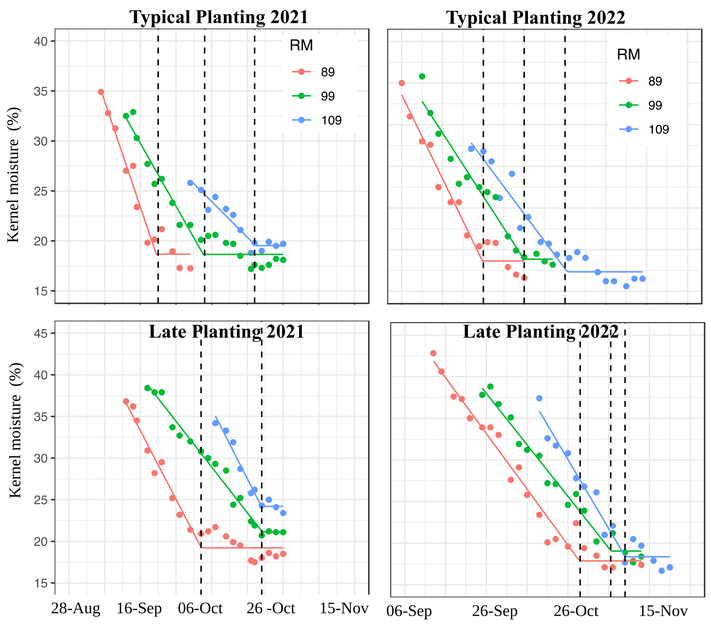

Fig. 6. Kernel dry down characteristics for three corn hybrids (89, 99, and 109 relative maturity, RM) across two planting dates (Typical: May 11; Late: May 30).

Planting Date	Relative Maturity	Dry down rate (%)	
		2021	2022
Typical (May 11)	89	1.00	0.88
	99	0.63	0.76
	109	0.36	0.66
Late (May 30)	89	0.87	0.67
	99	0.55	0.59
	109	0.84	0.83

- Greater dry down rate in 2022 than 2021, due to warmer drying conditions.
- Late-maturity hybrids dry down quicker with late planting.
- Plateau-moisture was similar with typical planting in both years, staying below 19%.
- Plateau-moisture with late planting stayed above 20% in 2021 but below 20% in 2022.

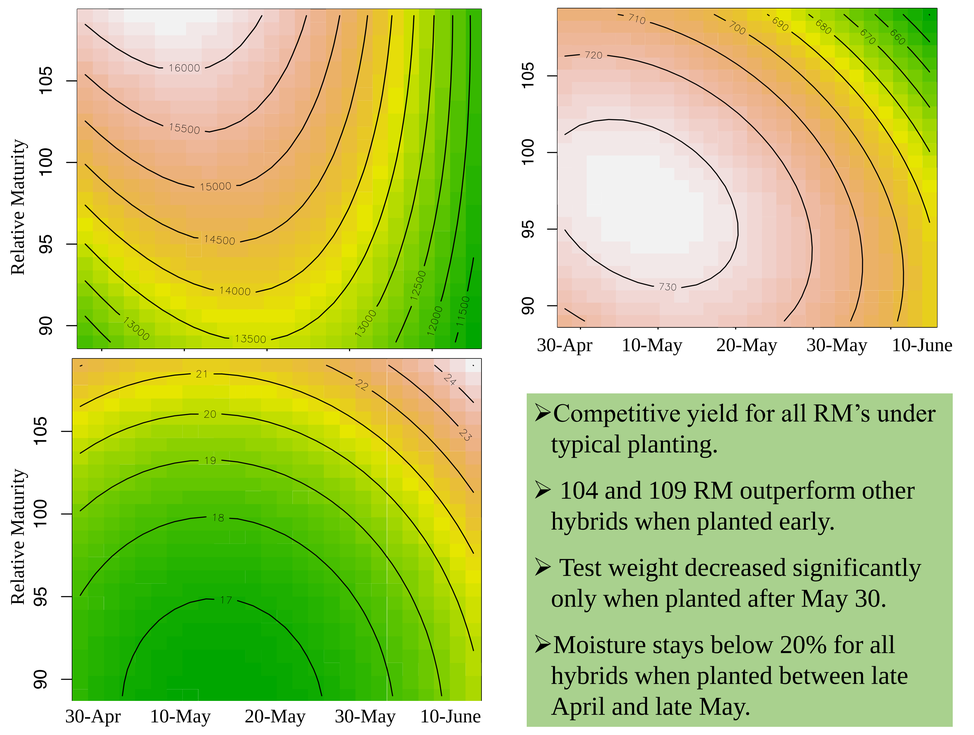

Fig. 7. Corn yield (kg ha^{-1}, top left), test weight (kg m^{-3}, top right), and moisture (%, bottom left) for planting dates (early planting in end April to very late planting in June) and hybrid maturities (89 to 109 relative maturity, RM). Brown areas indicate higher values while green areas indicate lower values for yield, moisture, and test weight.

- Competitive yield for all RM's under typical planting.
- 104 and 109 RM outperform other hybrids when planted early.
- Test weight decreased significantly only when planted after May 30.
- Moisture stays below 20% for all hybrids when planted between late April and late May.

Conclusions

- All hybrids planted **late** and **very late in the season** reached maturity before a killing frost in both years, probably due **GDU compression**.
- Kernel dry down was hugely influenced by weather conditions.
- Late-maturity hybrids planted **late in the season** dry down faster and may get to harvestable moisture with warm weather in late-October and early-November.
- Impact of hybrid maturity was minimal at typical planting. This indicates that growers can be flexible with hybrid selection at that time of the year.
- Using hybrids with maturity rating ≥104 was most beneficial under early planting.
- Switch to hybrids with lower maturity rating should be delayed till late-May. Yield can be maximized while achieving lower moisture.

Future Directions

- Explore kernel dry down characteristics of same ear in-field using innovative tools.
- Develop predictive tools for estimating corn phenology and dry down and optimize harvest decisions.

Acknowledgements and References

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- [1]EPA. (2016). *What Climate Change Means for Michigan.*