



Economic Consequences of Corn Hybrid Maturity Selection in the Northern Corn Belt



Maninder Singh, William Widdicombe, and Lori Williams
Department of Plant, Soil and Microbial Sciences, Michigan State University, East Lansing, MI

Introduction

- Shorter growing season experienced in the Northern Corn Belt requires the use of corn (*Zea mays* L.) hybrids with early relative maturity (RM) compared to hybrids used in the Central and Southern Corn Belt.
- Previous research has shown that early-RM hybrids has lower grain yield but also low moisture at harvest compared to mid- and late-RM hybrids.
- However, net returns under early-RM hybrids is often only slightly lower than late-RM hybrids, when both grain yield and moisture content in grain at harvest are considered, due to additional costs for grain drying in late-RM hybrids.
- Additionally, risk of frost and mycotoxin contamination increases with delayed harvest, more common in mid- to late-season hybrids.
- Overall, selecting corn hybrids with appropriate RM range is one of the most important management decisions growers in Michigan and other Northern Corn Belt states have to make.

Objectives

- To evaluate the profitability of the Northern Corn Belt commercial corn hybrids with different RM ratings based on their grain yield and moisture content at harvest.

Materials and Methods

- Performance of commercial corn hybrids is evaluated annually in zones ranging from south to north across Michigan (Figure 1).
- Climatic conditions are similar within each zone and consisted of three trial locations (counties) annually.
- These zones were established based on long-term accumulated growing degree days (GDD). The 30-year (1981-2010) normal accumulated GDD from May 1 to October 31 were 2557, 2478, and 2342 for zone 1, 2, and 3, respectively.

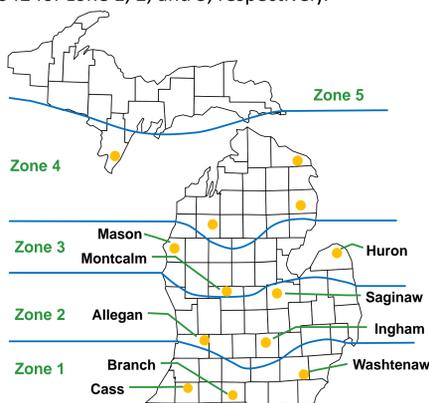


Figure 1. Trial locations within different zones across Michigan. Blue lines indicate contour lines of cumulative growing degree days. Zones 1-3 were used for this study.

- Hybrids entered in each zone were tested in each of the three locations within that zone, and were classified into two maturity groups of early or late based on their RM ratings provided by the seed companies. Hybrids in each zone were divided into two maturity groups, the cutoff RM between early and late groups was 107, 101, and 97 RM for zone 1, 2, and 3, respectively.
- Average RM for early and late group hybrids used in this study was 104 and 110 for zone 1, 98 and 104 for zone 2, and 94 and 100 for zone 3, respectively.
- Plots size was four rows 6.7m long and spaced 0.76m apart, and two center rows were harvested with a plot combine at maturity.
- Seeding rate across all sites was 84,000 plants/ha, other management was based on farmer cooperators' practices for that location.
- Data on annual grain yield (adjusted to 15.5% moisture) and harvest moisture were obtained for each hybrid entered in zones 1-3 from 2011-2017.
- Relative net returns were calculated using combinations of corn prices (\$2.50, \$3.50, and \$4.50/bu) and drying costs (\$0.03, \$0.04, and \$0.05/bu/point). No other costs besides drying costs were included in the analysis.
- Data was analyzed using Proc Glimmix in SAS with maturity group, zones, year and their interactions as fixed effect and hybrid as random effect. Means were separated using Tukey's adjustment at $P < 0.05$.

Results and Discussion

Grain Yield

- During the seven years of study period, the late maturity hybrids had higher grain yield than the early maturity hybrids only in zone 1 and 2, averaging 0.18 and 0.35 Mg/ha (2.8 and 5.6 bu/ac), respectively (Figure 2A).
- Late maturity hybrids had a higher overall yield only in three of the seven years studied, with early hybrids yielding higher in one year (Figure 2B).

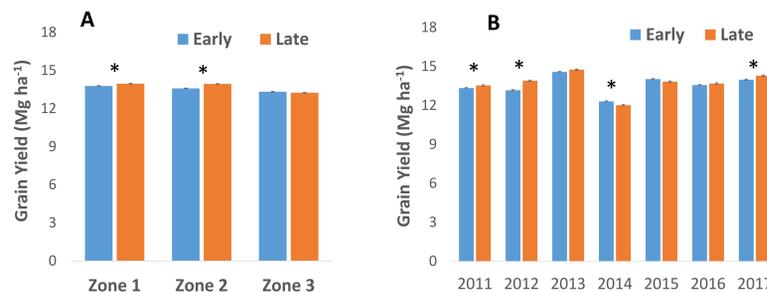


Figure 2. (A) Average grain yield of early and late maturity groups in Zone 1, 2, and 3 across 2011-2017 and (B) across the three zones from 2011 to 2017 for the early and late maturity groups. Error bars indicate ± 1 standard error of the mean. * indicated the two groups within a zone or year differ at $P < 0.05$.

- Abnormally cool temperatures during the 2014 growing season resulting in delayed planting and lower GDD accumulation had a greater negative impact on late hybrids, contributing to higher yield in early hybrids.
- Grain yield was higher in late maturity hybrids than the early hybrids only in six out of the 21 zone-year combinations studied (Figure 3).
- Early maturity hybrids had higher yield in the northern locations (zone 3) compared to the late hybrids in 2014.
- Slope of the regression line between hybrid RM and yield was significantly higher than zero in only nine out of 21 zone-years studied (data not shown), indicating that early hybrids can yield as much as late hybrids in the Northern Corn Belt.

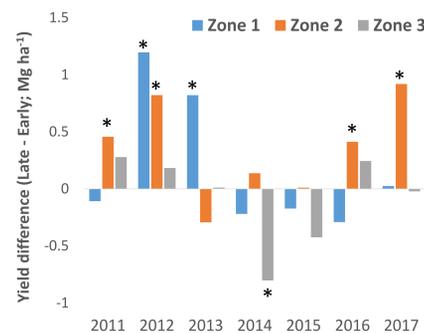


Figure 3. Estimated yield difference between the late and early maturity hybrids (Late - Early) for zones 1, 2, and 3 for the 7 years (2011-2017). * indicated that yield difference within a zone and year differ at $P < 0.05$.

Grain Moisture

- As expected, grain moisture at harvest was consistently and significantly higher for the late maturity hybrids in all the three zones (Figure 4A), as well as all the seven years studied (Figure 4B).
- Grain moisture difference between late and early hybrids were similar between the three zones studied, averaging 2.5% across zones.

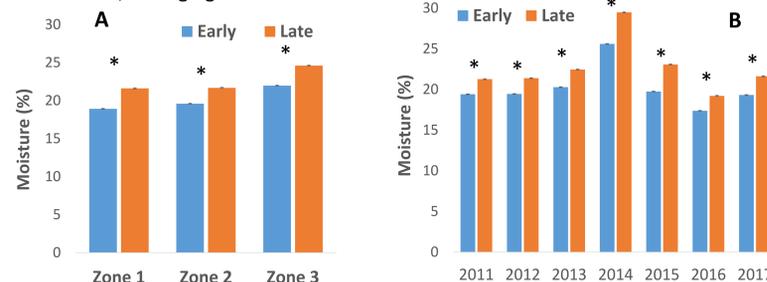


Figure 4. (A) Average grain moisture of early and late maturity groups in zone 1, 2, and 3 across 2011-2017 and (B) across the three zones from 2011 to 2017 for the early and late maturity groups. Error bars indicate ± 1 standard error of the mean. * indicated the two groups within a zone or year differ significantly at $P < 0.05$.

- More northern latitudes (zone 3 and 2) were expected to have greater moisture difference due to the short growing season.
- Grain moisture was consistently and significantly higher in late hybrids across all zone-year combinations studied (Figure 5).
- Highest differences were observed in 2014 and 2015 growing season, probably due to the cool temperatures and delayed planting.
- Slope of the regression line between hybrid RM and yield was always significantly higher than zero in all zone-years (data not shown), indicating higher moisture with increase in RM.

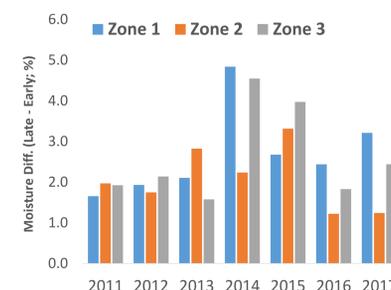


Figure 5. Estimated moisture difference between the late and early maturity groups (Late - Early) for zones 1, 2, and 3 for the 7 years (2011-2017). All moisture differences within a zone and year differ at $P < 0.05$.

Economic Returns

- High corn grain price and low grain drying cost scenarios should favor late maturity hybrids for economic returns, due to higher moisture and higher grain yield, the latter not consistent across the zones and years studied.
- Late hybrids had significantly higher returns relative to the early hybrids only during the 2012 growing season (high GDD accumulation and dry weather) when the corn grain price was high and/or drying cost was low (Table 1).

Table 1. Average economic return difference ($\$ \text{ha}^{-1}$) between the late and early maturity groups (Late - Early) in the three zones for 2011 to 2017. * indicated difference was significant at $P < 0.05$.

Drying cost (\$ bu^{-1} point $^{-1}$)	Corn grain price (\$2.50 bu^{-1})						
	2011	2012	2013	2014	2015	2016	2017
0.03	-12	36*	-22*	-80*	-74*	-18	-10
0.04	-22*	24	-35*	-96*	-92*	-28*	-24*
0.05	-33*	12	-48*	-113*	-110*	-38*	-37*
	Corn grain price (\$3.50 bu^{-1})						
	2011	2012	2013	2014	2015	2016	2017
0.03	-3	65*	-15	-91*	-81*	-13	2
0.04	-14	53*	-28*	-108*	-100*	-23	-12
0.05	-25	41*	-41*	-125*	-118*	-33*	-25
	Corn grain price (\$4.50 bu^{-1})						
	2011	2012	2013	2014	2015	2016	2017
0.03	5	94*	-8	-103*	-89*	-9	-14
0.04	-6	82*	-21	-120*	-107*	-19	0
0.05	-17	70*	-34*	-137*	-126*	-29	-13

- The early hybrids had substantially higher net returns when weather conditions were cool, as happened during the growing seasons of 2014 and 2015.
- Advantage to the early over late hybrids in the 2014 and 2015 season ranged from \$74 to \$137 per ha depending on the grain price and drying cost.

Table 2. Overall economic return difference ($\$ \text{ha}^{-1}$) between the late and early maturity groups (Late - Early) over 2011 to 2017 for zones 1, 2, and 3. * indicated difference was significant at $P < 0.05$.

Zone	Drying cost (\$ bu^{-1} point $^{-1}$)	Corn grain price (\$ bu^{-1})		
		2.5	3.5	4.5
1	0.03	-26*	-19*	-12
	0.04	-41*	-34*	-27*
	0.05	-56*	-49*	-42*
2	0.03	-3	11	25*
	0.04	-15*	-1	12
	0.05	-27*	-14	0
3	0.03	-48*	-51*	-54*
	0.04	-61*	-64*	-67*
	0.05	-74*	-77*	-80*

- Advantage of early maturity hybrids over late hybrids increased with the increase in latitude (zone 1 to zone 3) with the same corn grain price and drying cost (Table 2). Zone 2 net return differences were lower than that observed in zone 1, contrary to the higher return differences expected due to higher moisture in northern locations.
- In zone 3, early hybrids had a higher return with each combination of corn grain price and drying cost studied.
- Late hybrids showed advantage only in one of the 12 scenarios studied in zone 2 and none in zone 1.

Conclusions

- Late-maturity hybrids produced higher grain yield than the early hybrids in only two of the three zones and three of the seven years studied, indicating that early hybrids can yield as much as late hybrids in the Northern Corn Belt weather conditions.
- However, grain moisture at harvest was consistently higher for the late hybrids in all zones and years studied.
- As a result, the early hybrids had greater net returns in most scenarios evaluated while the late hybrids had significant economic advantage only with relatively higher corn price ($\geq \$4.50/\text{bu}$), lower drying costs ($< \$0.05/\text{bu}/\text{point}$), and favorable growing season conditions.
- Overall, results from this study indicated the economic benefit of selecting early maturity hybrids compared to the late hybrids in addition to the low perceived risk of frost damage and mycotoxin contamination.

Acknowledgements

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