



PIONEER



CORN

Quick Reference Guide

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CORN GROWTH STAGES



V_E

Emergence – first leaves push through coleoptile and emerge above soil surface. Requires about 100-125 GDUs. Establishing a good stand with uniform emergence is very important to growing a high yielding corn crop.

V(n)

"n" represents number of leaves with visible collars. **From V1-V14:** 1 leaf every 75 GDUs; **V15+:** 1 leaf every 52 GDUs or about every 2-3 days.

Key Vegetative Events

V₁

First-leaf collar visible. (First leaf has a characteristic oval-shaped tip).

Plant transitions from kernel energy reserves to its newly established nodal root system sometime V2-V3.

V₂

"Critical Weed-Free Period" is V2-V7. Always spray weeds before they are 4 inches tall and use multiple mode of action herbicides consisting of preemerge, postemerge, and residual herbicides in your weed management plans.

V₅

Leaf and ear shoot initiation complete and number of kernel rows determined V5-V8.

Growing point at or above soil surface. Nodal root system established and plant's ability to take up nutrients and water

V₆

established. Key side-dress nitrogen timing is V4-V6 so that N is available to the corn crop by V8.

V₈

70-80% of N requirement occurs after V8-V10. Roundup WeatherMax® can be applied over the top to corn with Roundup Ready® 2 Technology up to the V8 stage or until the corn reaches 30 inches tall, whichever comes first; according to label guidelines. Off-label glyphosate applications beyond this may result in corn ear injury known as "jumbled kernel syndrome" and 5-15% yield loss may be common.

V₁₂-

Number of ovules and kernels per row being determined.

Last branch of tassel is completely visible, silks are not visible. Brace roots start to form around V18.

VT

*Foliar fungicides should be applied post tassel (VT) if using a non-ionic surfactant with the fungicide.

Silking – silks are visible outside of husks 2-3 days after VT (silks start developing at the base of the ear and progress towards the ear tip).

R1

Pollen shed begins, brace roots fully establish, near maximum root mass. Moisture stress during silking may cause the greatest potential yield reduction. 30-40% of nitrogen requirement is after silking through grain fill.

Blister – kernels are white on outside and

R2

resemble blister shape (10-14 days after silking).

R3

Milk – kernels are yellow with milky-white inner fluid (18-22 days after silking).

R4

Dough – kernels have a pasty, doughy consistency (24-28 days after silking).

R5

Dent – kernels begin drying down, beginning with top starch, forming a dent (35-42 days after silking).

R6

Physiological maturity – a black or brown layer is visible at the base of the kernel. Grain has achieved maximum dry matter accumulation (55-65 days after silking).

CORN PLANTING DEPTH



- Planting depth is the length of mesocotyl + $\frac{3}{4}$ inch.
- Ideal planting depth for corn is 2 to $2\frac{1}{4}$ inches
 - » never more shallow than 1.5 inches and take into consideration some planter box hop that can occur
- Plant into moisture, and at a soil temperature of 50°F or above, followed by a 48 hr period of stable or warming soil temperatures.
- Stop planting 36-48 hours ahead of a cold rain/snow event to reduce potential for cold chill imbibition that could result in reduced plant stands.

GROWING DEGREE UNITS



(Daily high temp + daily low temp)
divided by 2, minus 50°F.

Daily high limit: 86 °F Daily Low limit: 50 °F.

Average # GDUs per day by month – Parkston, SD

May: 11 GDUs, June: 20 GDUs, July: 24 GDUs,
August: 23 GDUs, September: 14 GDUs

CORN GROWTH & DEVELOPMENT

Growth Stage*	Approx. GDDs**	Cum. GDDs	Calendar Date
Planting			May 1
VE Emergence	100	100	May 10
V3 3 leaves	180	280	May 24
V6 6 leaves	180	460	Jun 4
V9 9 leaves	180	640	Jun 14
V12 12 leaves	180	820	Jun 23
V15 15 leaves	180	1,000	Jun 30
V18 18 leaves	180	1,180	Jul 8
VT Tassel	60	1,300	Jul 13
R1 Silking	60	1,360	Jul 15
R2 Blister	300	1,660	Jul 27
R3 Milk	200	1,860	Aug 5
R4 Dough	140	2,000	Aug 11
R5 Dent	300	2,300	Aug 25
1/2 Milkline	220	2,520	Sep 5
R6 Black Layer	200	2,720	Sep 17

* Based on leaf collar method as defined by Ritchie et al. (1986), "How a Corn Plant Develops," Spec. Rep. #48, Iowa State Univ.

** Approximate growing degree days (GDDs) between growth stages. Comparison of the Two Leaf Staging Methods

CALCULATING ACREAGE



Corn, Soybeans, Sorghum & Sunflower:

Row Length (ft.) x Row Width (in.) x No. of Rows \div 522,720 = Acres

Wheat & Drilled Crops:

Length (Ft.) x Harvest Width (ft.) \div 43,560 = Acres

UNITS OF SEED CORN PLANTED

ACRES PLANTED/UNITS OF SEED CORN

seeds/ acre	acres planted/unit		seeds/ acre	acres planted/unit	
	80K	60K		80K	60K
16,000	5.0	3.8	30,000	2.7	2.0
18,000	4.4	3.3	32,000	2.5	1.9
20,000	4.0	3.0	34,000	2.4	1.8
22,000	3.6	2.7	36,000	2.2	1.7
24,000	3.3	2.5	38,000	2.1	1.6
26,000	3.1	2.3	40,000	2.0	1.5
28,000	2.9	2.1	42,000	1.9	1.4

PLANTING RATES



SUGGESTED PLANTING RATES

Yield Potential	Planting Rate
80 – 100 bu/acre	18,000 – 20,000 ppa
100 – 120 bu/acre	20,000 – 22,500 ppa
120 – 140 bu/acre	22,500 – 26,500 ppa
140 – 160 bu/acre	26,500 – 28,000 ppa
160 – 180 bu/acre	28,000 – 30,000 ppa
180 – 200 bu/acre	30,000 – 31,500 ppa
200 – 220 bu/acre	31,500 – 33,000 ppa
220 – 240 bu/acre	33,000 – 35,000 ppa
240 – 260 bu/acre	35,000 – 36,000 ppa
260 – 280 bu/acre	37,000 – 38,000 ppa
280 – 300 bu/acre	38,000 – 39,000 ppa
300 – 320 bu/acre	39,000 – 41,000 ppa

SEED SPACING

Planting rate/ acre	Final stand/ acre (5% loss)	Seed Spacing (inches)						
		15	20	22	30	36	38	40
inches between kernels								
12,000	11,400	34.8	26.1	23.8	17.4	14.5	13.8	13.1
14,000	13,300	29.9	22.4	20.4	14.9	12.4	11.8	11.2
16,000	15,200	26.1	19.6	17.8	13.1	10.9	10.3	9.8
18,000	17,100	23.2	17.4	15.8	11.6	9.7	9.2	8.7
20,000	19,000	20.9	15.7	14.3	10.5	8.7	8.3	7.8
22,000	20,900	19.0	14.3	13.0	9.5	7.9	7.5	7.1
24,000	22,800	17.4	13.1	11.9	8.7	7.3	6.9	6.5
26,000	24,700	16.1	12.1	11.0	8.0	6.7	6.3	6.0
28,000	26,600	14.9	11.2	10.2	7.5	6.2	5.9	5.6
30,000	28,500	13.9	10.5	9.5	7.0	5.8	5.5	5.2
31,000	29,450	13.5	10.1	9.2	6.7	5.6	5.3	5.1
32,000	30,400	13.1	9.8	8.9	6.5	5.4	5.2	4.9
33,000	31,350	12.7	9.5	8.6	6.3	5.3	5.0	4.8
34,000	32,300	12.3	9.2	8.4	6.1	5.1	4.9	4.6
35,000	33,250	11.9	9.0	8.1	6.0	5.0	4.7	4.5
36,000	34,200	11.6	8.7	7.9	5.8	4.8	4.6	4.4
37,000	35,150	11.3	8.5	7.7	5.7	4.7	4.5	4.2
38,000	36,100	11.0	8.3	7.5	5.5	4.6	4.3	4.1
39,000	37,050	10.7	8.0	7.3	5.4	4.5	4.2	4.0
40,000	38,000	10.5	7.8	7.1	5.2	4.4	4.1	3.9
42,000	39,900	10.0	7.5	6.8	5.0	4.1	3.9	3.7
44,000	41,800	9.5	7.1	6.5	4.8	4.0	3.8	3.6
46,000	43,700	9.1	6.8	6.2	4.5	3.8	3.6	3.4

STAND COUNTS



Length of row equal to $\frac{1}{1000}$ acre

Row width	Row length for $\frac{1}{1000}$ th acre
7.5"	69' 8"
15"	34' 10"
20"	26' 2"
22"	23' 9"
30"	17' 5"
36"	14' 6"
38"	13' 9"

PLANTING DATE



Corn Yield Potential by Planting Date

Planting Date	Corn Yield Potential
April 25	100 %
April 30	99 %
May 5	97 %
May 10	94 %
May 15	91 %
May 20	88 %
May 25	86 %
May 30	83 %
June 4	77 %
June 9	71 %
June 14	65 %
June 19	59 %

Source: Hicks et al., 1999; Southern Minnesota

LAST PLANTING DATES (SD)

SUGGESTED LAST PLANTING DATES FOR CORN HYBRIDS IN SOUTH DAKOTA

Planting Date	Hybrid Relative Maturity (Days)* **			
	Hwy 12 to North Dakota	Hwy 12 to Hwy 14	Hwy 14 to I-90	I-90 to Nebraska
May 15	103	105	107	112
May 20	97	101	103	110
May 25	94	97	99	105
June 1	90	95	97	100
June 5	84	87	90	95
June 10	75	80	82	90

*If farming on the Buffalo Ridge, reduce hybrid maturity another 4-5 CRM per planting date in the left hand column.

**Consider hybrids with an equal or earlier silk CRM and a faster drydown rating to help promote drier grain at harvest. Use local knowledge and field history to fine-tune these planting date decisions.

EMERGENCE TIMING



- **Corn Uniform Timing of Emergence:** Accounts for 5-9% of impact on yield. Achieving uniform plant spacing is also important but is 1-2% of impact on yield and having skips are worse than having doubles.
- Goal is to have all corn plants emerge within 48 hours of each other; especially by 72 hours or 3 days. Ear size and stalk diameter really starts to be negatively impacted by 3.5+ days of delayed emergence.
- Help achieve more uniform emergence in corn by properly managing residue size and distribution behind the combine, properly adjusted row cleaners on the planter to move residue off the row, proper planting speed, maintaining consistent planting depth and ensuring all seeds are planted into moisture, proper down-force on the planter to accommodate seed-bed variability across the field/rows, proper closing wheel settings, and reducing potential for soil crusting.
- 1 leaf collar behind (3-4 days delayed) in early June is usually a $\frac{2}{3}$ to $\frac{1}{2}$ size ear at harvest and 2 leaf collars behind (6-8+ days delayed) in early June is usually a $\frac{1}{4}$ size ear or barren at harvest. Drought years are worse.

EARS FROM PLANTS THAT WERE 1 LEAF STAGE BEHIND IN EARLY JUNE



EARS FROM PLANTS THAT WERE 2 LEAF STAGES BEHIND IN EARLY JUNE



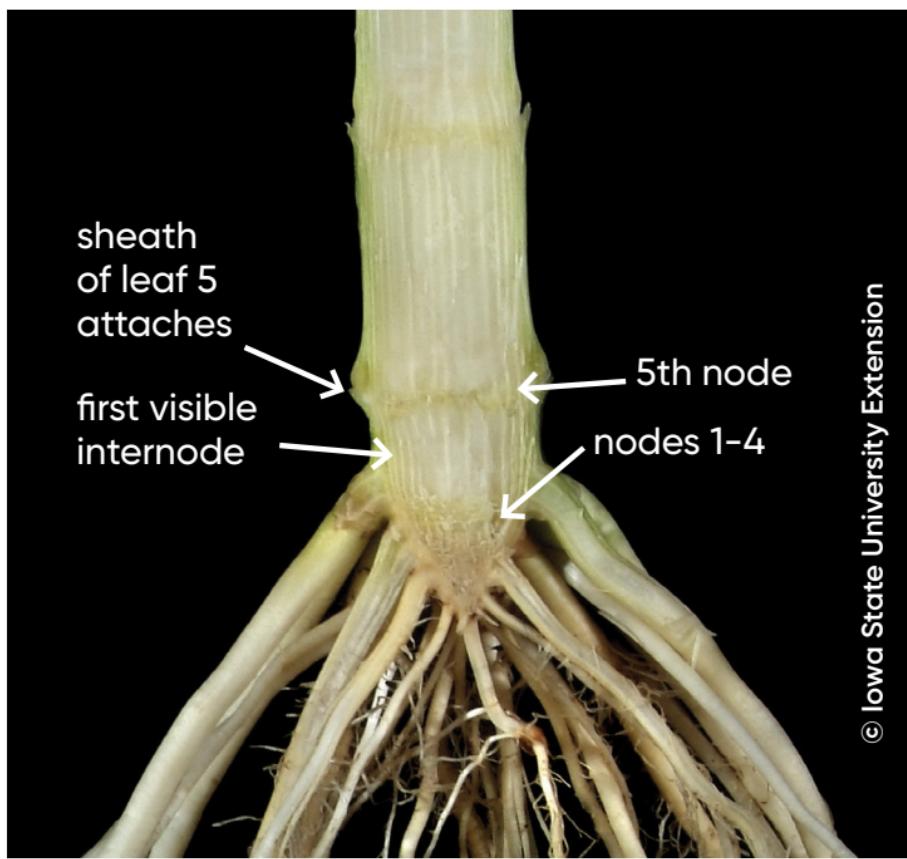
UNIFORMITY OF CORN EMERGENCE IMPACT ON EAR DEVELOPMENT AND STALK DIAMETER:



Source: October 20, 2017 Beresford, SD

Planting Date	Plant Population (1,000 plants/acre)						
	20	23	26	29	32	35	38
	% of maximum yield						
April 1-10	84	88	91	94	97	98	99
April 11-20	84	89	92	95	97	99	100
April 21-30	84	88	92	95	97	99	99
May 1-10	83	87	90	93	95	97	98
May 11-15	81	85	89	91	93	95	96
May 16-20	79	83	87	90	92	93	94
May 21-25	78	82	85	88	90	91	92
May 26-31	75	79	82	85	87	88	89
June 1-5	73	76	79	82	84	85	86
June 19	32	42	49	56	59	59	57

Source: Nafziger, E. 2020. Replanting Corn and Soybeans. Univ. of Illinois



YIELD LOSS



ESTIMATED PERCENT CORN GRAIN YIELD LOSS DUE TO DEFOLIATION AT VARIOUS GROWTH STAGES¹

Growth Stage ²	% Leaf Defoliation									
	10	20	30	40	50	60	70	80	90	100
	% Yield Loss									
7 leaf	0	0	0	1	2	4	5	6	8	9
9 leaf	0	0	1	2	4	6	7	9	11	13
11 leaf	0	1	2	5	7	9	11	14	18	22
13 leaf	0	1	3	6	10	13	17	22	28	34
15 leaf	1	2	5	9	15	20	26	34	42	51
17 leaf	2	4	7	13	21	28	37	48	59	72
19-21 leaf	3	6	11	18	27	38	51	64	79	96
Tassel	3	7	13	21	31	42	55	68	83	100
Silked	3	7	12	20	29	39	51	65	80	97
Silks Brown	2	6	11	18	27	36	47	60	74	90
Blister	2	5	10	16	22	30	39	50	60	73
Milk	1	3	7	12	18	24	32	41	49	59
Soft Dough	1	2	4	8	12	17	23	29	35	41
Early Dent	0	1	2	5	9	13	18	23	27	32
Late Dent	0	0	1	3	5	7	9	11	13	15
Mature	0	0	0	0	0	0	0	0	0	0

¹Adapted from the National Crop Insurance Services "Corn Loss Instruction" (Rev. 1984)

²As determined by counting fully expanded leaves (i.e., those with 40-50% of leaf exposed from whorl and whose tip points below the horizontal.)

YIELD REDUCTION IN CORN DUE TO DROUGHT			
Age of the Corn Plant	Growth Stage	Yield Reduction per Drought Day	Total Yield Reduction
1-33 days*	GE-V5	-	-
Next 22-32 days	V6-V15	2.0%	25%
Next 5-15 days	V16-R2	6.0%	50%
Next 20-30 days	R3-R5	1.5%	25%
Next 5-15 days**	R6	-	-

* Yield reduction depends on many variables including germination and upper soil profile moisture.

** Overall drought period will affect yield reduction. A continuous drought may result in 100% reduction.

Source: North Dakota State University

WATER USE



CONSUMPTIVE WATER USE - CORN

inches of water/day

Growth Stage	Cool and Humid	Average	Hot and Dry
4 Leaf	0.07	0.08	0.08
6 Leaf	0.08	0.1	0.12
8 Leaf	0.095	0.12	0.18
10 Leaf	0.12	0.17	0.24
12 Leaf	0.17	0.21	0.28
14 Leaf	0.21	0.245	0.31
16 Leaf	0.24	0.28	0.335
18 Leaf	0.27	0.3	0.35
Tassel	0.29	0.32	0.37
Silk	0.305	0.33	0.375
Blister	0.31	0.335	0.375
Milk	0.3	0.325	0.37
Late Milk	0.27	0.31	0.35
Early Dough	0.23	0.275	0.32
Dough	0.19	0.235	0.28
Early Dent	0.145	0.19	0.24
Full Dent	0.11	0.15	0.2
Starch line ½	0.09	0.12	0.145
Black Layer	0.08	0.1	0.12

GRAIN DRYDOWN



Stage	Days to Maturity*	GDU's Until Mature**
Silk	50-60	1100-1200*
Blister	40-50	900-1000
Late Milk	30-40	650-750
Full Dent	20-25	450-550
½ Milk Line	10-15	200-300
Physiological Maturity	0	0

* Actual days between stages vary greatly depending on temperature

**Approximate GDU's needed for a 100 Day RM hybrid to reach physiological maturity

CORN YIELD & MOISTURE RELATIVE TO PHYSIOLOGICAL MATURITY

Stage	% of Max Grain Yield	% of Max Yield Whole Plant	Moisture Content (%)	
			Grain	Whole Plant
Silk	0	50-55	-	80-85
Blister	0-10	55-60	85-95	80-85
Late Milk	30-50	65-75	60-80	75-80
Early Dent	60-75	75-85	50-55	70-75
½ Milk Line	90-95	100	35-40	65-70
Phys. Maturity	100	95-100	25-35	55-65

- The rate of corn grain moisture loss is highly dependent on air temperature, air movement, relative humidity, and grain moisture content.
 - » Drydown is highly related to hybrid characteristics, such as ear orientation, plant density, tightness and length of husks, and kernel hardness.
- As a general rule, it requires 30 GDDs to remove one point of moisture from the grain early in the drying process (30 to 25 percent), and 45 GDDs to remove one point of moisture late in the drying process (25 to 20 percent).
- Grain drying rates will vary between hybrids and environments.
 - » For example, corn dries better on a 50° F (10° C) sunny day than on a 50° F (10° C) rainy or cloudy day.
 - » Both days have the same number of heat units, but the additional energy provided by the radiant energy on a sunny day dramatically improves the drying process.

CORN DRY-DOWN RATE

(Average Daily Temperature X 0.0202) - 0.7133

Average Temperatures & Corn Dry-down Rates Mitchell, SD

Week of:	Weekly Average Temp	Avg. Dry-down % per day
1-Sep	66	0.62
8-Sep	64	0.58
15-Sep	61	0.52
22-Sep	58	0.46
1-Oct	55	0.40
8-Oct	51	0.32
15-Oct	48	0.26
22-Oct	44	0.18

YIELD ESTIMATION



CALCULATE CORN DRYING COST PER ACRE:

bu/acre x points of moisture to remove x 0.02
x Propane Cost (\$/gallon) = **\$/acre**.

Divide **\$/acre** drying cost by the corn **price/bu** to determine how many added bu/acre are needed to offset the drying cost.

This can be helpful when comparing two hybrids.

POINTS OF MOISTURE DIFFERENCE BETWEEN TWO HYBRIDS

Yield (bu/acre)	1	2	3	4	5
	Added bu/acre Needed to Offset Energy Cost of Drying Corn*				
75	0.5	1.1	1.6	2.1	2.7
100	0.7	1.4	2.1	2.8	3.6
125	0.9	1.8	2.7	3.6	4.4
150	1.1	2.1	3.2	4.3	5.3
175	1.2	2.5	3.7	5	6.2
200	1.4	2.8	4.3	5.7	7.1
225	1.6	3.2	4.8	6.4	8
250	1.8	3.6	5.3	7.1	8.9

*At propane cost of \$1.60/gal. and corn price of \$4.50/bu.

CORN YIELD ESTIMATION (BU/ACRE):

of Rows of Kernels x # of Kernels per Row
x plants per 1000th acre x 0.01116 = bu/acre

CALCULATING YIELDS FOR ALL CROPS (BU/ACRE):

Yield = (100 – Moisture) x (lbs of grain) x (factor) ÷ (row length in feet) ÷ (row width in inches) ÷ (number of rows)

CONVERSION FACTORS FOR YIELD CALCULATIONS				
Crop	Grain		Grain Standards	
	bu/acre	lbs/acre	lbs/bu	% moisture
Corn	109.815	6149.64	56 lbs.	15.0%
Soybeans	100.138	-	60 lbs.	13.0%
Sorghum	108.538	6078.14	56 lbs.	14.0%
Wheat	100.716	-	60 lbs.	13.0%
Sunflowers	-	5808.0	24 lbs.	10.0%

Conversion factor for ear corn = 90.439

SILAGE YIELD FORMULA:

(100 – Actual % Silage Moisture) x
(Green Wt. Silage in tons/acre) ÷ 30 = tons/acre of silage
adjusted to 70% moisture.

For 65% moisture silage, divide by 35 instead of 30.

For dry weight basis, divide by 100.

HARVEST LOSSES



MEASURING HARVEST LOSSES

- Two kernels per square foot equals 1 lost bushel per acre.
- Two ½ pound ears or equivalent per 1/100th acre approximates the loss of 1 bushel per acre.

ROW LENGTH (FEET) NEEDED TO EQUAL 1/100TH ACRE BASED ON ROW WIDTHS AND # OF ROWS HARVESTED

Row Width	Number Of Rows Harvested				
	Three rows	Four rows	Six rows	Eight rows	Twelve rows
20 inches	87.3	65.5	43.6	32.7	21.8
30 inches	58.0	43.6	29.0	21.8	14.5
36 inches	48.3	36.2	24.2	18.1	12.1

CONVERTING CORN TO MARKET STANDARD (CORN = 56# @ 15.0%):

% moisture	lbs shelled corn/bu	% moisture	lbs shelled corn/bu	% moisture	lbs shelled corn/bu
10	53	18	58	26	64
11	53	19	58	27	65
12	54	20	59	28	66
13	54	21	60	29	67
14	55	22	61	30	68
15	56	23	62		
16	56	24	62		
17	57	25	63		