Growing degree days

Focus question	What role does air temperature play in crop production?
Learning target	Students can explain how to calculate growing degree units for crop production.
Vocabulary	Growing Degree Units (GDUs)

MS-LS1: From Molecules to Organisms: Structures and Processes

Performance expectation MS-LS1-5	**Classroom connection:** Students select the appropriate hybrid for their local environment.

Science and engineering practices

Constructing Explanations and Designing Solutions	**Classroom connection:** Students begin to construct an explanation to select the proper hybrid for their local environment.

Disciplinary core ideas

LS1.B: Growth and Development of Organisms	**Classroom connection:** Growing Degree Units determine the growth rate of corn.

Cross-cutting concepts

Cause and Effect	**Classroom connection:** Environment has an impact on corn growth maturity.

This lesson focuses on Constructing Explanations and Designing Solutions as a means to determine the corn hybrid choice for a farm. Students will determine the thermal degree units that occur in a particular environment. Students will next research the different corn maturity varieties that are available and choose the variety that best meets the annual average growing degree units for that farm. Students will then construct an explanation for their corn variety choice and design a solution for a an accidental wrong choice.

Background

Corn growth stage development can vary according to corn maturity. An early-maturing product may produce fewer leaves or develop through growth stages faster than a slower-paced, late-maturing product. This is important to remember when staging corn in relation to accumulated Growing Degree Units (GDUs).

Corn development is directly correlated with air temperature. Therefore, development varies from year to year if calendar days are only used to track progress. However, development becomes predictable within and across growing seasons when evaluated using thermal time (degree units). The time required for corn to progress from one developmental stage to another is based on the amount of heat accumulated. Thermal time represents the length of time the crop spends within a defined temperature range considered optimum for that crop. For example, shoot emergence occurs approximately 125 Growing Degree Units (GDUs) accumulate after emergence. The GDU calculation assumes that corn development is consistent and linear within the defined temperature range of 50–86°F. For more information, visit Corn Growth Stages and Growing Degree Units: **dekalbasgrowdeltapine.com/en-us/agronomy/corn-growth-stages-and-growing-degree-units.html**

Materials

- Internet device
- Corn plant
- Student handout

Teacher preparation

1. Print student handout.
2. Ask the students about their local climate. Is it warm? Do you have an average summer temperature range between 50° F and 86° F? 50° F and 86° F are the minimum daily temperature (Tmin) and the maximum daily temperature (Tmax) respectively for corn growth.
3. Ask students to research the annual average number of growing degree days for your area. **cropwatch.unl.edu/growing-degree-day-gdd-accumulations-across-nebraska-corresponding-low-medium-and-high-freeze-risk**
4. Have students determine the GDUs for the corn plant they dissected in Lesson 3 of this unit.

Differentiation

Other ways to connect with students with various needs:

- **Local community:** Students can connect with a local agricultural expert or famer to discuss corn production and management. Students may take a field trip to a local corn field to better understand modern agriculture.
- **Students with special needs (language/reading/auditory/visual):** Allow students to see the growth and development of corn in relationship to a blog post, Odell's World, Corn Growth: https://odells.typepad.com/blog/corn-growth-stages.html. Students can plant corn to watch the growth stages as they occur in the classroom.
- **Extra support:** Kansas State University Corn Growth & Development: **agronomy.k-state.edu/extension/crop-production/corn/corn-growth-development/index.html** Corn Growth & Development Poster: **bookstore.ksre.ksu.edu/pubs/MF3305.pdf** **Odell's World:** **odells.typepad.com/blog/corn-growth-stages.html**
- **Extensions:** Students design a research project to test genetic variations of corn hybrids with environmental differences. For example, students can compar drought guard tolerant corn hybrids with non-drought tolerant corn in varying precipitation experiments.

GROWING AMERICA LESSON 3

Growing degree days

Focus questions	What role does air temperature play in crop production?
Vocabulary	Growing degree units (GDUs)

Background

Corn growth and development can vary according to corn maturity. An early-maturing product may produce fewer leaves or develop through growth stages faster than a slower-paced, late-maturing product.

Corn development is directly correlated with air temperature. Therefore, development varies from year to year if calendar days are only used to track progress. However, development becomes predictable within and across growing seasons when evaluated using thermal time (Growing Degree Units). The time required for corn to progress from one developmental stage to another is based on the amount of heat accumulated. Thermal time represents the length of time the crop spends within a defined temperature range considered optimum for that crop. For example, shoot emergence occurs when approximately 125 Growing Degree Units (GDUs) accumulate after emergence. The GDU calculation assumes that corn development is consistent and linear within the defined temperature range of 50–86°F. For more information visit Corn Growth Stages and Growing Degree Units: **dekalbasgrowdeltapine.com/en-us/agronomy/corn-growth-stages-and-growing-degree-units.html**

Instructions

1. Research the local average number of Growing Degree Units (GDUs) for crop production. How does this number compare across the state? Do all areas of the state have the same number of days?

Answers will vary.

home county.

Corn variety maturity	GDUs
Early: 85–100 days	2100–2400
Mid: 101–130	2400–2800
Late: 131–145	2400–3200
Choice:	

Student handout

3. Access the Growing Degree Unit calculator at: **nutrien-ekonomics.com/tools-to-calculate-fertilizer-needs/calculators/gdd/** to determine the number of accrued degree units for the test plot in question.
4. Enter the following information on the webpage:
   - Location
   - Choose your crop
   - Start date: May 15, 2019
   - End date: July 4, 2019
5. Hit "Calculate."
6. Use the growth stage chart to determine the approximate growth stage for the corn plant based upon your calculated GDUs for your current time in your local zone.

Answers will vary.

7. Observe your corn plant and compare/contrast your calculated GDUs to your analysis of the plant's current growth stage from the dissection lab in Lesson 2. How do they compare?

Answers will vary.

Equation and method

GDD = $[(T_{max} + T_{min} / 2] - 50$

GDUs are calculated from VE (emergence) and not the planting date. See the example below:

- Day 1: high 80°F, low 55°F
- Day 2: high 66°F, low 40°F
  (change 40°F to 50°F in the calculation)
- Day 3: high 92°F, low 72°F
  (change 92°F to 86°F in the calculation)

Calculations

Day 1: (80 + 55 / 2) – 50 = 17.5 GDUs
Day 2: (66 + 50 / 2) – 50 = 8 GDUs
Day 3: (86 + 72 / 2) – 50 = 29 GDUs

17.5 + 8 + 29 = 55 GDUs

Student handout

8. What environmental factors can impact the development of corn regardless of growth degree units?

Possible answers: excessive rain, drought, lack of nutrients, cloud cover, weed pressure, pests

9. What is the correct variety selection for your local area? **Create an explanation** based upon the knowledge you have gained in this unit.

Answers will vary.

Rubric for self-assessment

Skill	Yes	No	Unsure
I can identify the GDUs necessary for a corn to reach maturity in my area.			
I can explain what a GDU is.			
I can select the appropriate corn hybrid variety for my location.			

Assessments

Rubric for assessment

Skill	Developing	Satisfactory	Exemplary
Constructing Explanations	Students can determine the number of Growing Degree Units for their area.	Student can explain how air temperature drives corn production and select the proper hybrid for their local area.	Student can explain why a late-maturing corn plant can not grow to maturity in an early climate zone.

Rubric for self-assessment

Skill	Yes	No	Unsure
I can identify the GDUs necessary for a corn to reach maturity in my area.			
I can explain what a GDU is.			
I can select the appropriate corn hybrid variety for my location.			