Natural Selection of Leaf Thickness on Planet Eorthe, Galaxy Tlaloc

A Carolina Essentials™ Activity

Overview

In this introductory activity, students graph and analyze data, observing trends and change over time. The data set consists of leaf thickness measurements taken 4 times during a growing season and the number of fruits produced by plants with each thickness of leaf. The graphical data visualization can be the lead-in to more advanced statistical analysis for comparing differences among groups. With the data provided, students see a shift in the number of plants for each thickness—the thick-leafed plants increase in number and produce more fruit. Students are asked to use the data to make an argument for natural selection in the plants grown on Eorthe.

Life Science, Physical Science, Earth Science
Grades: 9–12

Phenomenon

These are examples of leaves. How can they be used as evidence for adaptation among plants?

Essential Question

How can data be used to support an argument that natural selection is occurring in an organism?

Activity Objectives

1. Use data to explain if natural selection may be taking place.
2. Use data to argue that adaptations in the plants are taking place since their arrival on Eorthe.

Next Generation Science Standards* (NGSS)

HS-LS4-3. Apply concepts of statistics and probability to support explanations that organisms with an advantageous heritable trait tend to increase in proportion to organisms lacking this trait.

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TIME REQUIREMENTS

PREP	ACTIVITY
10–15 min	30–40 min

Teacher Prep: 10–15 min
Student Activity: 30–40 min

SAFETY REQUIREMENTS

No PPE is required for the activity.

MATERIALS

Copies of student pages or online access

Graph paper or digital graphing access

TEACHER PREPARATION AND DISPOSAL

Copy the student pages or upload to a class web page.

HELPFUL LINKS

Gathering, Visualizing, and Interpreting Data

Turkeys and Their Domestication

Natural Selection in 50 Minutes

REFERENCE KITS

Carolina BioKits®: Natural Selection

Natural Selection with Drosophila Kit

CAROLINA®
www.carolina.com

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Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Analyzing and Interpreting Data • Apply concepts of statistics and probability (including determining function fits to data, slope, intercept, and correlation coefficient for linear fits) to scientific and engineering questions and problems, using digital tools when feasible.	**LS4.B: Natural Selection** • Natural selection occurs only if there is both (1) variation in the genetic information between organisms in a population and (2) variation in the expression of that genetic information—that is, trait variation—that leads to differences in performance among individuals. • The traits that positively affect survival are more likely to be reproduced, and thus are more common in the population. **LS4.C: Adaptation** • Differential survival and reproduction of organisms in a population that have an advantageous heritable trait leads to an increase in the proportion of individuals in future generations that have the trait and to a decrease in the proportion of individuals that do not. • Adaptation also means that the distribution of traits in a population can change when conditions change.	**Patterns** • Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.

Safety Procedures and Precautions

No PPE is required for the activity.

Teacher Preparation and Disposal

Copy the student pages or upload to a class web page.

Student Procedure

1. Graph the information for numbers of plants according to leaf thickness. Time should be on the x-axis and should include year and season. Color-code or symbol-code the 3 plant variations.
2. Calculate the average number of plants of each variety per a 1000 plant random sample for each year.
3. Your teacher may direct you to calculate summary descriptive statistics for each variety of plant.
4. Graph the information for numbers of fruit produced by leaf variation. Time should be on the x-axis and should include year and season. Color-code or symbol-code the 3 plant variations.
5. Calculate the average number of fruits for each variety per a 1000 plant random sample for each year.
6. Your teacher may direct you to calculate summary descriptive statistics for each variety of plant.

Teacher Preparation and Tips

Students may graph by hand on graph paper or use a graphing program such as excel or graphing calculators.

Depending on the level of students and time available, students should at least calculate averages/mean, but additional descriptive statistics may be assigned at your discretion.

Discuss the shape of the lines on both graphs and let students briefly interpret what the graphs indicate about changes in population variation.

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Data and Observations

Plant Data

Number of XR-45 Plants/1000 Plant Random Sample by Leaf Thickness (mm)				
Year	**Season**	**Leaf Thickness <0.5 mm**	**Leaf Thickness 0.5–1.0 mm**	**Leaf Thickness >1.0 mm**
3030	Spring 1	320	342	338
	Spring 2	315	344	341
	Summer 1	316	338	346
	Summer 2	303	335	362
3031	Spring 1	302	331	367
	Spring 2	299	331	370
	Summer 1	299	330	371
	Summer 2	283	332	385
3032	Spring 1	282	329	389
	Spring 2	280	300	420
	Summer 1	280	298	422
	Summer 2	260	287	453
3033	Spring 1	258	288	454
	Spring 2	255	287	458
	Summer 1	254	288	458
	Summer 2	250	287	463

XR-45 Leaf Thickness and Number of Fruit (1000 plant random sample)				
Year	**Season**	**Average Number of Fruit/Plant (Thin Leaf)**	**Average Number of Fruit/Plant (Moderate Leaf)**	**Average Number of Fruit/Plant (Thick Leaf)**
3030	Summer 1	12	14	18
3030	Summer 2	14	14	17
3031	Summer 1	9	14	19
3031	Summer 2	9	13	19
3032	Summer 1	9	12	20
3032	Summer 2	7	13	18
3033	Summer 1	4	10	19
3033	Summer 2	3	8	21

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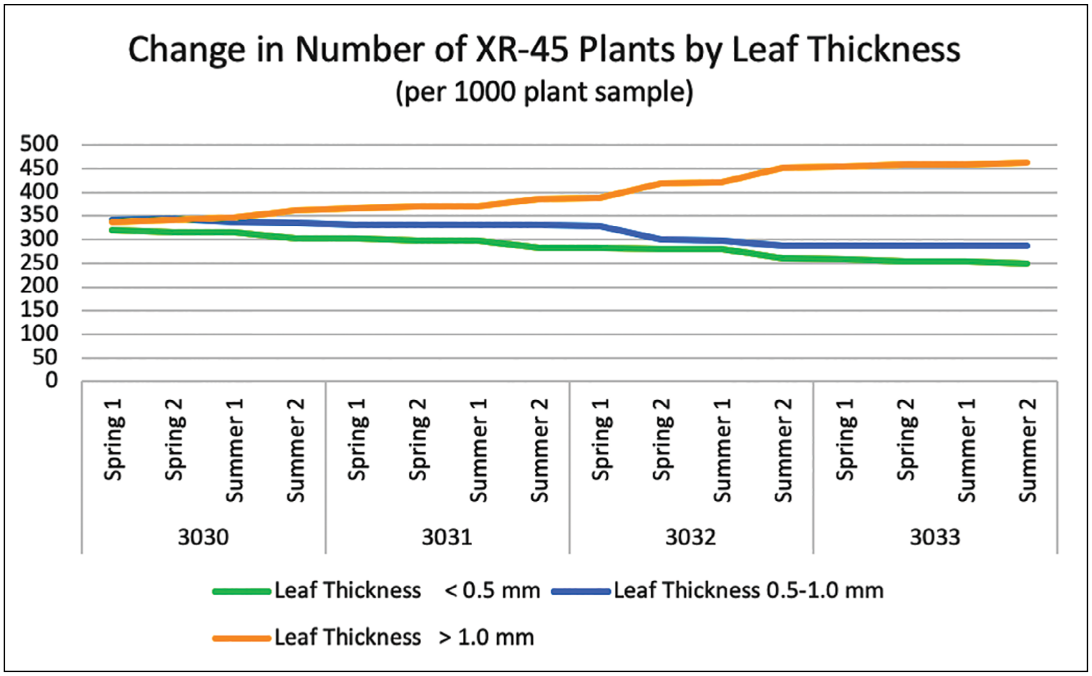
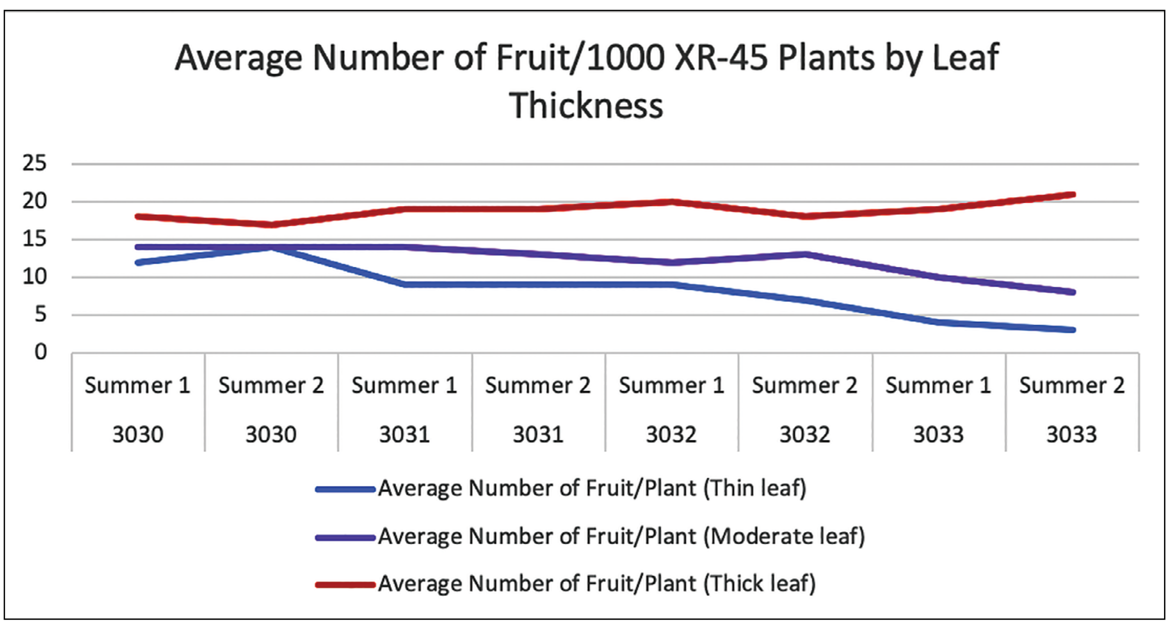
Graphing Results



Averages of numbers of plants for each leaf thickness

<0.5 mm = 285 plants
0.5–1.0 mm = 315 plants
>1.0 mm = 400 plants



Averages of numbers of fruits for plants by leaf thickness

<0.5 mm = 8 fruit
0.5–1.0 mm = 12 fruit
>1.0 mm = 19 fruit

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Analysis and Discussion

1. What is the percent abundance of each variety of XR-45 at spring 1 of 3030, at summer 2 of 3030, 3031, 3032, 3033?

Year	<0.5 mm	0.5–1.0 mm	>1.0 mm
Spring 1 3030	32%	34%	34%
Summer 2 3030	30%	34%	36%
Summer 2 3031	28%	33%	39%
Summer 2 3032	26%	29%	45%
Summer 2 3033	25%	29%	46%

2. Use the data, statistics, and graph to explain the trend in abundance of each variation in leaf thickness within the 1000 plant samples.

   Student answers will vary, but all students should explain the increase in population for the thick leaf variation of XR-45 and the decrease in the other 2 varieties. Student answers must contain the numeric values they calculated.

3. Use the data, statistics, and graph to explain the trend in abundance of fruit for each leaf thickness variation within the 1000 plant samples.

   Student answers will vary and must contain numerical support for their statements. The thick leaf plant is producing more fruit and the other 2 varieties are showing fruit reduction at about the same rate.

4. Explain the difference in fruit production among the 3 variations of plant leaf thickness that could lead to increased survival.

   The plant variety with the thicker leaf produces more fruit. By producing more fruit, the plant produces more seeds, which increases the probability of survival for that variety. The evidence supports this because there is an increasing number of the thick leaf variety every year.

5. Use your data to explain if natural selection and adaptation may be taking place in the plants since being transplanted to Eorthe.

   Student answers will vary and must contain numerical support for their statements. Natural selection and adaptation are probably taking place on Eorthe.

   Environmental changes that affect the growth of XR-45 seem to be impacting the proportion of plants with thicker leaves. The data show_______________ . When two sets of rainy seasons (spring) are followed by a dry season (summer), conditions appear to favor the plant variety that can retain water in its leaves, as evidenced by _______________.

   In turn, those plants can produce more fruit because there is adequate water stored in the leaf. More fruit production from the thick-leafed variety of XR-45 means that those genes will be passed on. This fits the definition of natural selection and adaptation.

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TEACHER NOTES