LESSON 23

A Grain of Rice and a Hillside of Knapweed

OBJECTIVES
Students will be able to define "noxious weed," understand the awesome power of exponential growth, and be able to apply the concept of exponential growth to knapweed population increase.

METHOD
As students listen to a folktale that illustrates the importance of understanding exponential growth, they calculate the numbers of grains of rice as they increase in the story. They explore how exponential growth applies to knapweed reproduction and population growth.

MATERIALS

- ✎ *A Grain of Rice* by Helena Clare Pittman **OR**
- ✎ *One Grain of Rice: A Mathematical Folktale* by Demi **OR** view a version of this story online at the following University of Georgia mathematics education link: **http://jwilson.coe.uga.edu/EMT668/EMAT6680.F99/Martin/ instructional%20unit/day4.exponential/excel/grainofrice.html**
- ✎ World map or globe
- ✎ 5 lb bag of rice
- ✎ Calculators (for older students you can use an Excel spreadsheet on computers)
- ✎ Paper
- ✎ Pencils
- ✎ **Worksheets** of rice calculations for 100 days
- ✎ Samples or pictures of knapweed/noxious weeds and native plants

BACKGROUND
Spotted knapweed (*Centaurea stoebe*) is an aggressive, introduced weed species that rapidly invades agricultural land, disturbed areas, and native grasslands. The weed is a prolific seed producer with 1000 or more seeds per plant. Seeds remain viable in the soil five years or more, so infestations may occur a number of years after vegetative plants have been eliminated. Spotted knapweed has few natural enemies and is consumed by livestock only when other vegetation is unavailable. The plant releases a toxin that reduces the growth of other species.

Grade level: 4-8
Subject Areas: Math, language arts/literature, social studies, science
Duration: 45 minutes
Setting: Indoors
Season: Any
Conceptual Framework Topics: Plant reproduction, invasive species ecology; invasive species spread by seed, plant populations and demographics

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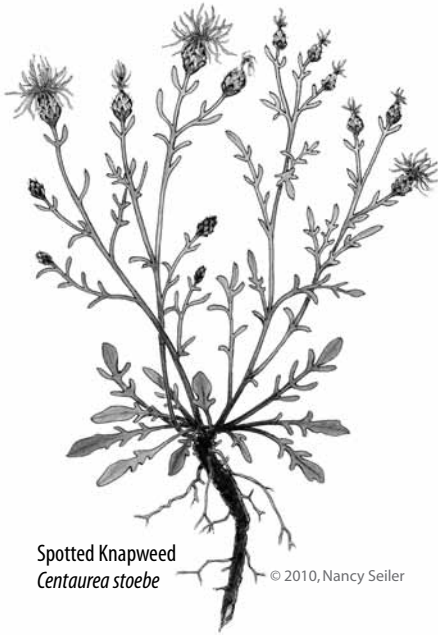
Spotted Knapweed
Centaurea stoebe   © 2010, Nancy Seiler

Historical records indicate that spotted knapweed was introduced from Eastern Europe into North America in the early 1900's as a contaminant in crop seed. It is now established on several million acres of grazing land in the northwestern United States and Canada. Spotted knapweed infestations have been found in every county in Montana. The invasions can largely be traced to unintentional seed spread, such as in transported hay or on the wheels of vehicles. Spotted knapweed may remain for several years in a confined location and then spread rapidly to adjacent areas.

In this lesson we will introduce the idea of exponential growth in order to illustrate how rapid population growth of invasive plant species occurs when large numbers of seeds are produced, such as in spotted knapweed.

PROCEDURE

1.   Locate China (if reading *A Grain of Rice*) or India (if reading *One Grain of Rice*) on a world map and introduce the story. Begin to read aloud *A Grain of Rice* by Helena Clare Pittman **OR** *One Grain Of Rice: A Mathematical Folktale* by Demi.

2.   When the grains of rice begin to be delivered in the story you are reading, pause and distribute cups of rice, paper, worksheets and calculators to small groups. As the story progresses, ask the students to model the rice deliveries by counting grains of rice. The groups should also calculate the total grains delivered each day and chart their results. *For older students, an Excel spread sheet can be used to do the calculations on computers.*

3.   When the process of counting amounts grows too great for the students, relieve them of these duties. Calculating should continue until the student calculators can no longer carry the appropriate number of place values as the story progresses and groups calculate the delivery amounts.

4.   Whole group discussion: Discuss the story using open-ended questions. What did you like or dislike about this story? Why do you think the author chose this tale? What did this story teach us?

5.   Discuss the math: How did you manage the task of counting? Calculating? What strategies did you use? How did you feel about this activity while you were doing it?

6.   Although the worksheet only goes up to 30 days, ask for predictions about the numbers at 50 days, 75 days, and 100 days. If they have no clue, ask them to predict how many places the numbers will take and give higher/lower hints until they are in the right ball park. Display the answers as the numbers are discussed. Involve the class in reading the numbers aloud together, or dictate the numbers and allow students to attempt to record the numbers on the board. Give place value nomenclature as needed (i.e. quintillions, octillions, etc.).

kNOweeds

7. With older students, discuss scientific notation and how that relates to estimation and rounding-off.

8. Making connections: Display pictures of knapweed and other noxious weeds of Montana as well as pictures of native plants of Montana. Compare and contrast pictures of native plant communities with weed-infested communities. Ask students to look up the meaning of "noxious" and create a working definition of "noxious weeds." Ask them how what they've learned about exponential growth might be related to invasive plants.

9. Ask the students to brainstorm in their small groups a way to record how many plants one spotted knapweed plant would generate in its eight year lifetime if five of its seeds become seedlings each year and grow to maturity. Allow time for discussion.

Extensions
Brainstorm ideas for delivering the appropriate quantities of rice without actually counting rice. Jump off into estimates and, for older students, exponential notation as a means of representing large numbers.

Teach *Lesson 25: The Knapweed Hitchhikers* to further develop understanding about reproduction and population growth in knapweed.

Teacher Help:
Answer Key for **How Many Grains of Rice Per Day** Worksheets:

1. **1**	21. **1,048,576**	41. **1,099,511,627,776**
2. **2**	22. **2,097,152**	42. **2,199,023,255,552**
3. **4**	23. **4,194,304**	43. **4,398,046,511,104**
4. **8**	24. **8,388,608**	44. **8,796,093,022,208**
5. **16**	25. **16,777,216**	45. **17,592,186,044,416**
6. **32**	26. **33,554,432**	46. **35,184,372,088,832**
7. **64**	27. **67,108,864**	47. **70,368,744,177,664**
8. **128**	28. **134,217,728**	48. **140,737,488,355,328**
9. **256**	29. **268,435,456**	49. **281,474,976,710,656**
10. **512**	30. **536,870,912**	50. **562,949,953,421,312**
11. **1,024**	31. **1,073,741,824**	51. **1,125,899,906,842,624**
12. **2,048**	32. **2,147,483,648**	52. **2,251,799,813,685,248**
13. **4,096**	33. **4,294,967,296**	53. **4,503,599,627,370,496**
14. **8,192**	34. **8,589,934,592**	54. **9,007,199,254,740,992**
15. **16,384**	35. **17,179,869,184**	55. **18,014,398,509,481,984**
16. **32,768**	36. **34,359,738,368**	56. **36,028,797,018,963,968**
17. **65,536**	37. **68,719,476,736**	57. **72,057,594,037,927,936**
18. **131,072**	38. **137,438,953,472**	58. **144,115,188,075,855,872**
19. **262,144**	39. **274,877,906,944**	59. **288,230,376,151,711,744**
20. **524,288**	40. **549,755,813,888**	60. **576,460,752,303,423,488**
100. **633,825,300,114,114,700,744,351,602,688**		

A Grain of Rice and a Hillside of Knapweed Worksheet

How many grains of rice were delivered each day?

1. answer: **1**	11.	21.
2. answer: **2**	12.	22.
3. answer: **4**	13.	23.
4.	14.	24.
5.	15.	25.
6.	16.	26.
7.	17.	27.
8.	18.	28.
9.	19.	29.
10.	20.	30.