

What nutrients do pumpkins need to grow, and how can these nutrients be replaced in the soil in a way that's safe for the environment?

PROJECT PUMPKIN (gr 3-5)

Nutrient Management 1

(ILS 6D, 10A and B, 11A, 12A and B)

Overview

This curriculum explores the relationship between people and the food they eat. By growing pumpkins in a garden plot, the curriculum takes teachers and students through six features of sustainable agriculture that separate it from conventional farming. If the entire curriculum is completed, students will gain an understanding of sustainability and people's place in the food chain.

Sustainable Agriculture, for the purpose of this curriculum, shall be defined as "a system of food production, supported by consumers, where farming operations, practices and technologies work in harmony with the natural systems that sustain life on earth."

Suggested Grade Level

This curriculum is designed for 3rd through 5th grade levels. The topics covered can be built upon in complexity throughout that age range.

Approximate Time

Session 1 requires 45-60 minutes; session 2 requires 20-30 minutes.

Objectives

1. The students will learn that pumpkins require nitrogen, phosphorus and potassium in a specific ratio for healthy plant growth.
2. The students will learn the parts of the pumpkin that are impacted by these three nutrients.
3. The students will learn that cover crops of leguminous plants may be used to restore nitrogen to garden and agricultural soils.

Activity Abstract

In this activity, students will play a game that will teach them the basic nutrients needed for a healthy pumpkin crop; will demonstrate how depletion of the soil nutrients produces fewer crops; how replenishment of nutrients will restore production. Students will receive instruction about the way that leguminous plants restore nitrogen to the soil.

Background Information

You have seen commercial fertilizers display the three major chemicals on their packaging. It might look like this: 5 - 10 - 5. This stands for: Nitrogen - Phosphorous – Potassium, which are abbreviated as "N", "P" and "K" respectively. The numbers represent the percentage of that chemical element in the fertilizer. Depending upon the



growth stage of your pumpkin, you should seek higher or lower levels of these chemicals.

Nitrogen. Apply higher concentrations of Nitrogen in the early growth stage of a plant. It provides for leaf, root and vine growth. High levels of nitrogen result in a lush, green plant that might not produce fruit but plenty of leaves. Of the three major chemicals, nitrogen can also cause the most damage as it can burn your plants if applied in too high a concentration. Avoid direct contact with leaves and vines since this can also result in a wilting of the plant due to burning. Too much nitrogen also can reduce or delay the emergence and number of flowers and fruit. If your plant seems to be thriving and is a healthy green, yet has no flowers, stop adding nitrogen for a week or two and the plant will redirect its energy from plant growth to fruit set and development.

Phosphorous. As the season moves towards the fruit set stage, switch to a formula higher in Phosphorous. 5-10-5 or 5-15-5 are common ratios. If you do not want to worry too much about what fertilizer to use, this is a good overall ratio for the entire year.

Phosphorous will promote both root growth and fruit set and development. Phosphorous is more forgiving as it does not burn your plants and is less water soluble so an over-application will not do major harm to your plant.

Potassium. This chemical will promote fruit growth. After fruit set, you should either switch to a high potassium fertilizer, or supplement your feedings with extra potassium. Like Phosphorous, it will not burn your plants. Excessive application, along with all the other ingredients (sun, water, rich composted soil) can cause your pumpkin to grow so quickly that it outgrows its skin and splits or explodes.

Materials

- Guinness Book of World Records

Enough for each **student**:

- Four orange construction paper pumpkins, 8 1/2X11, for each
- One tan or yellow construction paper seed, 8 1/2 X 11, for each, about 6" long (Use patterns in Appendix B and C for students to make their own.)
- Twenty small paper tokens (squares) made of green and tan construction paper.
- An additional forty tokens of orange paper will be needed. Label orange tokens with K, green with N, and tan with P.
- Three paper clips per student.
- Tally chart for Pumpkin Patch game
- Nutrient Cycle Handout (Appendix A).

Enough for each **team of 3-4**:

- Spinners 1, 2, and 3: each circle divided into 6 equal parts (a good way to use the protractor after dividing the circles in half). (See patterns in Appendix D.) Students can make these. They should be colored in the following pattern:
 - #1 -- 2 green, 2 orange, 2 tan or yellow segments
 - #2 -- 1 green, 2 orange, 2 tan or yellow, 1 uncolored
 - #3 -- 2 orange, 2 tan or yellow, 2 uncolored
- paper clip or bobby pin to be spun around a pencil point

Procedure (Session 1)



1. Have the class guess how large the biggest pumpkin ever grown was. Have a student look up the answer in the Guinness Book.
2. **Tap prior knowledge.** Ask the class, what did the plant need to grow such a big pumpkin. (Review the plant needs of life – sun, soil, air and water.)
3. **Share with a neighbor.** Explain that today we'll be focusing on the soil (and water, secondarily) needs. Have the students brainstorm, what are the reasons a plant needs soil to grow? If no one answers “nutrients” add it to the list.
4. Explain that they are going to be growing paper “pumpkins” from paper “seeds.” In order to do that, they'll need to get the correct nutrients from the soil (which the plant will suck up because they're dissolved in the water). They will be looking for three specific nutrients, Nitrogen (N), Phosphorus (P) and Potassium (K).
5. Pass out a paper seed to each student, and put chips on each table so that there 5 Nitrogen (green) chips, 10 Phosphorus (orange) chips, and 5 Potassium (tan) chips in front of each student.
6. Explain the game. Each student has to try to collect nutrients (represented by chips) from the soil. When they have collected the correct amounts of nutrients, they will grow a successful pumpkin. The correct ratio of nutrients to collect is 5 Nitrogen (green) chips, 10 Phosphorus (orange) chips, and 5 Potassium (tan) chips. They will collect their nutrients by spinning a colored spinner. Each time the pointer lands on a color, they can take one chip of that color, until they have the right amount. As they go, they should tally the total number of spins it takes to grow their pumpkin.
7. Pass out the Round 1 spinners (2 green, 2 orange and 2 tan segments)
8. **Hands-on experience.** Have students predict how long it will take to grow a successful pumpkin. Play round one, and compare predictions with results.
9. When the students have collected enough nutrients, they can exchange their chips and seed for a pumpkin.
10. Have the students exchange Spinner 1 for Spinner #2 (this spinner has one less nitrogen segments, therefore it will take longer for students to get the N-P-K ratio to grow pumpkins), carefully noting the difference between these two. Predict how many turns it will take to complete round 2. Play and tally the number of turns to “grow” the pumpkin. Deliver it to the Market. After reaching the Market, again compare prediction with actual number of spins.
11. Exchange Spinner 2 for Spinner #3 (this spinner has no nitrogen so the students will never get the necessary ratio to produce pumpkins), again noting the difference and making prediction. Stop after the third round and compare their actual spins with the predicted number of spins.
12. **Introduce scientific concept.** What did they notice about the number of spins it took to grow a pumpkin with each new round? (It takes longer with each successive spinner.) Did it take longer to get to market using one spinner over another? If use of each spinner represents a year, how long would it take before the crop would be negatively affected? How could this be changed? (Add more green/ nitrogen chips). Do they think that real plants use the nutrients in the soil

Teacher note:

So students remember, write the nutrients, their symbols and colors, and the desired amounts on the board!



- differently than the game? (With each successive spinner the soil has less nitrogen, while the phosphorus and potassium remain the same. In reality, all three nutrients would be consumed at the same time.) How might they be different? (Elicit the idea that the orange and tan minerals would be used up also, perhaps at a different rate.) So if the nutrients are leaving the soil, how do they get back in?
13. Explain that there are two major ways that nutrients get put back into the soil – compost (which adds P and K) and planting nitrogen-fixing legumes (which add N).
 14. Discuss with the students the nutrients that are needed for a good crop of pumpkins:
 - ***Nitrogen (N)** provides for **leaf, root and vine growth**.
 - ***Phosphorous** will promote both **root growth and fruit set** and development.
 - ***Potassium** will promote **fruit growth**. The last two are present in compost.
 15. Review the number of tokens they needed to have a mature pumpkin for the Market. (NPK). This is a good ratio of each nutrient needed for a successful pumpkin crop. (5-15-5 is OK, too). What might happen if too much of the different nutrients are given to the pumpkin plant? Go over each separately. Too much **nitrogen** can produce a green, lush plant with a shortage of flowers; it can also produce burn damage on leaves and vines by direct contact. Too much phosphorous will not burn the plants and is more forgiving. Too much **potassium**, combined with sun, water, and rich composted soil can cause the pumpkin to split or explode due to growing too quickly.
 16. Briefly discuss with the students the benefits gained when leguminous plants are grown as a cover crop and combined with compost to enrich a pumpkin patch.

Procedure (Session 2)

1. **Tap prior knowledge.** Review previous hands-on experience including use of their tally sheets.
2. **Hands-on activity.** Have students work in cooperative groups to design new spinners that will help restore the depleted nutrients and bring the pumpkin to market most quickly. They may use different fractional divisions of the circle.
3. Play Round 4, again keeping a tally of how many turns it took to complete the Round.
4. **Conclusion/Wrap-up.** Compare this to the Session 1 Round 1. Which produced the better results?
5. Share results with class; compare different groups' spinners.

Extensions

1. Use this activity to accompany a math lesson on measures of central tendency. Analyze data from any or all of the three rounds to demonstrate math terms such as, minimum, maximum, mean, median, mode.



2. Use this activity to accompany a math lesson on probability. What is the probability of landing on the various colors of the spinners? Students will originate and test these questions.
3. Create a Pumpkin Seed Viewer. See directions at <http://www.sadako.com/pumpkin/#> Watch a pumpkin seed grow in a home made sprouting chamber made of a plastic half gallon milk carton.
4. Research the various kinds of legumes that will grow in your area.



References

“The Matchmaker,” “Soil Prescription,” “Companion Planting Guide.” Jaffe, R. and Appel, G. 1990 The Growing Classroom: Garden Based Science. Addison-Wesley Publishing Company, Menlo Park, CA

<http://helios.bto.ed.ac.uk/bto/microbes/nitrogen.htm>

<http://www.pumpkinook.com/howto/fertile.htm>

<http://www.bartleby.com/65/ni/nitrocyc.html><http://zzyx.ucsc.edu/casfs/training/manual/contents.html> (instructional manual)

<http://www.yankeegardener.com/seeds/hartseed8b.html> planting directions

<http://www.sadako.com/pumpkin/activities.html> Watch a pumpkin seed grow in a home made sprouting chamber

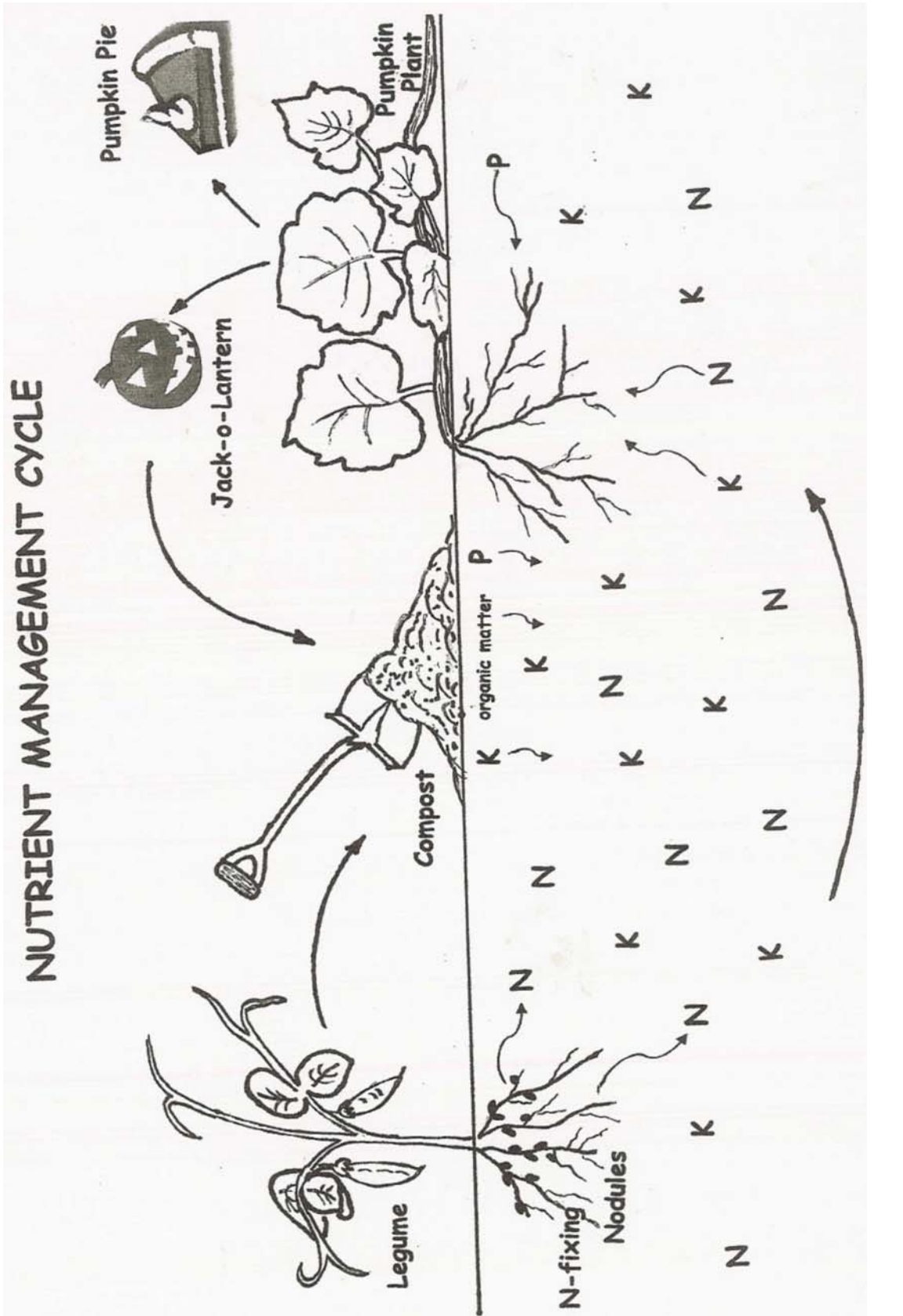
<http://www.farm-garden.com/growing-vegetables/growing-pumpkins.php>

Diagram of the Nitrogen Cycle by Kenneth J. Edwards Jr. - VP Alken-Murray Corporation <http://www.alken-murray.com/Nitrogen.html>

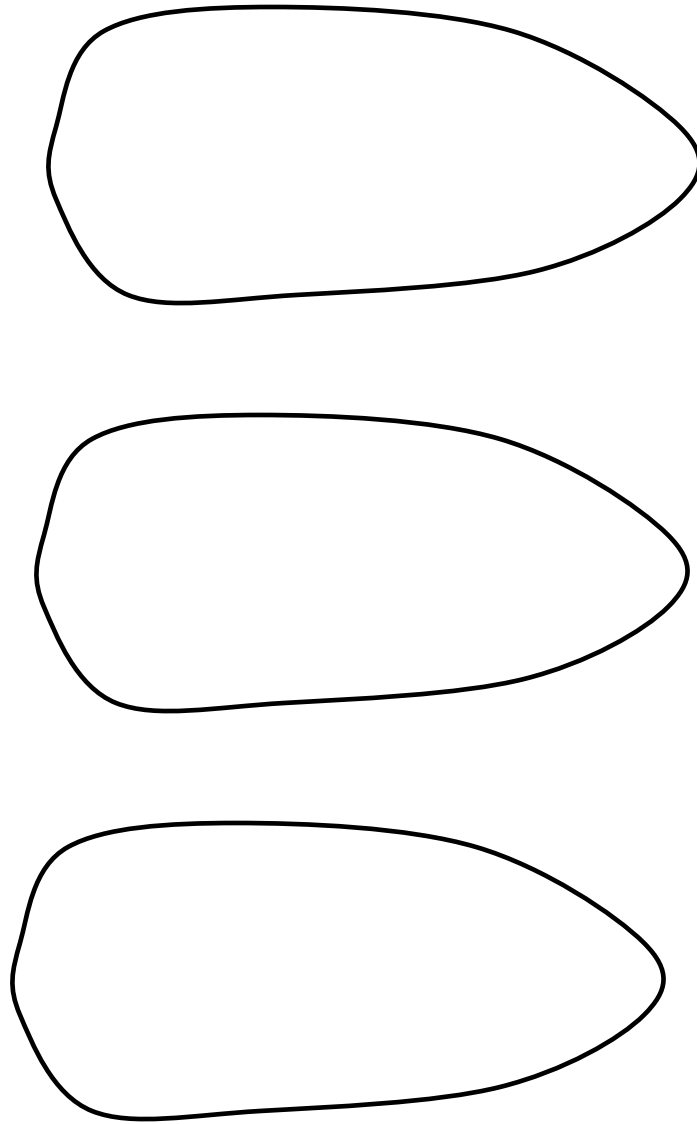
<http://zzyx.ucsc.edu/casfs/training/manual/contents.html>



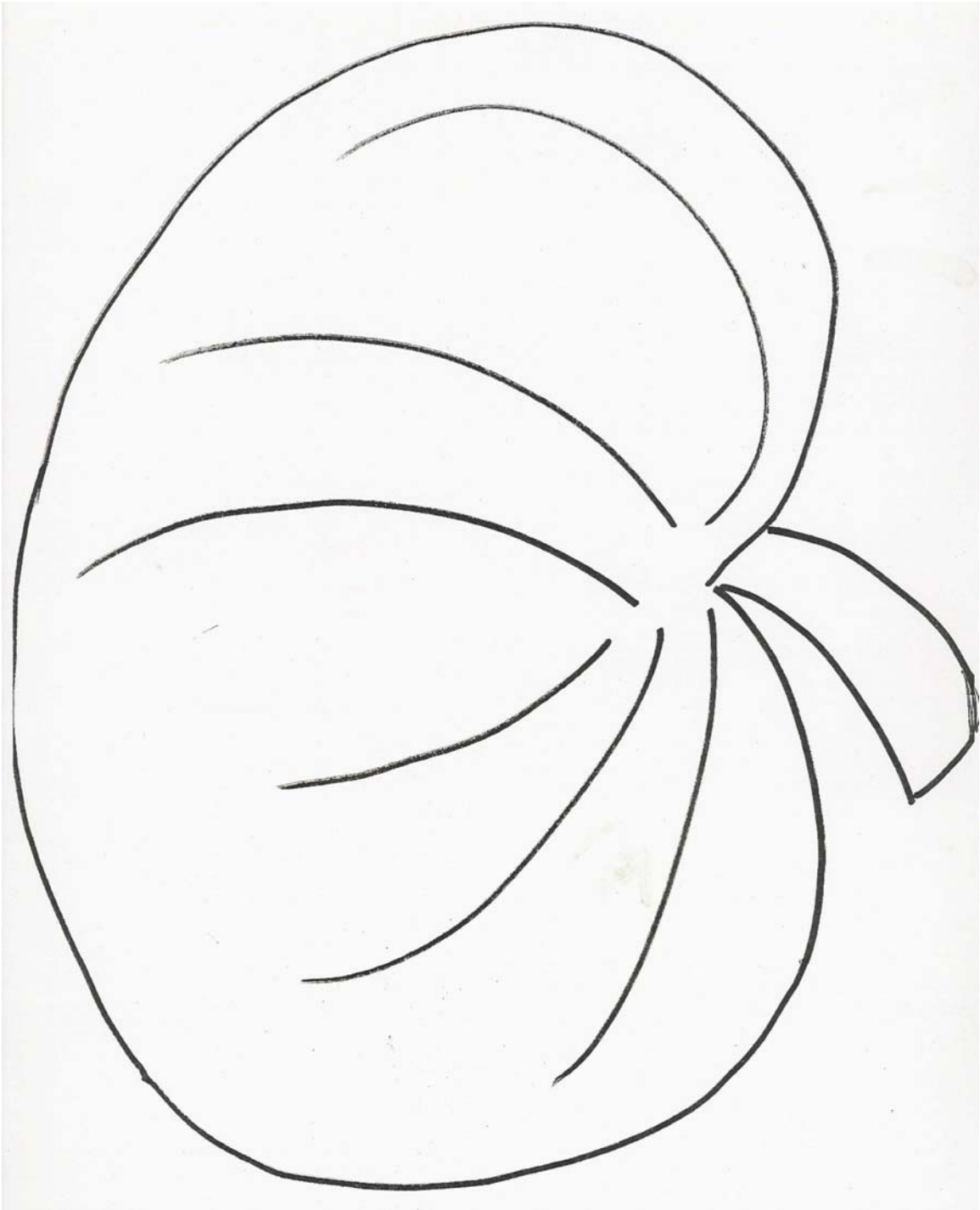
Appendix A: Nitrogen Cycle.



Appendix B: Pumpkin seed pattern



Appendix C. Pumpkin pattern.



Appendix D. Spinner Template.

