Compact Plants for Small Garden Spaces

Overview: Compact plants, often called dwarf varieties, can be valuable components of an urban landscape. Where do these smaller plants come from? In this lesson, students will research how dwarf varieties can develop in nature as adaptations to challenging environmental conditions through the process of natural selection. They'll also learn how they can arise from human intervention through the expertise of plant breeders. Finally, students will also explore the benefits compact plants offer urban environments and how they can change the accessibility and availability of gardens and gardening.

Grade Level/Range: 9 – 12th Grade

Objectives:
Students will:

- Learn about plant varieties and cultivars and how they arise in nature and through human intervention.
- Explore the benefits of compact plant varieties
- Propose ways to bring more gardens to their community by taking advantage of compact plants.

Time: 1+ hours

Materials:

- A diversity of apples (optional)
- Internet access and/or seed catalogs
- Dwarf Varieties and Cultivars Worksheet
- Graph paper
- Pencils

Background Information
Plants are grouped by similar characteristics, and each genetically different plant is given an individual two-word classification comprised of a Latin genus and species name to distinguish it from other plants.

Within a species, there is usually some genetic variation. This is because seeds are produced through sexual reproduction, which results in the offspring having a blend of genetic material from both parent plants. Thus, there will be some variation in DNA and observable characteristics in the offspring even though they fall under the same genus and species name.

Varieties
However, sometimes the offspring exhibit characteristics that are different enough from the rest of the plants in the species to warrant a special classification. We call these outliers "varieties" if

they occur in nature, or "cultivars" — short for cultivated varieties — if developed by plant breeders. (Note that the latter are sometimes called "hybrids"; however, botanically speaking, hybrids can also occur in nature.)

When the mature size of a plant is markedly smaller than the usual for the species, botanists might give it a variety or cultivar name. These names often hint at the unusual size characteristic. *Rosmarinus officinalis prostratus*, for example, is a low-growing, spreading variety of rosemary. Flower Carpet® Red Rose (Rosa x 'Noare'), grows to a height of just 2-3' — significantly shorter than other roses — and planted in groups it creates a "carpet" of color. 'Tom Thumb,' a pea cultivar, grows on 10" tall vines that are significantly shorter than most pea vines.

The Appeal of Dwarf Plants

Gardeners, farmers, and landscapers often desire dwarf plants — plants that are shorter or more compact than the species. Smaller plants offer many benefits to human-made landscapes, especially urban landscapes that are short on space. They're also popular in fruit and vegetable production because many dwarf varieties produce a larger per-acre harvest.

A dwarf variety isn't necessarily small, it's just smaller and sometimes slower-growing than the typical plant of the same species. A dwarf bald cypress tree, for example, will still grow into a big tree, but it will be much smaller than typical bald cypress.

Natural Dwarf Varieties

Dwarf varieties can arise in nature through adaptations to climate conditions and through natural selection over time. For example, compact plants are common in tundra and alpine environments where there is a lot of wind and winter temperatures are cold. Low branches are less susceptible to wind breakage and damage from heavy snow loads. Also, the low and dense structure holds leaf litter, helping insulate roots from the cold, holding moisture, and providing nutrients to roots as it decomposes. These traits provide them with a competitive edge over other plants and allow them to succeed through natural selection.

When plant breeders discover potentially useful specimens, they can bring them back to the lab and propagate them.

Growing Dwarf Plants from Seed

Through selection and careful cross-pollination, breeders can create plants with compact growing habits. One way they do this is to plant large numbers of seeds of a particular species and search for the ones that have the most compact growth. They then collect seeds from those plants and cross-pollinate them, using the pollen from one compact plant to fertilize the flowers on a different compact plant. Next, they collect the seeds from these controlled crosses and plant them out in hopes that the new plants will also be compact. They then repeat this process many times over many generations until they consistently achieve the desired growth habit.

Plant breeders can also take advantage of plants they find in nature that are more compact than other plants in the species due to a random genetic mutation. Breeders then use careful breeding to stabilize the trait.

Cloning Dwarf Plants

The word "clone" might conjure up a science fiction thriller; however, clones are common in the plant world. Botanically speaking, a clone is simply a plant that is genetically identical to its parent plant. They are produced when a plant reproduces asexually. In nature, clones are created in a variety of ways. For example, some plants send out horizontal runners that form roots where they touch the soil, and then a new plant grows there. That new plant is a clone and is genetically identical to the parent plant.

Many woody plants are propagated by rooting hardwood or softwood cuttings, which produce multiple plant clones that are genetically identical to the original plant. The Flower Carpet® Red Rose, for example, is propagated by cloning. The breeders applied for and received a patent for this cultivar, making it illegal to propagate it without written authorization from the patent holder.

Careers in Plant Breeding

Plant breeding is a rewarding job, but one that requires a great deal of patience. Trait selection, controlled pollination, seed collection, and production of generations of plants require time and meticulous record-keeping. Plants with an annual life cycle, like corn, require an entire outdoor growing season to produce seeds, so it can take several years to hone in on a unique cultivar. For plants like fruit trees, it can take 5 to 7 years for just the first generation to produce fruit and seeds, so breeding experiments must span many decades. That said, imagine the delight and satisfaction that comes from introducing a new plant to the world. And who knows, the next generation of plant breeders might just bring us the elusive blue-flowered rose!

Laying the Groundwork

- Bring in a collection of different types of apples. Ask students to note their similarities and differences. Next, share the apple information page from NC State's Plant Toolbox about apples: https://plants.ces.ncsu.edu/plants/malus-domestica/. Point out the list of cultivars/varieties. Use the Background Information to explain what varieties and cultivars are and how they are created.

  Watch the video on the Plant Toolbox page. In the video, they mention that most commercially grown apple trees are dwarf varieties and cultivars. What benefits do they mention related to dwarf apple trees? Ask students how this could relate to other edible plants. What could this mean for food production in urban areas?

- You can also supplement your teaching by having students read articles about plant breeding such as Why It Takes Decades to Breed new Apples by *Discover Magazine*.

- If you would prefer to focus on landscape plants, rather than edibles, have students read the article "'Little Gem' Really Is" by Arelene Marurano in the *Columbia Star* (August 25, 2017). Magnolia 'Little Gem' is a popular landscape plant in southern regions. It has the highly prized shiny evergreen leaves and attractive large white blooms of the traditional southern magnolia but is about half the size, so it is much better suited to urban landscapes.

  Discuss some of the benefits of dwarf plants listed in the article. What are some locations that can benefit from smaller, compact plants? Ask students to specifically brainstorm areas in their own community that would benefit from plants that are smaller and more compact.

Exploration

1. Ask students to create a list of common dwarf plants. They can use seed catalogs or the internet and can focus on edibles, ornamentals, or a combination of both. (*Hint: Have them look for descriptives like compact, low-growing, miniature, and other words that denote something small.*) They can use the KidsGardening Dwarf Varieties and Cultivars Worksheet to compile and analyze their findings.

2. Next, ask them to work individually or in groups to create a design for a small garden space spotlighting dwarf plants. This can be a real or an imaginary garden space such as a courtyard, a balcony, or an entryway. For further instructions on creating a design, check out Designing and Placing the Garden. Encourage students to browse garden design websites for ideas.

3. Finally have students share their designs. During their presentations, have them explain the benefits of the dwarf plants they selected.

Making Connections

Encourage students to research the Green Revolution of the 20th Century. The Green Revolution describes work conducted in the 1940s through 1960s by the Cooperative Wheat Research and Production Program in Mexico to develop more efficient farming practices and better varieties of crops to increase food production around the world. Dr. Norman Borlaug directed this research and through plant breeding experiments (controlled pollination and selecting of plants with desirable traits) conducted over a span of twenty years, he developed a variety of wheat that was shorter, produced a higher yield, and was more disease resistant than traditional varieties. The new seed varieties were planted around the world to help increase food availability for an increasing world population. In 1970, Dr. Borlaug received the Nobel Peace Prize for his work to decrease world hunger through the development of new plant varieties. He is credited with saving millions of lives by increasing food production worldwide.

Reflecting on this work 50 years later, some of the unintended consequences and negative impacts of using plant breeding to significantly alter the growing patterns of crop plants are being discussed Have students review the article series by PBS titled The Green Revolution: Norman Borlaug and the Race to Fight Global Hunger and then arrange a debate of the students to discuss the pros and cons of human intervention in plant biology.

As technology continues to advance, the range of plant breeding techniques has broadened to include direct genetic modification, meaning we can now make even more changes to the plant world at an even faster rate. If interested, you can encourage students to dive deeper into this topic.

Branching Out

Check out Seed Your Future's spotlight on Plant Breeders (scroll down the left column to "Plant Breeders"). Lead a discussion about the opportunities and requirements for this type of career.

Although the time constraints of a school year make it difficult to try your hand at true plant breeding, you do have time to demonstrate the fact that seeds do not produce plants that look exactly like their parents. In the fall, collect seeds from annual

plants around the school and take a digital photo of the plant while it is still in bloom. Zinnias, marigolds, coleus, and petunias planted in multi-colored beds work well because the seeds are easy to save and often the seeds do not produce plants identical to the parent plant. This is because many are hybrids grown from seeds created through a cross between two different plants but have not been bred to the point that the new traits stay true for their offspring.

Plant the seeds in your classroom and grow them to maturity. Describe your new plants and group them into different categories. Compare your new plants to the digital photos of their parent plant.

As an alternative, you may want to look into purchasing Wisconsin Fast Plants which offer kits to specifically study genetic variation (and include dwarf varieties) in short amounts of time.

Find background information on other plant propagation techniques:
Make New Plants and Keep the Old

Related Resources:

Compact Varieties for Small Garden Spaces

Dwarf Conifers

Plant Breeding 101

Dwarf Varieties and Cultivars Worksheet

Plant Name	Cultivar/Variety	Mature Height/Width	Description
Tomato	"Patio"	24"	A dwarf determinate tomato plant that produces small to medium-sized tomatoes on sturdy plants that grow just 24" high. Well suited to being grown in containers or raised beds.