



Gardening With Kids — Classroom Activities in Horticultural Science

Growing Under Lights

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Adequate water and light are the two most crucial requirements for growing plants indoors. Of these, light is usually the limiting factor, especially in schoolrooms where outside windows are small, face the north, or not present. Growing under lights relies on the intensity, quality, and quantity of light produced by fluorescent lamps.

Properties of Light

Intensity (Brightness)

Plants have different requirements for light intensity. Desert plants, such as cacti, require very high levels of light; whereas, most tropical foliage and flowering plants require medium levels of light. Plants are generally segregated into the following categories based on their light requirement and intensity as expressed in foot-candles (ft-c). One foot-candle is defined as the light produced by a single candle's flame as measured at a distance of one foot.

Sunny or very high (>1000 ft-c)

- Areas receiving at least 5 hours of direct sunlight in winter
- Window facing southeast, south, or southwest

Semi-sunny or high (500-1000 ft-c)

- Areas receiving 2-5 hours of direct sunlight per day in winter
- Window facing east or west

Semi-shady or medium (150-500 ft-c)

- Areas having bright, open light, but little or no direct sunlight
- Obstructed window facing east or west

Shady or low (<150 ft-c)

- Areas receiving no direct sunlight, but having enough light to cast a shadow
- Window facing north

Fluorescent lamps are a good source of light for growing plants because they distribute light uniformly across the lamp and over lamp life. Plants can be grown very close to the lamps without heat damage. However, intensity rapidly decreases as distance from the lamp increases (Figure 1).

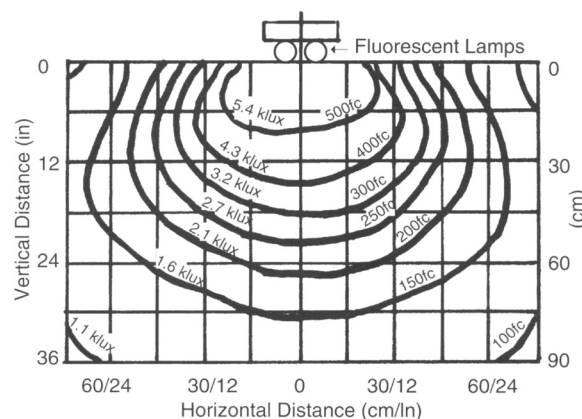


Figure 1. Light intensity as a function of distance from two fluorescent lamps. Source: USDA

Fluorescent lamps are usually suspended a few inches above the plant leaves. For example, seedlings, which require 700-1000 ft-c, should be lighted by eight, 40 watt (48" long) fluorescent lamps, spaced within a 30" width and suspended 8" above the soil's surface. As the seedlings emerge and grow, the lights should be raised to maintain 8" above the upper leaves.

Quality (Color)

Plant growth lights, e.g. GroLux and GroLux WS by Sylvania or Grow & Show by General Electric, produce most of their light in the blue, red, and far red regions. Blue light provides energy for photosynthesis. Red and far-red light are important for flower initiation. Standard "cool white" fluorescent lamps produce light in the lower visible spectrum, i.e. blue to green to orange, and thus will satisfy the light requirements of many plants. Combining two of the plant growth lamps with two, cool white lamps per four-lamp fixture will provide good spectral distribution.

Quantity (Duration)

The intensity of light cast on plants' leaves and the duration are important to the maintenance and growth of those plants.

- Seedlings require 16 hours of light per day.
- Flowering indoor plants require 14-16 hours of light per day.
- Foliage indoor plants require 10-12 hours of light per day.

Building a Lighted Garden

Building a lighted garden for plants requires a minimum number of tools and about a day's work. Polyvinyl chloride (PVC) plumbing pipe is readily available from hardware stores and is easily cut with a hacksaw and joined with PVC cement. PVC plumbing pipe is rated "schedule 40" or "schedule 80," according to the water pressure it can carry. Since the pipe is purely being used to create a structure to support the light fixtures and plants, "schedule 40" is sufficiently sturdy. The lighted garden, as diagrammed, is a free standing floor unit that provides two levels for growing and uses four, 4-lamp fixtures. A single level lighted garden for use on a tabletop may be configured by eliminating the portion marked "lower level." Alternatively, upright pieces of PVC shorter than those denoted "A" in the lower level (Figure 2) can be used to create a supply shelf, rather than a second growing area.

Materials

- 54 foot of schedule 40 PVC pipe, 1 1/2 inch diameter
- 8 PVC elbows
- 16 PVC tees
- 4 oz. can of PVC cement
- 4-heavy duty, 4-lamp fluorescent fixtures, approximately 13 inches wide x 48 inches long
- 4-48 inch (40 watt) plant growth lamps
- 12-48 inch (40 watt) cool white lamps
- 16-48 inch lamp protector sleeves
- 4 male electrical plugs with ground
- 32 foot of 16/3 power cord (8 foot per fixture)
- 1-grounded, 24 hour timer
- 1-grounded extension cord
- 1-grounded, multi-receptacle power strip with ON/OFF switch
- 1-package assorted Fast-Ties (zipper ties)
- 8-eye bolts and nuts (2 per fixture)
- 16-"S" hooks (4 per fixture)
- 1-24 foot chain (cut to 3 foot lengths, 2-per fixture)
- 2-plywood shelves, 2 1/2 foot x 4 foot x 1/2 inch, painted or finished to resist water

Assembly

Mark and label the PVC pipe with a pencil before cutting to obtain maximum use of each length of pipe. Always measure more than once. Cut the PVC pipe into lengths with a hacksaw as specified in Table 1.

Select a well-ventilated, open area to assemble the lighted garden. Assemble one of the ends of the lighted garden, but do not glue. Check alignment of the pieces, especially noting the angles. After verifying the fit of all pieces comprising an end unit, mark the fit of each straight piece of pipe with a pencil to indicate the depth at which it penetrates its associated fittings, and then disassemble the end into an "exploded" view. Observe all precautions on the PVC cement label and begin

cementing the pieces together, paying particular attention to the position and angles of the elbows and tees. The cement dries fast (within 30 seconds) and will not permit repositioning of pieces. Repeat this sequence for the other end unit of the lighted garden.

Position one of the end units flat on the floor with the open ends of the tees that will receive the laterals facing up. Insert the lateral pipes (D) into the tees (Figure 3). After verifying the fit of the six laterals, mark the fit of each with a pencil to indicate the depth at which it penetrates its associated tee, and then remove the laterals. Cement laterals, one at a time, into their associated tees to the depth marked.

Rotate the partially assembled, lighted garden into its normal, free-standing position, and then fit the other end unit onto the laterals. Check the fit of the six laterals and make sure the ends are parallel. Mark the fit of each lateral with a pencil to indicate the depth at which it penetrates its associated tee, and then remove the loose end unit. Cement all six laterals simultaneously, into their associated tees on the loose end unit to the depth marked. Having a partner to assist with this final assembly is extremely helpful.

Mounting the Lights and Shelves

Assemble each light fixture and attach a power cord per the manufacturer's instructions. Install two eye-bolts with nuts into the top of each light fixture; secure tightly. Suspend two light fixtures per level of the lighted garden, using the chains and "S" hooks to adjust the fixtures' height above the growing surface (Figure 4). Position the light fixtures so the power cords emerge at the same end of the lighted garden. Use Fast-Ties to mount the power strip and to secure the power cords. Tighten the Fast-Ties firmly around the power strip; however, tighten the Fast-Ties only loosely around the power cords, so the cords can be slipped through them as the fixtures are adjusted in height.

Place each painted shelf onto the laterals beneath the lights. Shelves may be covered with plastic sheeting for protection. Spare cafeteria trays work well to hold plants and prevent water from spilling onto the shelves and floor.

The lighted garden provides ample light to start seedlings for later planting in a garden, to maintain and grow potted foliage and flowering plants, to root cuttings, to grow ferns from spores, etc.

Table 1. PVC Pipe and Fittings.

Quantity	Description	Key Label
8	30" PVC Pipe, 1.5" schedule 40	A
12	6" PVC Pipe, 1.5" schedule 40	B
6	11.5" PVC Pipe, 1.5" schedule 40	C
6	43" PVC Pipe, 1.5" schedule 40	D
8	1.5" PVC Pressure 90° Elbow schedule 40	E
16	1.5" PVC Pressure Tee, schedule 40	T

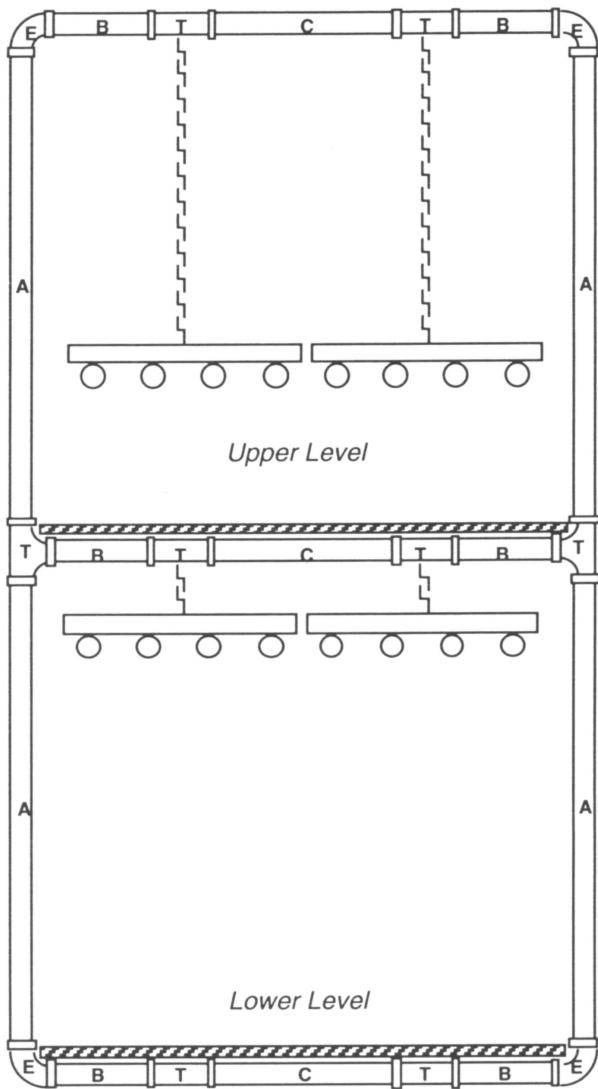


Figure 2. Lighted Garden's Diagrammatic End View.

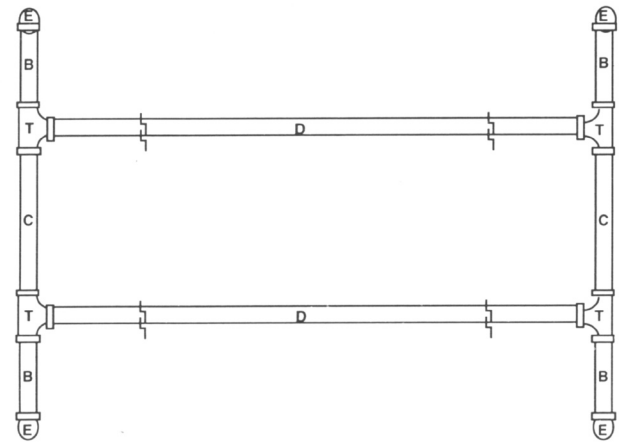


Figure 3. Lighted Garden's Diagrammatic Top View.

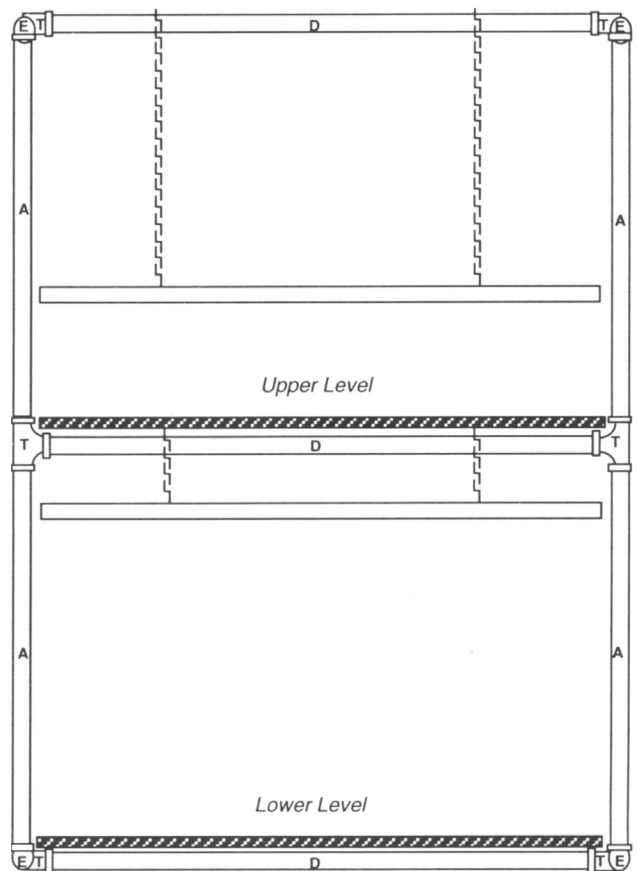


Figure 4. Lighted Garden's Diagrammatic Face View.

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