GROWING EARLY VEGETABLE PLANTS UNDER GLASS

by

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Several important vegetables must be started under glass in the early spring in order to mature at a desirable date for harvesting the crop. In the case of cabbage, cauliflower, lettuce, onions, celery, muskmelons, and early squash, plants are started in the spring in order to bring the crops to an early date of maturity. It is not necessary to start these crops under glass in order that they may have long enough time in which to mature a crop, so that the sole object in the case of these vegetables is to develop a crop for an early market.

In the case of tomatoes, peppers, and eggplant, however, it is necessary that the plants be started under glass, or a glass substitute, in order that the plants mature a satisfactory crop of fruit at the proper season. Thus, there are two classes of crops which may require some kind of a forcing structure in which young plants are grown.

The vegetable grower has the option of growing his own plants or purchasing them from some reliable plant grower. Whether he shall do one thing or another will be dependent largely upon the equipment which he may have for plant growing. In some cases, the tomato grower may be able to buy his plants more cheaply from some extensive grower of plants than he can produce them himself. On the other hand, if he has a plant-growing structure such as a greenhouse or a series of hotbeds, the necessary plants may be grown therein. Many growers of the vegetable crops above mentioned have small greenhouses in which young plants are grown.

It is generally realized by growers of early vegetables that a vigorous and healthy young plant with a good stout top growth, together with a well-developed root system is fundamental in the production of an early crop and satisfactory yield. The price of plants is a secondary consideration in contrast with quality. Higher priced plants that are stronger and stockier will usually give far more satisfaction than those plants bought at a cheap price which have been crowded in the plant boxes or flats.

Forcing Structures

Plant greenhouses. There are various forms of greenhouse structures that are used for plant growing. These vary from a small, inexpensive building up to one of standard construction and moderate size. A desirable type of greenhouse for plant growing would be the even-span standard sidewall type of construction which would call for a house of widths varying from eighteen to thirty feet or so with eaves of six to six and one-half feet, and an interior arrangement of benches for plant growing. For details concerning the construction of such houses see Extension Circular No. 295 or any greenhouse builder.

In some cases the interior arrangement of such a house can be modified so that a bench or two can be used on one side of the house and a ground bed for the other, the former for growing such plants as tomatoes and peppers, etc.
while the ground bed can be used for holding plants of muskmelons, watermelons, cucumbers, or early squash. Also, if desired, the ground bed can be used for growing tomatoes and cucumbers to maturity at the time of the year when no young plants are being grown. Such a greenhouse could be heated by a simple hot water system which could be inexpensively installed.

During recent years there has been an increasing interest in the use of small greenhouses for plant growing with a corresponding displacement of hotbeds of one type or another. There are several advantages to the grower in having a greenhouse, among which are: (1) complete protection of the plants and the grower himself in operating during weather of any kind (2) satisfactory light, temperature, and air conditions readily provided (3) ease of handling plants through the use of benches, thus affording more convenient and rapid work (4) possible use of the greenhouse for the production of crops between plant growing seasons (5) durability of the structure (6) comparative inexpensiveness and possibility of soon paying for the original investment.

The manure-heated hotbed. Due to the scarcity of manure, particularly horse manure, the growing of plants in manure-heated hotbeds is rapidly being displaced by other means of heating. There are some disadvantages to the manure hotbed, including the necessity of soil excavation for putting in the manure, the necessity of removing the manure after the plants are out of the bed and the possibility of inconsistency in the heating materials to furnish a uniform temperature for the young plants. Those desiring a circular on the manure heated hotbed can obtain Extension Circular No. 275.

The flue-heated hotbed. A very satisfactory way of growing young vegetable plants is to start them under a glass sash or a glass substitute covering a frame which is heated by hot air passing through tile placed under the soil, the hot air being provided by fire from the firebox much on the same principle by which a residence is heated by hot air. The value of this form of heat for growing young plants lies in the fact that there is no excavation necessary once the tile has been put into place. The heat is consistent and can be regulated by simply varying the amount of fire in the firebox. Each spring, it is but necessary to start the fire to dry out the soil in the frame and bring it up to the desired temperature for sowing seeds or transplanting plants. Extension Circular No. 343 describes in detail the flue-heated hotbed.

Electric hotbeds. This type of bed for growing young plants is becoming more popular largely because of lower rates for electricity and certain advantages which these beds have over other types of hotbeds. Station Bulletin 307, "Electric Hotbeds and Propagating Beds," discusses fully the method of construction and operation of these beds. Automatic temperature control can be obtained at any desired degree. Also, plants grow rapidly in electric hotbeds and the seasonal job of building the hotbed is eliminated. Due to the rapidity with which plants can be grown, electric hotbeds can be used two or more times in one season. A soil heating cable costs about $5.00 for a 6 x 6 foot bed and a thermostat costs from $5.75 to $11.00. The thermostat can be used to control a bed as large as 6 x 24 feet.

Observations regarding the average power consumption of electric hotbeds indicate a cost of about 75¢ to $1.00 per 3 x 6 foot sash per month. This will, of course, vary according to the power cost in the immediate area, weather conditions prevailing and the kind of plants grown,
Some advantages of electric hotbeds over greenhouses for plant growing have been stated as follows: (1) the initial cost of the installation is less; (2) extra coldframes for hardening the plants for transplanting are not needed; (3) it will not be necessary to use plant boxes or flats to grow the plants in the hotbed for the plants will be set in the soil in the beds; (4) an electric hotbed can be quickly changed to a coldframe by turning off the electric heat.

For details concerning these beds, consult Station Bulletin 307.

Hotbeds can also be heated by hot water carried in pipes placed under the soil or attached to the side of the frame of the bed. The flow and return pipes are 1-1/4", the header pipe 2", and a 3" flow pipe carries the water from the boiler to the 2" header pipe.

For details address the writer of this circular.

**Plant Growing**

**Soils.** Satisfactory soil for seeding and transplanting cannot be obtained out of doors in the winter or very early spring because of excessive wet and cold. It is therefore necessary to prepare soil for plant growing some months ahead of the time that it is to be used, for the soil should be well composted before operations begin. A good mixture of soil for this purpose would consist of one-fairly heavy loam, one-third sandy loam and one-third manure, preferably rotted manure. Rotted leaf mold is also a desirable ingredient of plant-growing soil and in some cases peat moss can be used instead of the manure. This mixture can be composted out of doors, preferably under cover, in the work shed or in the greenhouse bench where the manure will be rott ing when mixed with the other ingredients. The soil should be turned over from time to time where it is being composted in order that the manure may rot thoroughly with the soil, which should be well mixed.

A good soil for sowing seed is one that is friable and will not form a crust on the surface. The soil is usually screened before it is put into the flats, bench or hotbed. A screen of not less than four to the inch should be used and the top surface of the soil sometimes screened even more finely, especially in the sowing of fine seeds.

**Soil treatment.** Plant growing soils are always possible carriers of the damping-off fungus which affects young seedlings both before and after they appear above the surface of the ground, the most common appearance of the ailment being the collapse of the seedling at the soil surface, the stem being constricted and darkened. If the grower decides to treat the soil for the control of this disease previous to seed sowing or transplanting, this can be done by various methods such as: (1) electric soil heating; (2) drenching the soil with formaldehyde; (3) treatment with formaldehyde dust; (4) mixing formaldehyde solution with the soil; and (5) the use of boiling water.

The electric heating method is suitable for treating reasonably small quantities of soil although in some cases whole benches have been treated with large electrical units. Individual flats of soil used for seeding can be economically and profitably treated by using a portable electric pasteurizer.* Electric

* A blueprint of such a pasteurizer can be obtained for fifty cents by writing to the department of Agricultural Engineering, Oregon State College.
soil pasteurization is satisfactory for damping-off control if the soil is brought to a temperature of 150 degrees F.

The method of using formaldehyde for soil treatment is discussed in detail in Extension Circular 291. The principal disadvantage in the use of this material lies in the necessary period of some 10-14 days elapsing between the treatment and the use of the soil. A more recent method of using formaldehyde so that there is very little delay between the application of the material and the use of the soil is the thorough mixture of diluted formaldehyde with the soil for flats or benches, allowing the soil to stand 12 to 24 hours before being used. The proportions recommended are two tablespoons of 40 per cent formaldehyde, diluted with five or six tablespoons of water for each cubic foot of soil.

Another method that makes possible a fairly rapid use of the soil after its treatment is the mixing of 1-1/2 ounces of a six per cent commercially made formaldehyde dust per square foot of soil, the dust being worked well into the surface of the soil. It is possible to sow seed or transplant plants to this soil within 36 hours after treatment.

For small quantities of soil, hot water is satisfactory. A five minute immersion of soil containers, such as pots or small flats, in boiling water or several successive drenchings of the soil in flats or pots with boiling water will kill the damping-off disease.

Seed treatment. If there has been no soil treatment for the control of damping-off, it may be desirable to treat seed with either one of three materials; red copper oxide, zinc oxide, or organic mercury compounds such as Semesan. Some seeds do not thrive as well with one kind of seed treatment material as with another. Red copper oxide is satisfactory for seeds of tomato, pepper, eggplant, melons, cucumber and squash, while zinc oxide is especially good for cabbage, cauliflower, cucumber, eggplant, tomato, pepper and lettuce. Semesan is useful in treating cabbage, tomatoes, cucumbers and melons.

For melons and cucumbers 1/20th of an ounce of red copper oxide is used for one pound of seed; for tomatoes and eggplant, 2/5ths of an ounce. Instructions for the use of these materials as shown on the container or accompanying leaflets should be carefully followed. Seed treatment does not necessarily protect plants from attacks of damping-off after the emergence of the plants above ground. Lettuce plants do not damp off readily but those of the cabbage tribe quickly succumb, as do tomatoes and melons.

Seeding. Seeds of cabbage, lettuce, cauliflower, tomato, eggplant and pepper may be sown in rows at the rate of 8 to 10 to the linear inch in rows which are marked off in the flat, bench or hotbed soil with a straight-edge about 3/4 of an inch in width. It is preferable to distribute the seed in a wide furrow rather than a narrow one, thereby obtaining more plants per row. Plants in a broad row have a better chance to spread and grow into good stocky plants for transplanting than those plants of which the seed is sown in a narrow, pointed furrow. Another method of seeding is to broadcast the seed over the flat, bench, or hotbed soil in which case care should be taken that the seed is spread evenly and not too thickly. The covering of small vegetable seeds should be only such as will be necessary to surround them with soil. Most of the seeds mentioned above are sown at a depth of 1/4 to 3/8 of an inch.
Some growers cover the seed with washed sand. Some also use sand in which to sow the seeds, adding to the sand a little nutrient solution such as one ounce (two tablespoonsfuls) of calcium nitrate or nitrate of soda per gallon of water.

Temperatures for germinating seeds should range between 60 and 75 degrees with a preferred temperature about 68 to 70°F.

Transplanting young plants. The same type of soil as stated in which the seed is grown will be useful for transplanting plants. With most kinds of seedlings, the first transplanting is made when the third leaf, which is the first true leaf, is well formed. If seedlings are allowed to stand for some time after this stage, they will become spindling, are more difficult and costly to handle and oftentimes take more time to become established in the flat, bench or bed. On the other hand they should not be "pricked out" too early before a satisfactory root system is formed. The accompanying table indicates approximate dates of seeding, transplanting and setting of plants in the field.

In order to facilitate the work of transplanting a large number of seedlings, the soil into which they are to be "pricked out" may first be "spotted" by means of a spotting board that will mark the holes where each plant is to be set. This will assure the plants of an even distribution and equal space between each other as well as making it unnecessary for the grower to figure just where each plant should be set.

It is also important to water down all flats, bench or hotbed soil, from which plants in the seed rows are to be taken for transplanting, several hours previous to the operation. In this way the plants will be turgid and plump and the plants will readily separate out from each other, retaining all of the original root system that will enable them to make a rapid pickup.

In the process of transplanting, the plants should be lifted carefully out of the seed rows so that as few roots as possible will be broken off. In transferring the plants to the spotting bed, they should be set slightly deeper than they originally were in the seedbed. The general rule is to set the young seedlings so that the crotch of the seed leaves is just above the ground.
### Table of Seeding and Transplanting Dates

<table>
<thead>
<tr>
<th>Vegetable</th>
<th>Date of Seeding</th>
<th>Time of Transplanting</th>
<th>Distance Between Plants Inches</th>
<th>Date of Transplanting to Field</th>
<th>Distance of Field Planting Rows Inches</th>
<th>Plants Inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cabbage</td>
<td>1/15-3/1</td>
<td>After 12-14 days</td>
<td>1-1/2-2</td>
<td>3/10-4/15</td>
<td>30</td>
<td>18-24</td>
</tr>
<tr>
<td>Lettuce</td>
<td>1/15-3/1</td>
<td>After 12-14 days</td>
<td>2</td>
<td>3/10-4/15</td>
<td>18-24</td>
<td>12-15</td>
</tr>
<tr>
<td>Cauliflower</td>
<td>2/15-</td>
<td>After 12-14 days</td>
<td>2</td>
<td>4/10-5/1</td>
<td>30-36</td>
<td>24-28</td>
</tr>
<tr>
<td>Tomato</td>
<td>2/15-3/15</td>
<td>After 18 days</td>
<td>2 1/2-4</td>
<td>4/25-</td>
<td>60-72</td>
<td>48-72</td>
</tr>
<tr>
<td>Pepper</td>
<td>2/15-3/15</td>
<td>After 18-21 days</td>
<td>2 1/2-4</td>
<td>5/1-20</td>
<td>30</td>
<td>24</td>
</tr>
<tr>
<td>Eggplant</td>
<td>2/15-3/15</td>
<td>After 21-26 days</td>
<td>3 or 4&quot; bands or hallocks</td>
<td>After frost</td>
<td>30</td>
<td>24</td>
</tr>
<tr>
<td>Onion</td>
<td>2/1</td>
<td>No transplanting</td>
<td>4/10-25</td>
<td>18</td>
<td>3-4</td>
<td></td>
</tr>
<tr>
<td>Celery</td>
<td>2/20 and in succession</td>
<td>After 30 days</td>
<td>1 1/2-2</td>
<td>4/25- onward</td>
<td>30-36</td>
<td></td>
</tr>
<tr>
<td>Melons</td>
<td>4/1-10</td>
<td>None</td>
<td>Grow plants in 3 or 4&quot; hallocks</td>
<td>5/10 After frost</td>
<td>72</td>
<td>60-72</td>
</tr>
<tr>
<td>Cucumbers</td>
<td>4/1-10</td>
<td>None</td>
<td>Grow plants in 3 or 4&quot; hallocks</td>
<td>5/10 After frost</td>
<td>72</td>
<td>60-72</td>
</tr>
<tr>
<td>Squash</td>
<td>4/1-10</td>
<td>None</td>
<td>Grow plants in 3 or 4&quot; hallocks</td>
<td>5/10 After frost</td>
<td>84</td>
<td>34</td>
</tr>
</tbody>
</table>

Dates are variable according to the localities in the state of Oregon, also according to the variations in individual earliness or lateness of seasons. Tender plants, such as tomato, eggplant, pepper, melon and cucumber should not be set in the field until all indications of frost have passed, unless the plants can be covered with protectors of some kind. Cabbage, lettuce and onions will stand slight frosts but cauliflower plants may run to seed if exposed to such weather. Celery plants are set out in succession, beginning when the frosts are over.

Individual containers for plants. In the case of tomato, eggplant, pepper, melon, cucumber, etc., it is often desirable to grow the plants in individual containers such as veneer bands of a size 3" x 3" x 3" or sometimes in second-hand
berry hallocks of a size 4" x 4" x 4". The particular value of these individual containers lies in the fact that there is little or no root disturbance when the plants are set out in the field. This is especially desirable in the case of melons and cucumbers, the plants of which do not transplant readily unless they are put in individual containers.

In the case of tomatoes, peppers and eggplant, the young seedlings can be placed immediately from the seedbed into the center of the individual container. With melons, cucumbers, early squash, etc., several seeds are sown in each "individual" and the number of ensuing plants are thinned to two or three per band as desired.

**Maintenance and care of young vegetable plants.** There are three things of importance in the care of young vegetable plants: (1) providing a suitable temperature both day and night; (2) careful watering; and (3) adequate ventilation. Plants of tomato, pepper, eggplant, melons and cucumbers require slightly higher temperatures than such plants as lettuce, cabbage, cauliflower, onions and celery. For the former plants, temperatures of 70 to 75 degrees in the daytime and a night temperature of 55 to 58° F. are suitable. For the cooler plants, day temperatures of 60 to 65 and night temperatures of 50 to 55 are suitable.

Young plants require a moderate amount of water, but they should not be watered excessively, particularly during dull weather, otherwise there is a tendency for the damping-off fungus to develop. It is advisable to water early in the day or in the morning of bright sunny days rather than toward the latter part of the day.

Both in greenhouses and hotbeds, the young plants should be given as much fresh air as necessary to provide for proper sanitary conditions within the structure. Plants should not be allowed to become chilled or to be in a direct cold draft, neither should there be such a lack of ventilation as to allow moisture to condense on the under-sides of the glass. High temperatures, excessive watering and insufficient ventilation tend to make the plants spindling, weak and susceptible to disease.

If young plants become affected with damping-off in flats, bench or bed they may be treated with a solution of red copper oxide, one ounce to three gallons of water. The plants themselves as well as the soil should be well wetted with this material.

**The use of coldframes.** Coldframes are used for hardening plants before they go into the field. It is not wise to take plants grown in a warm greenhouse directly into the garden, exposing them to lower temperatures which may sometimes give the plants a considerable check in growth. Hardening is intended to be a slowing-up process but not a checking operation. It can be accomplished in two ways: (1) by decreasing the water given to the plants; (2) by increasing the ventilation of the frames and giving the plants more air so that they will become gradually accustomed to the lower temperatures. The hardening process usually covers a period of 10 to 14 days. During this time the plants should have enough water to keep them from wilting but not as much as formerly given in the early stages of the growth of the plants. Towards the end of the hardening period the sashes covering the coldframes can be entirely lifted in the daytime.
and later on left off entirely at night provided weather conditions warrant the lack of covering of the plants.

"Booster" solutions for young plants. Some plants may show by a slow growth or a yellow color the necessity for more available plant food. In some cases it is desirable to give plants a stimulus by using nitrate of soda, calcium nitrate or sulfate of ammonia in solution, one ounce to one gallon. One and three-fourths level tablespoonsfuls of either of these three materials is equal to an ounce, or one may apply a tablespoonful of ammo-phos 11–48 or 16–20 to a gallon of water. In some cases it may be desired to definitely give the young plants some fertilizer in liquid form before transplanting, even though they do not show the need for stimulation. If so, a "booster" solution may be made up by mixing 20 ounces of ammo-phos 11–48 with 10 ounces of calcium nitrate and 10 ounces of sulfate of potash to 50 gallons of water, applying about half a pint or so of this solution to each plant before it is taken to the field.

(This is a revision of Circular 250, January 1931)