Practical-8

Protecting Plants from Sub-optimal Temperature Conditions to Cultivate Off-Season Vegetables

EXERCISE

8.1 Protection of vegetable plants from low temperature to produce early crop.

8.2 Protection of vegetable plants from high temperature.

OBJECTIVE:

- Imparting training to raise vegetable crops in the off-season by protecting from low as well as high temperature.

Delivery schedule: 02 periods.

Student's expectations/learning objective:

- Importance of protecting plants from sub-optimal temperature conditions.
- To demonstrate the technologies for raising off-season vegetable cultivation under low and high temperature conditions.

Pre-learning required: Effects of low and high temperature on different growth stages of vegetable crops.

Handouts/material /equipment's and tools required: Paper sheet and pen to note down the steps, organic mulch, plastic sheets, smudge pot, shading nets *etc.*

Introduction:

Temperature is considered as the most important factor in deciding a location for growing different vegetables. All physiological activities in a plant are influenced by temperature as it regulates different biochemical processes. Extremes of temperatures may inhibit seed germination, reduce pollen viability or germination of pollen on stigma, decrease fruit set or may check various developmental activities of the crop plants. Many tropical and subtropical vegetables are susceptible to frost or chilling injury and get damaged at temperature below 10°C *e.g.* tomato, okra, cucurbits *etc.* In the tropical environment, heat injury is more detrimental

than cold injury. High temperature leads to flower and fruit drop in tomato, bell pepper, French bean *etc.* Therefore, to overcome the problems due to extremes of temperatures may help to grow vegetables in off-season. The off-season cultivation of vegetables provide better remunerations to the vegetable growers.

Exercise 8.1: Protection of vegetable plants from low temperature to produce early crop.

The methods used to protect the vegetable crops from low temperature are:

8.1.1 Use of plastic mulch: Mulch modifies soil temperature *e.g.* plastic mulch raises the soil temperature quickly in the spring season which enhances the plant growth and thus early harvest can be obtained. Mulches are used to raise soil temperature during winter season and should be applied late in the fall before the onset of harsh winters. The plastic mulch besides raising soil temperature, also effectively control weed emergence and result in early crop growth. Black plastic mulches may raise soil temperature by 15-30° F during the early season allowing vegetables to grow at a faster pace.

Procedure/methodology of application:

- Apply plastic mulch prior to planting.
- Prepare the land for planting and land should have good soil moisture at the time of placing plastic sheet.
- Spread plastic sheet over the row to be planted.
- Bury the edges to prevent it from blowing away.
- Cut slits or make holes at the recommended spacing for transplanting tomato, bell pepper, cucurbits *etc.* A few additional slits can be made to allow water to infiltrate.
- The drip irrigation lines should be placed carefully in the rows under the mulch. These drip lines provide water and liquid fertilizers to the crop.

Growing tomato using black polythene mulch

- Remove weeds which may emerge through planting holes and path between the mulched beds generally need weeding.
- Remove plastic mulches from the field at the end of the growing season.

8.1.2 Cultivation under plastic low tunnels or row covers: This technology is used to advance the growing season for selected vegetables for producing early crop and obtaining good price in the market. Row cover

or low tunnel technology has been effectively used to raise cucurbits and even solanaceous vegetables during winters in the open fields. The transparent plastic sheet is covered over the rows/beds of transplanted vegetables to enhance plant growth due to raised temperature. These covers also protect the crop from frost, hails and cold wind injury. Low tunnels are used for 4-8 weeks immediately after transplanting and should be removed with the initiation of flowering to allow proper pollination.

Methodology/Procedure

- Raise seedlings in plastic pro-trays having 1.5 inch cell size in the month of December-January in the protected structures.
- Transplant one month old seedlings which have attained 3-4 true leaf stage in cucurbits under row covers or plastic low tunnels in the open field during mid January – early February in the northern Indian plains where night temperatures are very low.
- Fix flexible galvanized iron hoops at a distance of 1.5-2.0 m. The width of two ends of hoops is kept 1m with a height of 45-60 cm above the surface of beds.
- Transplanting should be done on the beds by keeping row to row distance of 1.5 m.

Growing French bean and summer squash under plastic low tunnels

- Make the tunnels in north to south direction to receive maximum sun light.
- Transparent plastic sheet of 30-50 micron should be used for making low tunnels.
- Cover the sheet after transplanting the seedlings of desired cucurbits.
- The plastic can be vented during the growing season as the temperature increases inside the tunnel during peak day time. Generally, 3-4 cm size vents are made on eastern side of the tunnel just below the top.
- Remove the plastic completely from the plants during February or March depending upon the growth and prevailing night temperature at that time

8.1.3 Other technologies to protect vegetables from low temperature/frost injury

i) **Fog or smoke:** Clouds and fog are well-known for their ability to reduce radiative heat loss from the surface. Smoke from smudge pots or burning tires or refuse and mist from fine water nozzles have been

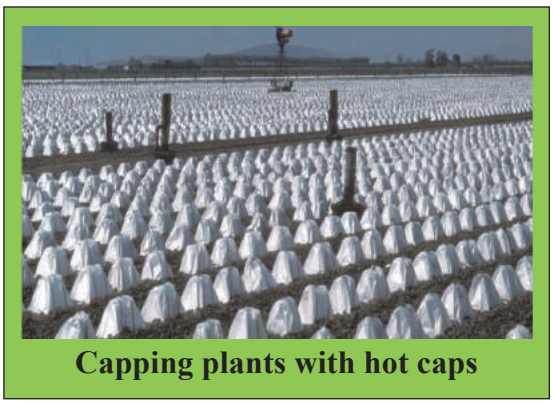
used to reduce the heat loss. Since it is difficult to maintain the smoke over the sensitive crop area and to produce droplets the optimum size to intercept the long-wave radiation, this method is not very effective. In addition, our environmental laws now prohibit the use of this method, where smoke is involved.

ii) **Wind Machines:** Wind machines or helicopters are sometimes used to bring the warmer air down to the crop level to replace the cold air layer at the surface. This method can be effective when there are large temperature differences between air layers near the surface and those up high. Equipment and operating costs are high. Effectiveness varies in the range of 1 to 4° C.

iii) **Sprinkling of water:** A very low rate of water application through irrigation can be effective in preventing freeze damage through the release of heat during cooling and freezing. Sprinkling water on the crop should be started with the onset of freezing conditions and a film of water is maintained continuously until the temperature rises above the freezing level. If sprinkling is discontinued prematurely, heat will be drawn from the leaves to melt the ice and freeze damage may occur. The added moisture has the beneficial effects of increasing the capacity of the soil to store heat and improving conduction of heat to the surface.

iv) **Heating:** This method is intended to add enough heat to the layer of air surrounding the crop and through radiant heat to the crop to maintain the temperature above the freezing point. Fuel costs are high whether solid fuel bricks, oil or propane gas heaters are used. Capital and labour costs add to the expense and therefore only crops which have a very high value per unit area can be protected from frosts using this method.

v) **Capping plants with hot caps:** Tomatoes and other garden vegetables can withstand freezing temperatures as low as 28 to 30° F but cannot withstand frost. Frost is crystallized dew that forms on the plant surface and destroy plant cell walls on melting. Under severe conditions, even death of the plants may occur. Use of hot caps over individual plants protect them from frost. To protect rows of vegetables from frost, gardeners often cover the row with a frost blanket. These covers should be removed from the vegetable during warm days. When frost conditions are predicted, cover the vegetables during night hours.



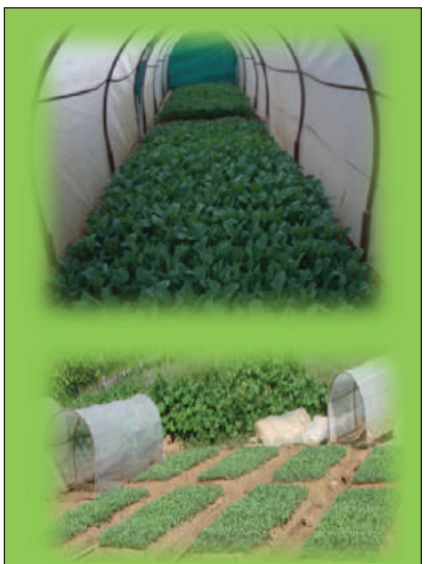
Capping plants with hot caps

vi) **Capping plants with polybags:** In certain parts of northern India especially Punjab, Haryana and Uttar Pradesh, for growing early spring summer crop of tomato the nursery sowing is done by October end or mid November and seedlings are transplanted in November end or early December on the ridges. These seedlings after transplanting are covered with 100 gauge polythene bags of size 35 cm × 25 cm. Three sides of the bag are buried in the soil and the fourth side is kept open for aeration. Thus, the seedlings are

protected against the frost. Though, the rate of plant growth is slow due to prevailing low temperature but the plants are protected from the frost. The frost is over by January and polythene can be removed. The plants pick up growth with rise in temperature and are ready for harvest one month earlier than the normal planted spring-summer tomato crop.

vii) Smudging: A smudge pot is an oil-burning device used to prevent frost on vegetable plants. A smudge pot has a large round base with a chimney coming out of the middle of the base. The burning oil creates some heat but lot of smoke particulates, carbon dioxide and water vapour. This artificial smog forms a "blanket" that blocks infrared light, thereby preventing radiative cooling that would otherwise cause or worsen frost.

viii) Cost effective polyhouse cultivation technologies:



Portable Low tunnel technology for off-season nursery raising

- Off-season nursery raising of vegetables under low cost protected structures in soil less media or under portable low tunnels during winter season.
- Year round high quality cucumber cultivation under naturally ventilated polyhouses is highly cost effective technology. Three crops of cucumber (parthenocarpic varieties) can be harvested in one year with a production of 100 t/ha.
- Tomato and sweet pepper can be grown successfully for 6-9 months period under naturally ventilated polyhouses instead of climatic controlled green houses.
- Walk in tunnels are low cost and semi permanent protected structures with a central height in the range of 6-12 feet. They are very effective for off-season cultivation of tomato, bell pepper and cucurbits mainly musk melon, water melon, summer squash *etc.* during peak winter period in northern Indian plains of India.

Exercise 8.2 Protection of vegetable plants from high temperature

The methods used to protect the vegetable crops from low temperature are:

i) Uniform Irrigation: Most of the vegetables are very sensitive to the high temperature. When high temperature occurs for an extended period, flowers of heat-sensitive vegetables may abort or the blossoms may drop off. When this happens, fruit development may be delayed, even if the plants appear to be healthy. When consistent high temperatures occur, it is critical to keep the soil moist with uniform irrigations, and this may help in reducing heat stress. Remove the dead plant parts and water the plants as per the need.

ii) **Providing Shade:** Shade nets helps in the protection of plants from direct sunlight and offers better ventilation, improves light diffusion, reflects summer heat and keep the covered area cooler. In general, the nets should provide 30-80% shading. Provision of a little shade during the hottest time of the day may extend the life of crop plants. So, the shading should be provided between 11 AM to 3 PM to protect the plants from the scorching sun on hot days. Shade nets are often spread over crops to reduce heat stress however, in enclosed net (shade) houses, temperatures during the day are typically higher than outside and may be lower at night.

Protecting nursery by using shade nets

iii) **Providing organic mulch:** Organic mulch acts as an insulator which keeps soil temperature low and therefore, should be applied later in the season. This helps in checking seedling mortality and improving crop stand. They include plant residues such as saw dust, straw, leaves, corncobs, pine needles, animal manures, peat moss and wood products *etc.*

Capsicum with straw mulch

Methodology/Procedure

- Apply organic mulch when the vegetable crops have established well (10-15 cm tall) and the soil has warmed to near-optimum temperatures.
- Make the area weed free before the application of mulch.
- Spread the mulch evenly over the soil surface just away from the plants.
- The thickness of wood and bark mulches should not be more than 5-7.5 cm, grass clippings or shredded leaves should never be more than 5 cm in thickness.
- Apply organic mulches when there is optimum soil moisture and before the weather turns hot.

Protected cultivation:

These days few high value vegetable crops can be grown under sub-optimal environmental conditions. The followings structures can be utilized for raising vegetable crops under both low and high temperature conditions:

1. **High tech or fully climate controlled high cost greenhouses:** This type of greenhouse is constructed to achieve higher degree of climate control to enhance the cultivation period of the crops. Evaporative cooling and the heaters are used to maintain the required temperatures inside greenhouse as and when needed. The greenhouse consists of a sensor, a comparator and an operator. The temperature humidity and

light are automatically controlled. These greenhouses are mostly used for cultivation of tomato and sweet pepper over a longer period of time. The greenhouses are made up of plastic except in cold places where rigid plastic or glass is used.

2. **Partial climate controlled or medium cost greenhouses:** The structural frame is made up of galvanized iron pipes, like the climate controlled green house, but only the exhaust fans with evaporative cooling pads are provided to maintain the favourable temperature and humidity during summer. The basic cost of installation of these greenhouses is half to that of high tech or fully climate-controlled greenhouses.

3. **Naturally ventilated or low cost greenhouses:** These are simple greenhouses with low initial investment. The frame may be galvanized iron pipes, bamboos, wooden logs or steel pipes, or any other local material. In these structures, no heating or cooling systems are provided. The top of the greenhouses is covered with the plastic and the sidewalls have the insect proof nets from ground or at 2-4 feet to a height of 5 to 8 feet with or without manually rolling plastic cover. The initial cost of these greenhouses is less than half to that of semi climate controlled greenhouses. Modified naturally ventilated polyhouses offer great potential for commercial cultivation of high value vegetables including raising of seedlings in plug trays in hills during both the seasons and raising off-season crop during winters in plains.

Exercise

1. Visit vegetable garden in your nearby area during peak summer and winter months and enlist the practices which are being adopted by the farmers to protect different vegetables from extremes of temperatures.