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Potato Crop Protection against Frost

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Introduction:

Potato being the third most important crop in the world in terms of food consumption, after rice and wheat, and hundreds of millions of people in developing countries depend on potatoes for their survival. More than 156 countries produce potatoes and more than a billion people worldwide eat them on a regular basis. The potato produces more food on less land faster than any other major food crop and, as a result, potato crops are an excellent alternative for farmers who need to feed growing populations with limited areas of crop land. Potatoes are rich in protein, calcium and vitamin C and have an especially good amino acid balance. A single medium-sized potato contains about half the daily adult requirement of vitamin C; other staples such as rice and wheat have none. Boiled, it has more protein than maize, and nearly twice the calcium. Potatoes are a valuable source of nutrition in many developing countries, contributing carbohydrates, vitamins, and minerals to the diet of millions. Farmers harvest potato crops in the tropics within 50 days of planting - a third of the time it takes in colder climates. In highland areas of southern Asia, the potato is emerging as an off-season crop; planted in rotation with maize, it brings relatively high prices at the market. Similarly, across other areas of the world, the potato's importance as a winter cash crop is rising considerably.

Damage to potato crop as well as other vegetables by frost causes a huge yield loss, somewhere in every year. Such damages range from cold set-back of alfalfa in spring to loss of tomatoes in a home garden in the fall. Some of these losses can be prevented. A number of different methods are available for preventing freeze damage to crops. It is important for growers to be aware of these so that they can evaluate which procedures are feasible and economical for combating freeze damage. This article provides some information on various freeze prevention methods that are available.

The terms frost and freeze are often used interchangeably. Here the word freeze will be used for the subfreezing temperature conditions that cause crop damage and have the same meaning as 'killing frost'. The word frost will refer to the condition that exists when air temperatures drop to the freezing point of water (0°C), or lower, but which may

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or may not result in freeze damage to crops.

The Signs of Frost Damage on Plants:

Frost damage tends to have a few distinct characteristics, including limp, droopy leaves, long cracks on tree trunks, and leaves that gradually turn black and die in as little as a few hours. But even if a plant loses all of its foliage after freezing weather, it doesn't necessarily mean that it's dead. And even if a plant looks perfectly fine after a frost, the damage could take months to appear.

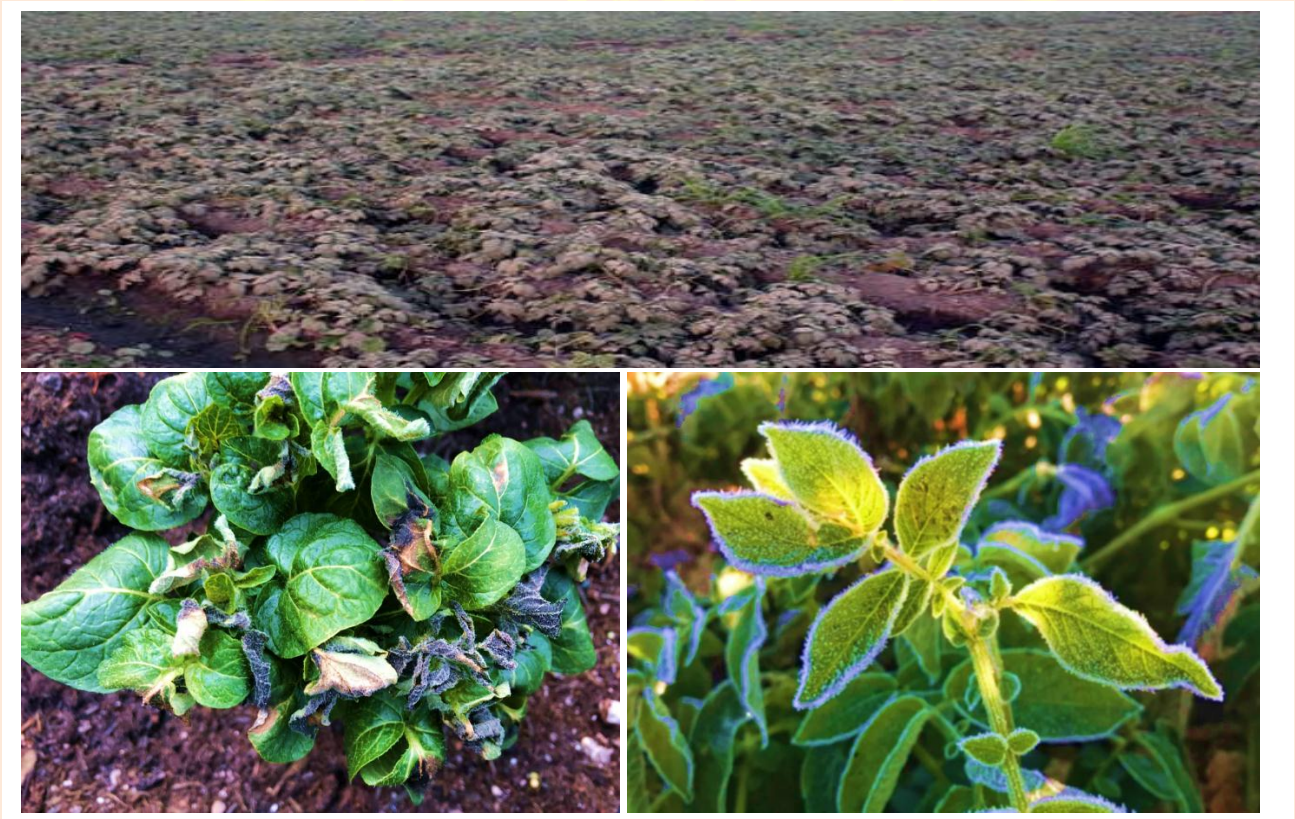

Figure-1: Effect of frost on potato crop plant.

Frost or cold damage:

On foliage:

- ✓ Frost causes burns and leaf withering. The worst affected leaves are usually the top leaves and the ones around the edge of the plant (Figure- 1).
- ✓ In the case of young plants (5-10 cm), a severe frost can cause the green parts to wither completely. Growth recommences with the unaffected parts.
- ✓ Prolonged cold can cause a purplish discolouration of the edges of the leaflets, although this formation of anthocyanins may be due to other stress factors (deficiency or virus infection).

On tubers:

- ✓ The symptoms appear when the plants are getting warm again after frost. The frozen part of the tuber becomes soft.

- ✓ The inside becomes liquid and blackens. In the case of a partial frost, irregular grey to black spots (Figure- 2) may be observed in the flesh but more commonly in the outer part of the tuber.

Figure-2: Effect of frost on potato tuber

How frost damage to the potato plant: In potato leaves, under natural conditions, ice nucleates between -0.5 and -3 °C, and leaves become frost-damaged at -3 °C. Frost causes deadly damage to *Solanum tuberosum* leaves. The reason behind leaves damage is intracellular freezing. Ice crystals forms inside the cell due to intracellular freezing, killing the protoplasts and rapture the cell wall.

Methods of frost protection: The methods are described in terms of active and passive techniques. Active methods are those which are used when the danger of a freeze is present and include such techniques as adding heat and covering crops. Passive methods are those which are used well in advance of the freeze and include proper scheduling of planting and harvesting within the safe freeze-free period, proper crop and field selection, among others. Specific examples of both methods will be discussed in more detail.

Passive protection: Passive protection includes methods that are implemented before a frost night to help avoid the need for active protection. Passive methods are usually less costly than active methods and often the benefits are sufficient to eliminate the need for active protection. The main passive methods are:

Site selection: The land selected to grow a frost-sensitive crop should have an adequate freeze-free period. Locations near large water bodies are usually less prone to frost as air masses over water cool less rapidly at night than over land. Coastal areas frequently experience land breezes at night which help prevent frost.

Managing cold air drainage: For high risk crops, avoid low-lying fields where cold air tends to drain to and be trapped. Dense wind breaks, forested areas, road embankments or other obstructions can result in "pools" of cold air by preventing the cold air from moving down the slopes.

Variety selection: It is important to choose potato varieties which will mature within the available freeze-free period and that reduce the probability of damage due to freezing, and are more tolerant of freezing.

Crop nutritional management: Unhealthy plants are more susceptible to frost damage than the healthy plants. However, the relationship between specific nutrients and increased resistance is obscure. In general, nitrogen and phosphorus fertilization before a frost encourages growth and increases susceptibility to frost damage. However, phosphorus is also important for cell division and therefore is important for recovery of tissue after freezing. Potassium has a favourable effect on water regulation and photosynthesis in plants.

Active protection: Active protection takes place just before and during the occurrence of the frost after a warning has been issued in the weather forecast. The basic concept of these methods is very simple. They either depend on the reduction of heat loss from the surface, stirring the air to break up the temperature inversion, or adding heat to maintain the temperature above the danger point. Active protection methods includes:-

Irrigation: Irrigation sprinklers can be used to protect plants from freezing when the expected lows are just below freezing. Sprinkler irrigation is beneficial on frosty nights as it reduces frost damage in potatoes. It is recommended for areas with undulating topography, extremely sandy soil and scarce water supply. Under such situations, the use of sprinkler systems increases water use efficiency by 40% as compared to furrow irrigation.

Plant covers: Plant row covers are warmer than the clear sky and hence increase downward long-wave radiation at night, in addition to reducing convectional heat losses to the air. Woven and spun-bonded polypropylene plastics are sometimes used to protect the crop. Clear plastic may transmit some long-wave radiation, whereas dark,

opaque covers do not. Any cover is effective in reducing heat loss by convection. When covers are placed, particularly thin materials such as plastics, care must be taken to prevent contact with the plant to reduce heat loss by conduction, as the temperature of the exposed surface is usually lower than the air below it. Covers should be removed during the day as air humidity would be higher under the cover and this would increase the danger of certain plant diseases.

Soil covers: Plastic covers are often used to warm the soil and increase protection. Mulching is also performed to protect the crop from frost damage.

- ✓ Mulches underneath plants prevent heat coming out of the soil at night from reaching these plants and thereby result in lower plant temperatures.
- ✓ In general, vegetative mulches are only recommended for locations where soil freezing and heaving are a problem.

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 in attempts to reduce this 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.

- ❖ All methods and combinations are done during a frost night to mitigate the effects of sub-zero temperatures. The cost of each method varies depending on local availability and prices. In some cases, a frost protection method has multiple uses (e.g. sprinklers can also be used for irrigation) and the benefits from other uses need to be subtracted from the total cost to evaluate fairly the benefits in terms of frost protection.

References:

1. https://www.allaboutgardening.com/potatoes-frost/
2. https://greenupside.com/can-potato-plants-survive-frost-3-ways-to-protect-them/#:~:text=Potato plants can survive a,as cloches or row covers).
3. https://greenupside.com/does-frost-kill-vegetable-plants-which-ones-can-survive/
4. omafra.gov.on.ca/english/crops/facts/85-116.htm
5. https://homeguides.sfgate.com/save-potato-plants-after-late-freeze-23463.html