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## METHOD OF PROTECTING PLANTS AGAINST FROST

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The present invention relates to a method of protecting plants against frost.

To protect plants against the danger of frost it has already been proposed to smear or spread upon the plants foams of aqueous liquids or of solutions of salts which reduce the freezing point or develop heat during crystallizing out. These foams consist, as far as their volume is concerned, largely of air. The liquid wall between the individual air bubbles is thin in proportion to the diameter of the air bubble. According to the magnitude the volume of air is 10–25 times as large as that of the liquid in these foams. With a proportion of 10 only an average wall thickness of the cells of about 0,01 to 0,02 mm is calculated for a foam the individual cells of which have a diameter of about 1 mm. At points where the walls of two or more cells touch each other, i. e. at the edges and corners, accumulations of liquid are formed, whereas towards the middle the foam foils become colloidally thin. This is obtained by the fact that in the liquid, i. e. the water, a foam former or producer is solved which reduces the surface tension of the liquid and thereby allows the formation of liquid films of such small wall thicknesses. If the outside temperature reaches the freezing point, the outermost layer of the foam enveloping the plants first solidifies. This freezing process very slowly proceeds to the plant itself. A firmly coherent coating, however, is not formed. It has been shown, moreover, that the foam solidifies in the state of snow. This snow is finer, i. e. of smaller crystals, than ordinary snow. As is well known snow neither forms a hindrance for the breathing nor for the other processes of the plant. It is remarkable that on rethawing the foam assumes again its original state.

In practically carrying out the method according to the invention it has been found that in some cases a success is obtained, whereas in an inexplicable manner this method often failed, particularly in connection with plants which are highly sensitive against frost.

Now, the main object of the present invention is to obtain in all cases a positive success with such foams. This is obtained by using foams the freezing point of which lies as near as possible to 0° C.

If for instance a plant enveloped with a foam was subjected to an outside temperature of −10° C, it took 1–2 hours until the temperature of the foam sunk to the freezing point. The temperature remained for a further 1–2 hours at the freezing point until then it slowly sunk further.

The damages caused by frost mainly are due to the fact that the liquids in the tissue of the plants, mostly consisting of water, freeze and the ice formed thereby prevents the circulation of the juice and, moreover, tears the tissue by its expansion. Now, these liquids do not consist of pure water, but of aqueous solutions the freezing point of which lies lower than that of pure water, i. e. lower than 0° C. A portion of these liquids, representing less concentrated molecular solutions, has a freezing point which lies a little below 0° C. If the temperature is below this freezing point these liquids freeze to ice. If other liquids still maintain their liquid state such partial ice formation is already sufficient to injure or even kill the plant. Whereas, therefore, a temperature of 0° C cannot yet be harmful to the plant, the freezing of some liquids soon starts on sinking of the temperature. At a temperature below −1° for instance such a large portion of the liquid is frozen already that the plant is seriously injured or killed.

This prooves that the protecting effect of a foam is no longer present if the freezing point of the foam lies below the critical temperature of the plants to be protected. If first of all during sinking of the temperature of the foam to the freezing point, a certain protecting effect is obtained, just the further protecting effect of the frozen foam is rendered illusory, if indeed the plants are protected against further sinking of the temperature by the frozen foam, are, however, already in a harmful range of temperature.

Very small differences are hereby a matter of consequence and, therefore, it is within the essence of the present invention that the freezing temperature of the foam forming liquid lies as near as possible the freezing point of pure water.

On the basis of this knowledge it has been proved to be wrong to add any salts to the liquid. As is well known each kind of additional of soluble substances causes a depression of the freezing point. By the heat abstraction under partial crystallisation according to the French patent 840,346, the freezing point is more slowly reached indeed, but this freezing point lies at a temperature of below −1° to −3°, so that then the plants to be protected are already within the dangerous range.

In practice the waters available for the foam formation must be known in respect to this. It is only necessary to have the freezing point tested at a suitable point of time to know which water is to be used for the formation of the foam in the moment of danger by frost.

It has been found that water may be rendered suitable for this method also by chemically eliminating therefrom solved substances. This purification also may be obtained by freezing out, or distillation and condensation.

Ordinary snow- or rain-water is particularly suitable for this method. If such water is available in cisterns or collecting tanks it is the best water to be used for this purpose. Relatively small quantities of water are required. The foam has a volume of 15–20 times. By adding rain- or snow-water to other water the solved substances may be diluted so far that the freezing point will not be too far below 0° C.

For the production of foam in large quantities the well known apparatus, serving for fire extinguishing by foam, are sufficient. For smaller quantities of foam more simple stirring apparatus, filter tubes and so on may be used.

Saponine and the various other well known substances may serve as foam formers or producers which, when added in small amounts to the water, effect the foaming. In this case also care is to be taken, that the contents of foam formers or producers are so chosen as to add as little as possible in depressing the freezing point.

*Example*

Three groups of 10 azaleae covered with foam were subjected to a temperature of −10° C. In group 1 each plant was enveloped by foam consisting of rain-water containing 0.5% of saponine. In group 2 each plant was enveloped by a foam consisting of tap-water containing 0.5% of saponine. In group 3 each plant was enveloped by a foam consisting of well-water containing 0.5% of saponine. The rain-water, the tap-water and the well-water each containing 0.5% of saponine had freezing points of −0.2°, −0.5° and 1.5° C respectively. In the moment the three foams were applied to the plants they had a temperature of 12° C. Then it took about one hour until the foams enveloping the individual plants reached the freezing point measured at the plant. On this freezing point the foams were maintained for about 2 hours, whereby the foams gradually solidified to a coherent snow. Then the plants were brought into a room again having a temperature of several degrees above the freezing point. It was found that after thawing and removing of the foam no alteration was to be ascertained with the first group of plants. The plants of group 2 were partially attacked, but soon recovered. All plants of group 3 were attacked. Four plants were killed by the frost.

It was found, moreover, that the heat protecting effect of the foam might considerably be increased if oils or fats of mineral, vegetable or animal origin were introduced into the foam in the form of small drops. For these purposes it is necessary that in the moment of the foam formation the oil or fat is emulsified in the water to be formed to foam which also still contains the foam former, for instance 0.5% of saponine. This may preferably be effected by combining the dispersion of the air in the water by pressing in the air by way of porous walls stirring or other well known methods with the emulsification of the oil. As far as the oils and fats are concerned the condition is to be fulfilled that they contain no water soluble constitutents which may cause a depression of the freezing point. In a rather simple manner this may be effected by previously stirring with water the oil to be used, whereby the soluble constituents pass into the water. Only if it is absolutely sure that no soluble substances in the oil depressing the freezing point are introduced into the water to be foamed, the formation of the foam may take place.

So for instance an acid containing paraffine oil was introduced into a foam in the manner described above. 50 gr of paraffine oil were strongly stirred with 1 liter of rain-water containing 5 gr of saponine serving as foam former. A solid foam with embedded drops was formed having a freezing point of 0.9° C. If the paraffine oil was sufficiently freed from the acid by previously treating the oil with water, the freezing point of the foam still was 0.2° C. Tests carried out with azaleae in the manner described above proved that, when using the first mentioned foam, some of the plants were damaged or injured, and that, when using the last mentioned foam, the plants after treatment were fresher than after treating with water containing no paraffine.

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