

**FREEZE PROBABILITIES
IN VIRGINIA,
AND
PROTECTION
PRACTICES**

Research Report 119

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Freeze Probabilities in Virginia, and Protection Practices

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This report on the climate in Virginia provides probabilities of the last occurrence in spring and the first occurrence in fall of critically low temperatures in 50 localities distributed throughout the state of Virginia.

The occurrence of freezing temperatures of various degrees of severity may affect many economic interests, but none is more vitally affected than agriculture. The information given in this publication is intended to advise farm operators, orchardists, nurserymen, florists, commercial vegetable growers, and home gardeners of the relative risk to be expected from the occurrence of certain specified low temperature levels based on a weather history of 30 years. This information should also be of value to transportation, commerce, recreation, and similar industries which must cope with weather and to the individual interested in natural variation in weather patterns.

Explanation of Maps and Tables

The table presents data for 50 locations distributed over the Coastal Plain, Piedmont, Blue Ridge Mountain, and Allegheny Mountain regions. The data is given for 5 critical temperature levels of 32, 28, 24, 20, and 16^oF. A freeze is defined as a temperature at or below one of the critical levels. The locations for which these data are given are arranged alphabetically within the state, rather than by regions.

Figure 1 shows a map of the geographical distribution of the 50 stations used in this study. The number plotted next to the station is its elevation in feet. Elevation is one of the critical factors affecting spring and fall temperatures. All of the locations are stations in the Climatological Network of the U. S. Weather Bureau. For convenience, low temperatures between January 1 and June 30 were considered spring freezes; and those between July 1 and December 31 were considered fall freezes. Blank spaces in the table indicate that there was no probability of occurrence for that date.

The tabular presentation of freeze probabilities is a most useful part of this report. The table gives the probabilities of a 32, 28, 24, 20, and 16^oF. freeze occurring after the tabulated date in spring and before the tabulated date in fall.

Using Probability Dates in the Tables

To understand the significance of these probability dates, it should be understood that the dates given in Table 1 correspond to several percentages of probabilities given. For example, at Ashland, Virginia, the probability

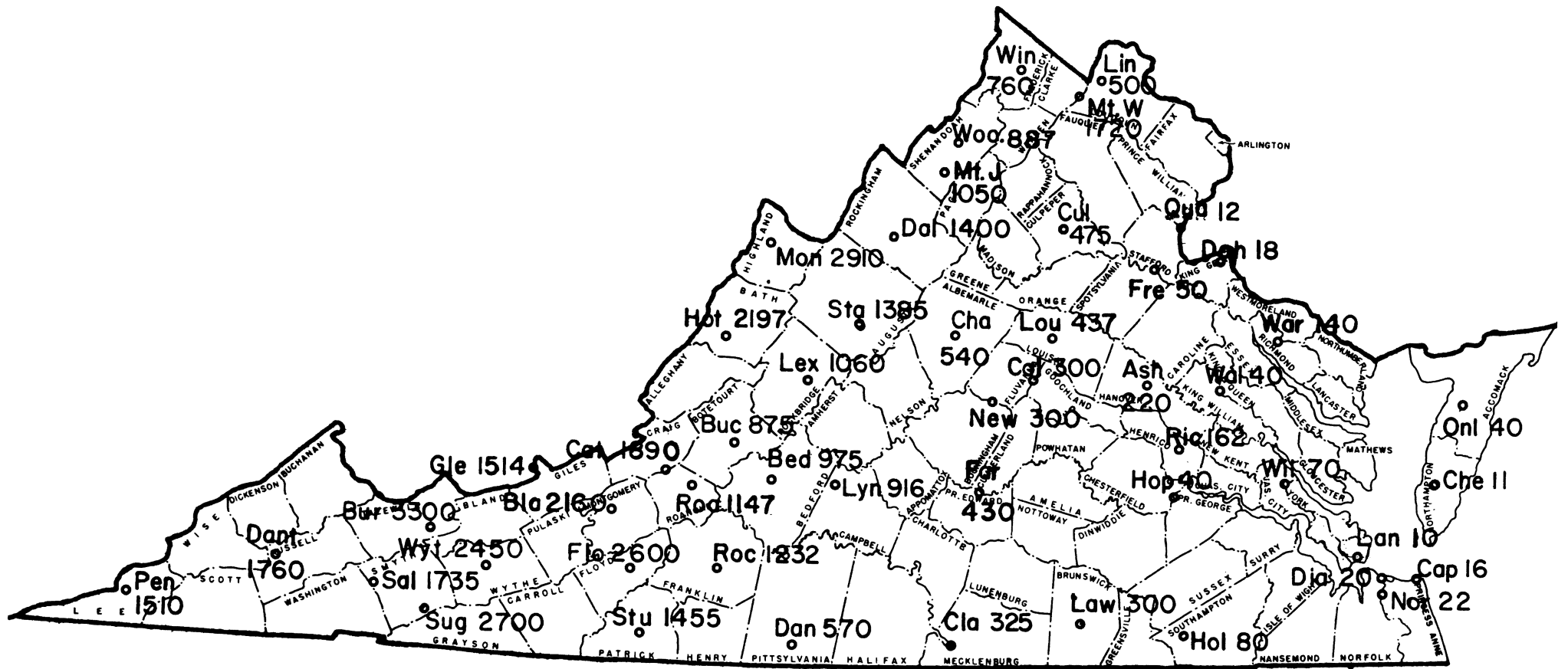


Figure 1. Station location and altitudes.

that 32°F. will occur after April 15 in the spring is 90%. This means that we may expect the occurrence of a 32°F. temperature as late as April 15 in 9 out of 10 years. However, for the date of May 13, almost a month later, we may expect the last occurrence of 32°F. only 1 time in 10 years. In the same manner, it may be said that a 16°F. minimum temperature may be expected as late as March 8 in 4 out of 10 years. This is based on the fact that in the last 30 years, it occurred in 4 out of 10 years, or 40% of the time.

By means of the table, the user of this report can estimate the risk of the last spring and first critically low fall temperatures for a particular locality. For example, planning for seedling emergence as early as the 80% date involves a high risk since there remain 8 chances out of 10 that the temperature will drop to that temperature or below after that date. Waiting until the 20% date will change the probability of freezing to 2 chances in 10. A vegetable farmer may wish to plant an early crop that can be sold at a higher price than a later crop. He may want to plant early to avoid possible yield reduction from summer heat or drought. The risk of low temperature injury to the crop must also be considered. By consulting Table 1, he can choose the risk he wishes to take.

In the fall, the first occurrence of low temperature is the subject of concern. The order of probability is reversed in order to show the increasing risk of occurrence as the season progresses. The increasing risk of delaying an operation for which low temperatures are critical may be evaluated in a similar manner. If the first occurrence of 24°F. is important, then one can estimate the future risk based on past records to predict the date when that event becomes a serious risk. In both seasons, the user of this report should be able to plan those activities which are limited by low temperature with a better understanding of the probabilities than if he only knew the average or 50% probability date.

Those wanting information for locations not listed in the tables should make a careful examination of data for nearby points. In some cases, it may be advisable to use a station similar in altitude although another one may be closer. Also data for cities should not be applied in rural areas because of warmer city temperatures.

Data in these tables are primarily for long-range planning. The daily weather forecast is the best guide to expected temperatures for the immediate future.

Geographical and Local Influences

Because of its broad geographic distribution extending from the Appalachian Mountains to the Atlantic Ocean, Virginia has a great deal of variation from one locale to another in dates of the last freeze in spring and the first in fall. The freeze-free period is 1 to 2 months longer in the Tidewater area than in the mountainous western regions.

Altitude difference is by far the greatest factor causing varying freeze dates between eastern and western parts of the State. In general, temperature decreases about 3° for each 1,000' of elevation increase. This effect is great enough so that several freezes occur each year at some of the higher mountain locations while temperatures are above freezing in the lower levels

The Atlantic Ocean, lower Chesapeake Bay, and estuaries of the Tidewater portion of the State exercise a pronounced moderating effect on the climate. Some localities in close proximity to these relatively warm bodies of water seldom have a severe freeze.

The general decrease of temperature with increase in latitude exerts a small, but still significant, influence on temperature. Other conditions being equal, the length of the freeze-free period becomes progressively shorter from south to north over the State.

The local variation of topography can cause quite large temperature differences over short distances during radiation freeze conditions. This is an entirely different effect from that of elevation discussed above. For example, cold air, which is heavier than warm, may settle in low places while higher locations nearby remain warmer. The low areas are sometimes called frost pockets. Since the cold air tends to flow downward along the ground surface, obstructions to air flow, like hedgerows and trees, may lessen the freeze hazard in valleys but tend to increase the danger of freeze above them. Topographical positions listed from lowest to highest radiation freeze danger are: (1) crests and upper parts of slopes, (2) plains and plateaus, (3) broad and flat valleys, (4) narrow, bending valleys, (5) closed troughs (3).

On a clear, calm night favorable for radiation freeze, the minimum temperature at the ground may be several degrees below that measured in an instrument shelter about 5' above the ground. This difference may be 6° or more. Under the same conditions, the temperatures at tree height will be higher than at the level of the thermometer shelter.

Statistical Treatment of Data

The dates of several probabilities of last freeze in spring and first in fall are shown in Table 1. This information is based upon available weather records at 50 locations in Virginia during the period 1921 through 1950.

The dates of last spring and first fall freezing temperatures have been shown to be random variables and their distribution follows the normal frequency curve (4). This makes probabilities of freeze dates comparatively easy to estimate by computing their means and standard deviations. In order to reduce sampling errors for a few stations with fewer than 30-year temperature records, variances were averaged for small groups of stations. This was done separately by physiographical sub-divisions and by temperature values, as well as separately for the spring and fall seasons, in order to minimize the risk of eliminating possible significant differences in variance.

Temperatures as low as some of the freeze levels used for this bulletin do not occur every year at some stations in Virginia. The data in these cases were considered as forming mixed distributions, and techniques developed by Thom (5) were used to combine the series of freeze and freezeless years.

The calendar dates of 10%, 20%, 40%, 60%, 80%, and 90% probabilities of the last spring and first fall occurrence of temperatures below or equal to 32° , 28° , 24° , and 16° were computed by the methods described above.

TABLE I. PROBABILITY OF FREEZING TEMPERATURES FOR FIFTY LOCALITIES ON OR AFTER INDICATED DATES IN THE SPRING AND ON OR BEFORE INDICATED DATES IN THE FALL

Station	Temp (F)	Probability -- Spring						Frost Free Days	Probability -- Fall					
		90%	80%	60%	40%	20%	10%		10%	20%	40%	60%	80%	90%
Ashland	32	Apr 15	Apr 20	Apr 26	May 2	May 8	May 13	171	Oct 4	Oct 9	Oct 14	Oct 20	Oct 25	Oct 30
	28	Mar 25	Mar 31	Apr 8	Apr 15	Apr 22	Apr 28		Oct 16	Oct 21	Oct 27	Nov 2	Nov 9	Nov 13
	24	Mar 14	Mar 20	Mar 28	Apr 5	Apr 13	Apr 19		Oct 28	Nov 2	Nov 8	Nov 14	Nov 20	Nov 25
	20	Mar 2	Mar 9	Mar 19	Mar 27	Apr 6	Apr 13		Nov 5	Nov 10	Nov 17	Nov 23	Nov 30	Dec 5
	16	---	Feb 11	Feb 26	Mar 8	Mar 20	Mar 29		Nov 14	Nov 20	Nov 28	Dec 5	Dec 16	---
Bedford	32	Apr 8	Apr 13	Apr 20	Apr 26	May 3	May 8	176	Oct 2	Oct 7	Oct 13	Oct 19	Oct 25	Oct 30
	28	Mar 21	Mar 28	Apr 6	Apr 14	Apr 23	Apr 30		Oct 14	Oct 20	Oct 28	Nov 3	Nov 11	Nov 17
	24	Mar 9	Mar 16	Mar 25	Apr 2	Apr 11	Apr 18		Oct 26	Nov 1	Nov 8	Nov 14	Nov 21	Nov 27
	20	Feb 14	Feb 22	Mar 5	Mar 15	Mar 26	Apr 3		Nov 13	Nov 18	Nov 25	Dec 1	Dec 8	Dec 13
	16	Feb 3	Feb 11	Feb 22	Mar 4	Mar 15	Mar 23		Nov 23	Nov 28	Dec 5	Dec 11	Dec 18	Dec 23
Blacksburg	32	Apr 15	Apr 20	Apr 27	May 3	May 10	May 15	164	Sep 26	Oct 1	Oct 7	Oct 13	Oct 19	Oct 24
	28	Apr 1	Apr 7	Apr 16	Apr 22	May 1	May 7		Oct 7	Oct 12	Oct 19	Oct 25	Oct 31	Nov 6
	24	Mar 13	Mar 19	Mar 28	Apr 5	Apr 14	Apr 20		Oct 19	Oct 25	Nov 3	Nov 11	Nov 20	Nov 26
	20	Feb 28	Mar 7	Mar 17	Mar 25	Apr 4	Apr 11		Nov 1	Nov 8	Nov 18	Nov 26	Dec 6	Dec 13
	16	Feb 9	Feb 16	Feb 27	Mar 7	Mar 18	Mar 25		Nov 12	Nov 19	Nov 30	Dec 8	Dec 19	Dec 26
Buchanan	32	Apr 12	Apr 17	Apr 23	Apr 29	May 5	May 10	173	Oct 4	Oct 8	Oct 14	Oct 20	Oct 26	Oct 30
	28	Mar 26	Apr 1	Apr 8	Apr 14	Apr 21	Apr 27		Oct 14	Oct 19	Oct 25	Oct 31	Nov 6	Nov 11
	24	Mar 2	Mar 9	Mar 18	Mar 26	Apr 4	Apr 11		Oct 26	Oct 31	Nov 7	Nov 13	Nov 21	Nov 27
	20	Feb 12	Feb 20	Mar 3	Mar 13	Mar 24	Apr 1		Nov 8	Nov 14	Nov 22	Nov 28	Dec 6	Dec 12
	16	Feb 2	Feb 10	Feb 21	Mar 3	Mar 14	Mar 22		Nov 21	Nov 27	Dec 4	Dec 11	Dec 21	Dec 31
Burkes Garden	32	May 1	May 6	May 13	May 19	May 26	May 31	136	Sep 15	Sep 20	Sep 26	Oct 2	Oct 8	Oct 13
	28	Apr 17	Apr 23	May 2	May 8	May 17	May 23		Sep 23	Sep 28	Oct 5	Oct 11	Oct 18	Oct 23
	24	Apr 1	Apr 7	Apr 16	Apr 24	May 3	May 9		Sep 30	Oct 5	Oct 13	Oct 19	Oct 27	Nov 1
	20	Mar 18	Mar 25	Apr 4	Apr 12	Apr 22	Apr 20		Oct 12	Oct 18	Oct 26	Nov 3	Nov 11	Nov 17
	16	Feb 25	Mar 4	Mar 15	Mar 23	Apr 2	Apr 10		Oct 30	Nov 5	Nov 13	Nov 19	Nov 27	Dec 3
Cape Henry* WB City	32	Feb 27	Mar 5	Mar 13	Mar 19	Mar 27	Apr 2	258	Nov 13	Nov 19	Nov 26	Dec 2	Dec 11	Dec 19
	28	Feb 13	Feb 20	Feb 28	Mar 8	Mar 16	Mar 23		Nov 25	Nov 30	Dec 7	Dec 14	Dec 27	---
	24	Jan 11	Jan 19	Jan 28	Feb 13	Feb 22	Feb 28		Dec 3	Dec 9	Dec 18	---	---	---
	20	---	---	Jan 6	Feb 1	Feb 13	Feb 22		Dec 13	Dec 24	---	---	---	---
	16	---	---	---	---	Jan 29	Feb 12		---	---	---	---	---	---

* Urban or near urban station which may not be representative of open country conditions.

Catawba	32	Apr 8	Apr 13	Apr 19	Apr 25	May 1	May 6	181	Oct 8	Oct 12	Oct 18	Oct 24	Oct 30	Nov 3
	28	Mar 20	Mar 26	Apr 2	Apr 8	Apr 15	Apr 21		Oct 21	Oct 26	Nov 1	Nov 7	Nov 13	Nov 18
	24	Mar 4	Mar 11	Mar 20	Mar 28	Apr 6	Apr 13		Nov 2	Nov 7	Nov 14	Nov 20	Nov 27	Dec 2
	20	Feb 20	Feb 27	Mar 8	Mar 16	Mar 25	Apr 1		Nov 13	Nov 18	Nov 26	Dec 3	Dec 11	Dec 18
	16	Feb 7	Feb 15	Feb 25	Mar 5	Mar 15	Mar 23		Nov 20	Nov 26	Dec 4	Dec 10	Dec 20	Dec 31
Charlottes- ville	32	Mar 27	Apr 1	Apr 8	Apr 14	Apr 21	Apr 26	210	Oct 23	Oct 28	Nov 3	Nov 9	Nov 15	Nov 20
	28	Mar 5	Mar 12	Mar 21	Mar 20	Apr 7	Apr 14		Nov 2	Nov 8	Nov 16	Nov 22	Nov 20	Dec 6
	24	Feb 21	Feb 28	Mar 9	Mar 17	Mar 26	Apr 2		Nov 12	Nov 18	Nov 25	Dec 1	Dec 8	Dec 14
	20	Feb 6	Feb 14	Feb 25	Mar 7	Mar 18	Mar 26		Nov 24	Nov 29	Dec 6	Dec 13	Dec 22	Dec 31
	16	Jan 23	Feb 2	Feb 13	Feb 23	Mar 6	Mar 14		Nov 30	Dec 6	Dec 14	Dec 24	---	---
Cheriton	32	Mar 12	Mar 18	Mar 26	Apr 1	Apr 9	Apr 15	231	Oct 31	Nov 5	Nov 12	Nov 18	Nov 25	Nov 30
	28	Feb 26	Mar 5	Mar 13	Mar 21	Mar 29	Apr 5		Nov 17	Nov 22	Nov 28	Dec 4	Dec 10	Dec 15
	24	Feb 10	Feb 17	Feb 25	Mar 5	Mar 13	Mar 20		Nov 26	Dec 2	Dec 11	Dec 22	---	---
	20	---	---	Jan 30	Feb 9	Feb 20	Feb 27		Dec 10	Dec 17	---	---	---	---
	16	---	---	---	Jan 19	Feb 6	Feb 16		Dec 26	---	---	---	---	---
Clarks- ville	32	Mar 28	Apr 2	Apr 8	Apr 14	Apr 20	Apr 25	194	Oct 9	Oct 14	Oct 19	Oct 25	Oct 30	Nov 4
	28	Mar 9	Mar 15	Mar 23	Mar 20	Apr 6	Apr 12		Oct 18	Oct 23	Oct 29	Nov 4	Nov 10	Nov 15
	24	Feb 23	Mar 1	Mar 9	Mar 15	Mar 23	Mar 29		Nov 1	Nov 6	Nov 12	Nov 18	Nov 24	Nov 29
	20	Feb 7	Feb 14	Feb 24	Mar 4	Mar 14	Mar 21		Nov 15	Nov 20	Nov 27	Dec 3	Dec 11	Dec 20
	16	Jan 21	Jan 30	Feb 11	Feb 20	Mar 2	Mar 10		Nov 22	Nov 28	Dec 6	Dec 14	Dec 25	---
Columbia	32	Apr 11	Apr 16	Apr 22	Apr 28	May 4	May 9	175	Oct 4	Oct 9	Oct 14	Oct 20	Oct 25	Oct 30
	28	Mar 23	Mar 29	Apr 6	Apr 12	Apr 20	Apr 26		Oct 6	Oct 8	Oct 17	Oct 23	Oct 29	Nov 3
	24	Mar 9	Mar 15	Mar 23	Mar 29	Apr 6	Apr 12		Oct 29	Nov 3	Nov 9	Nov 15	Nov 21	Nov 26
	20	Feb 19	Feb 26	Mar 8	Mar 16	Mar 26	Apr 2		Nov 7	Nov 12	Nov 19	Nov 25	Dec 2	Dec 7
	16	Feb 7	Feb 15	Feb 26	Mar 6	Mar 17	Mar 25		Nov 18	Nov 24	Dec 2	Dec 9	Dec 17	Dec 27
Culpeper	32	Apr 8	Apr 13	Apr 18	Apr 24	Apr 29	May 4	184	Oct 9	Oct 13	Oct 19	Oct 25	Oct 31	Nov 4
	28	Mar 18	Mar 24	Apr 1	Apr 7	Apr 15	Apr 21		Oct 18	Oct 23	Oct 30	Nov 5	Nov 12	Nov 17
	24	Mar 1	Mar 8	Mar 16	Mar 24	Apr 1	Apr 8		Nov 1	Nov 6	Nov 13	Nov 19	Nov 26	Dec 1
	20	Feb 16	Feb 23	Mar 4	Mar 16	Mar 21	Mar 28		Nov 8	Nov 14	Nov 22	Nov 30	Dec 8	Dec 14
	16	Feb 7	Feb 15	Feb 25	Mar 5	Mar 15	Mar 23		Nov 25	Nov 30	Dec 7	Dec 13	Dec 21	Dec 29
Dahlgren	32	Mar 17	Mar 23	Mar 31	Apr 6	Apr 14	Apr 20	222	Oct 27	Nov 1	Nov 8	Nov 14	Nov 21	Nov 26
	28	Mar 1	Mar 8	Mar 16	Mar 24	Apr 1	Apr 8		Nov 8	Nov 13	Nov 19	Nov 25	Dec 1	Dec 6
	24	Feb 17	Feb 28	Mar 4	Mar 12	Mar 20	Mar 27		Nov 15	Nov 20	Nov 27	Dec 4	Dec 13	Dec 31
	20	Feb 3	Feb 11	Feb 21	Mar 1	Mar 11	Mar 18		Nov 25	Nov 30	Dec 6	Dec 16	---	---
	16	---	---	Jan 22	Feb 10	Feb 22	Mar 5		Dec 5	Dec 11	Dec 21	---	---	---

TABLE 1 CONT'D. PROBABILITY OF FREEZING TEMPERATURES FOR FIFTY LOCALITIES ON OR AFTER INDICATED DATES IN THE SPRING AND ON OR BEFORE INDICATED DATES IN THE FALL

Station	Temp (°F)	Probability -- Spring						Frost Free Days	Probability -- Fall					
		90%	80%	60%	40%	20%	10%		10%	20%	40%	60%	80%	90%
Dale Enter- prise	32	Apr 16	Apr 21	Apr 27	May 3	May 9	May 14	167	Oct 1	Oct 5	Oct 11	Oct 17	Oct 23	Oct 27
	28	Apr 1	Apr 7	Apr 14	Apr 20	Apr 27	May 3		Oct 14	Oct 19	Oct 25	Oct 31	Nov 6	Nov 11
	24	Mar 14	Mar 21	Mar 30	Apr 7	Apr 16	Apr 23		Oct 25	Oct 30	Nov 6	Nov 12	Nov 19	Nov 24
	20	Feb 24	Mar 3	Mar 12	Mar 20	Mar 29	Apr 5		Oct 31	Nov 6	Nov 14	Nov 20	Nov 28	Dec 4
	16	Feb 13	Feb 21	Mar 3	Mar 11	Mar 21	Mar 29		Nov 19	Nov 24	Dec 1	Dec 7	Dec 14	Dec 19
Dante	32	Apr 18	Apr 23	Apr 30	May 6	May 13	May 18	162	Sep 28	Oct 3	Oct 9	Oct 15	Oct 21	Oct 26
	28	Mar 28	Apr 3	Apr 12	Apr 18	Apr 27	May 5		Oct 10	Oct 15	Oct 22	Oct 28	Nov 4	Nov 9
	24	Mar 14	Mar 20	Mar 29	Apr 6	Apr 15	Apr 21		Oct 23	Oct 28	Nov 5	Nov 11	Nov 19	Nov 24
	20	Feb 23	Mar 2	Mar 12	Mar 16	Mar 30	Apr 6		Nov 3	Nov 9	Nov 17	Nov 25	Dec 3	Dec 9
	16	Feb 11	Feb 18	Mar 1	Mar 9	Mar 20	Mar 27		Nov 14	Nov 20	Nov 28	Dec 5	Dec 14	Dec 24
Danville	32	Mar 26	Mar 31	Apr 7	Apr 13	Apr 20	Apr 25	198	Oct 12	Oct 17	Oct 23	Oct 29	Nov 4	Nov 9
	28	Mar 2	Mar 9	Mar 18	Mar 26	Apr 4	Apr 11		Oct 22	Oct 28	Nov 5	Nov 11	Nov 19	Nov 25
	24	Feb 16	Feb 23	Mar 4	Mar 12	Mar 21	Mar 28		Nov 7	Nov 13	Nov 20	Nov 26	Dec 3	Dec 9
	20	Jan 28	Feb 7	Feb 19	Mar 1	Mar 12	Mar 21		Nov 20	Nov 26	Dec 3	Dec 10	Dec 20	---
	16	---	Jan 16	Feb 6	Feb 18	Mar 2	Mar 11		Nov 27	Dec 2	Dec 11	Dec 21	---	---
Diamond Springs	32	Mar 10	Mar 16	Mar 24	Mar 30	Apr 7	Apr 13	234	Nov 2	Nov 7	Nov 14	Nov 20	Nov 27	Dec 2
	28	Feb 20	Feb 27	Mar 7	Mar 15	Mar 23	Mar 30		Nov 13	Nov 18	Nov 24	Nov 30	Dec 6	Dec 11
	24	Feb 6	Feb 14	Feb 24	Mar 3	Mar 12	Mar 19		Nov 27	Dec 2	Dec 9	Dec 17	Dec 30	---
	20	Jan 19	Jan 31	Feb 10	Feb 19	Feb 28	Mar 7		Dec 2	Dec 9	Dec 19	---	---	---
	16	---	---	---	Jan 29	Feb 14	Feb 24		Dec 21	Dec 31	---	---	---	---
Farmville	32	Apr 9	Apr 14	Apr 20	Apr 26	May 2	May 7	175	Oct 2	Oct 7	Oct 12	Oct 18	Oct 23	Oct 28
	28	Mar 23	Mar 29	Apr 6	Apr 12	Apr 20	Apr 26		Oct 14	Oct 19	Oct 25	Oct 31	Nov 6	Nov 11
	24	Mar 5	Mar 11	Mar 19	Mar 25	Apr 2	Apr 8		Oct 27	Nov 1	Nov 7	Nov 13	Nov 19	Nov 24
	20	Feb 23	Mar 2	Mar 12	Mar 20	Mar 30	Apr 6		Nov 9	Nov 14	Nov 21	Nov 27	Dec 4	Dec 9
	16	Feb 4	Feb 12	Feb 23	Mar 3	Mar 14	Mar 22		Nov 17	Nov 23	Nov 30	Dec 7	Dec 15	Dec 23
Floyd	32	Apr 13	Apr 18	Apr 25	May 1	May 8	May 13	167	Sep 28	Oct 3	Oct 9	Oct 15	Oct 21	Oct 26
	28	Mar 25	Mar 21	Apr 9	Apr 15	Apr 24	Apr 30		Oct 7	Oct 12	Oct 19	Oct 25	Nov 1	Nov 6
	24	Mar 13	Mar 19	Mar 28	Apr 5	Apr 14	Apr 20		Oct 22	Oct 27	Nov 4	Nov 10	Nov 18	Nov 23
	20	Mar 6	Mar 13	Mar 23	Mar 31	Apr 10	Apr 17		Nov 2	Nov 8	Nov 16	Nov 24	Dec 2	Dec 8
	16	Feb 19	Feb 26	Mar 9	Mar 17	Mar 28	Apr 4		Nov 14	Nov 20	Nov 28	Dec 4	Dec 12	Dec 18

Fredericks- burg	32	Apr 7	Apr 12	Apr 18	Apr 24	Apr 30	May 5	186	Oct 12	Oct 17	Oct 22	Oct 28	Nov 2	Nov 7
	28	Mar 19	Mar 25	Apr 2	Apr 8	Apr 16	Apr 22		Oct 20	Oct 25	Oct 31	Nov 6	Nov 12	Nov 17
	24	Mar 4	Mar 10	Mar 18	Mar 24	Apr 1	Apr 7		Nov 3	Nov 8	Nov 14	Nov 20	Nov 26	Dec 1
	20	Feb 17	Feb 24	Mar 6	Mar 14	Mar 24	Mar 31		Nov 14	Nov 19	Nov 26	Dec 2	Dec 9	Dec 14
	16	Feb 2	Feb 10	Feb 21	Mar 1	Mar 12	Mar 20		Nov 23	Nov 29	Dec 7	Dec 14	Dec 22	Dec 31
Glen Lyn	32	Apr 10	Apr 15	Apr 22	Apr 28	May 5	May 10	174	Oct 2	Oct 7	Oct 13	Oct 19	Oct 25	Oct 30
	28	Mar 22	Mar 28	Apr 6	Apr 12	Apr 21	Apr 27		Oct 17	Oct 22	Oct 29	Nov 4	Nov 11	Nov 16
	24	Mar 4	Mar 10	Mar 19	Mar 27	Apr 5	Apr 11		Oct 24	Oct 29	Nov 6	Nov 12	Nov 20	Nov 25
	20	Feb 20	Feb 27	Mar 9	Mar 17	Mar 27	Apr 3		Nov 5	Nov 11	Nov 19	Nov 27	Dec 5	Dec 11
	16	Feb 11	Feb 18	Mar 1	Mar 9	Mar 20	Mar 27		Nov 17	Nov 23	Dec 1	Dec 7	Dec 15	Dec 21
Holland	32	Apr 2	Apr 8	Apr 16	Apr 22	Apr 30	May 7	188	Oct 9	Oct 14	Oct 21	Oct 27	Nov 3	Nov 8
	28	Mar 13	Mar 20	Mar 28	Apr 5	Apr 13	Apr 20		Oct 28	Nov 2	Nov 8	Nov 14	Nov 20	Nov 25
	24	Feb 22	Mar 1	Mar 5	Mar 17	Mar 25	Apr 1		Nov 11	Nov 16	Nov 22	Nov 28	Dec 4	Dec 9
	20	Feb 10	Feb 17	Feb 26	Mar 6	Mar 15	Mar 22		Nov 22	Nov 27	Dec 4	Dec 10	Dec 17	Dec 25
	16	---	Jan 19	Feb 12	Feb 22	Mar 4	Mar 12		Dec 2	Dec 7	Dec 14	Dec 23	---	---
Hopewell	32	Mar 23	Mar 29	Apr 6	Apr 12	Apr 20	Apr 26	201	Oct 12	Oct 17	Oct 24	Oct 30	Nov 6	Nov 11
	28	Mar 7	Mar 14	Mar 22	Mar 30	Apr 7	Apr 14		Oct 29	Nov 3	Nov 9	Nov 15	Nov 21	Nov 26
	24	Feb 21	Feb 28	Mar 8	Mar 16	Mar 24	Mar 31		Nov 8	Nov 13	Nov 19	Nov 25	Dec 1	Dec 6
	20	Feb 7	Feb 14	Feb 23	Mar 3	Mar 12	Mar 19		Nov 23	Nov 28	Dec 5	Dec 11	Dec 19	Dec 27
	16	Jan 11	Jan 23	Feb 4	Feb 13	Feb 23	Mar 3		Dec 5	Dec 11	Dec 20	Dec 31	---	---
Hot Springs	32	Apr 23	Apr 28	May 4	May 10	May 16	May 21	156	Sep 26	Sep 30	Oct 6	Oct 12	Oct 18	Oct 22
	28	Apr 8	Apr 14	Apr 21	Apr 27	May 4	May 10		Oct 5	Oct 10	Oct 16	Oct 22	Oct 28	Nov 2
	24	Mar 20	Mar 27	Apr 5	Apr 13	Apr 22	Apr 29		Oct 17	Oct 22	Oct 29	Nov 4	Nov 11	Nov 16
	20	Mar 5	Mar 12	Mar 21	Mar 29	Apr 7	Apr 14		Oct 29	Nov 4	Nov 12	Nov 18	Nov 26	Dec 2
	16	Feb 15	Feb 23	Mar 5	Mar 13	Mar 23	Mar 31		Nov 13	Nov 18	Nov 25	Dec 2	Dec 10	Dec 16
Langley AF Base*	32	Mar 7	Mar 13	Mar 21	Mar 27	Apr 4	Apr 10	239	Nov 3	Nov 8	Nov 15	Nov 21	Nov 28	Dec 3
	28	Feb 17	Feb 24	Mar 4	Mar 12	Mar 20	Mar 28		Nov 13	Nov 20	Nov 26	Dec 2	Dec 8	Dec 13
	24	Feb 8	Feb 15	Feb 23	Mar 3	Mar 11	Mar 18		Nov 25	Nov 30	Dec 7	Dec 14	Dec 25	---
	20	Jan 21	Jan 29	Feb 8	Feb 16	Feb 26	Mar 5		Dec 3	Dec 10	Dec 20	---	---	---
	16	---	---	Jan 13	Feb 3	Feb 17	Feb 26		Dec 12	Dec 21	---	---	---	---
Lawrence- ville	32	Apr 9	Apr 14	Apr 20	Apr 26	May 2	May 7	180	Oct 6	Oct 11	Oct 16	Oct 22	Oct 27	Nov 1
	28	Mar 17	Mar 23	Mar 31	Apr 3	Apr 11	Apr 17		Oct 19	Oct 24	Oct 30	Nov 5	Nov 11	Nov 16
	24	Feb 28	Mar 6	Mar 14	Mar 20	Mar 28	Apr 3		Oct 30	Nov 4	Nov 10	Nov 16	Nov 22	Nov 27
	20	Feb 16	Feb 23	Mar 5	Mar 13	Mar 23	Mar 30		Nov 9	Nov 14	Nov 21	Nov 27	Dec 4	Dec 9
	16	Jan 31	Feb 9	Feb 21	Mar 2	Mar 12	Mar 20		Nov 23	Nov 29	Dec 6	Dec 13	Dec 21	Dec 28

* Urban or near urban station which may not be representative of open country conditions.

TABLE I CONT'D. PROBABILITY OF FREEZING TEMPERATURES FOR FIFTY LOCALITIES ON OR
AFTER INDICATED DATES IN THE SPRING AND ON OR BEFORE INDICATED DATES IN THE FALL

Station	Temp (°F)	Probability -- Spring						Frost Free Days	Probability -- Fall					
		90%	80%	60%	40%	20%	10%		10%	20%	40%	60%	80%	90%
Lexington	32	Apr 13	Apr 18	Apr 24	Apr 30	May 6	May 11	171	Oct 2	Oct 6	Oct 12	Oct 18	Oct 24	Oct 28
	28	Mar 23	Mar 29	Apr 5	Apr 11	Apr 18	Apr 24		Oct 15	Oct 20	Oct 26	Nov 1	Nov 7	Nov 12
	24	Mar 1	Mar 8	Mar 17	Mar 25	Apr 3	Apr 10		Oct 28	Nov 2	Nov 9	Nov 15	Nov 22	Nov 27
	20	Feb 15	Feb 22	Mar 3	Mar 11	Mar 20	Mar 27		Nov 8	Nov 14	Nov 22	Nov 28	Dec 6	Dec 12
	16	Feb 4	Feb 12	Feb 22	Mar 2	Mar 12	Mar 20		Nov 20	Nov 26	Dec 3	Dec 10	Dec 20	Dec 31
Lincoln	32	Apr 5	Apr 10	Apr 15	Apr 21	Apr 26	May 1	191	Oct 13	Oct 17	Oct 23	Oct 29	Nov 4	Nov 8
	28	Mar 21	Mar 27	Apr 4	Apr 10	Apr 18	Apr 24		Oct 22	Oct 27	Nov 3	Nov 9	Nov 16	Nov 21
	24	Mar 4	Mar 11	Mar 19	Mar 27	Apr 4	Apr 11		Nov 5	Nov 10	Nov 17	Nov 23	Nov 30	Dec 5
	20	Feb 20	Feb 27	Mar 8	Mar 16	Mar 25	Apr 1		Nov 16	Nov 22	Nov 30	Dec 8	Dec 16	Dec 22
	16	Feb 6	Feb 14	Feb 24	Mar 4	Mar 14	Mar 22		Nov 23	Nov 28	Dec 5	Dec 11	Dec 19	Dec 28
Louisa	32	Apr 16	Apr 21	Apr 27	May 3	May 9	May 14	167	Oct 1	Oct 6	Oct 11	Oct 17	Oct 22	Oct 27
	28	Apr 1	Apr 7	Apr 15	Apr 21	Apr 29	May 5		Oct 13	Oct 18	Oct 24	Oct 30	Nov 5	Nov 10
	24	Mar 17	Mar 23	Mar 31	Apr 6	Apr 14	Apr 20		Oct 26	Oct 31	Nov 6	Nov 12	Nov 18	Nov 23
	20	Feb 24	Mar 3	Mar 13	Mar 21	Mar 31	Apr 7		Nov 3	Nov 8	Nov 15	Nov 21	Nov 28	Dec 3
	16	Feb 10	Feb 18	Mar 1	Mar 9	Mar 20	Mar 28		Nov 16	Nov 21	Nov 29	Dec 5	Dec 13	Dec 18
Lynchburg* WB Airport	32	Mar 22	Mar 27	Apr 3	Apr 9	Apr 16	Apr 21	204	Oct 13	Oct 18	Oct 24	Oct 30	Nov 5	Nov 10
	28	Mar 1	Mar 8	Mar 17	Mar 25	Apr 3	Apr 10		Oct 24	Oct 30	Nov 7	Nov 13	Nov 21	Nov 27
	24	Feb 17	Feb 24	Mar 5	Mar 13	Mar 22	Mar 29		Nov 11	Nov 17	Nov 24	Nov 30	Dec 7	Dec 13
	20	Feb 3	Feb 11	Feb 22	Mar 4	Mar 15	Mar 23		Nov 20	Nov 25	Dec 2	Dec 9	Dec 18	Dec 31
	16	Jan 13	Jan 25	Feb 7	Feb 17	Feb 28	Mar 9		Nov 30	Dec 5	Dec 14	Dec 24	---	---
Mt. Jackson	32	Apr 12	Apr 17	Apr 22	Apr 28	May 3	May 8	169	Sep 28	Oct 2	Oct 8	Oct 14	Oct 20	Oct 24
	28	Apr 2	Apr 8	Apr 16	Apr 22	Apr 30	May 6		Oct 10	Oct 15	Oct 22	Oct 28	Nov 4	Nov 9
	24	Mar 16	Mar 23	Mar 31	Apr 8	Apr 16	Apr 23		Oct 28	Nov 2	Nov 9	Nov 15	Nov 22	Nov 27
	20	Mar 1	Mar 8	Mar 17	Mar 25	Apr 3	Apr 10		Nov 6	Nov 12	Nov 20	Nov 28	Dec 6	Dec 12
	16	Feb 13	Feb 21	Mar 3	Mar 11	Mar 21	Mar 29		Nov 19	Nov 24	Dec 1	Dec 8	Dec 16	Dec 28
Mt. Weather	32	Apr 10	Apr 15	Apr 20	Apr 26	May 1	May 6	180	Oct 10	Oct 14	Oct 20	Oct 26	Nov 1	Nov 5
	28	Mar 25	Mar 31	Apr 8	Apr 14	Apr 22	Apr 28		Oct 15	Oct 20	Oct 27	Nov 2	Nov 9	Nov 14
	24	Mar 6	Mar 13	Mar 21	Mar 29	Apr 6	Apr 13		Nov 4	Nov 9	Nov 16	Nov 22	Nov 29	Dec 4
	20	Feb 28	Mar 7	Mar 16	Mar 24	Apr 2	Apr 9		Nov 8	Nov 14	Nov 22	Nov 29	Dec 8	Dec 16
	16	Feb 18	Feb 26	Mar 8	Mar 16	Mar 26	Apr 3		Nov 22	Nov 27	Dec 4	Dec 10	Dec 18	Dec 27

* Urban or near urban station which may not be representative of open country conditions.

New Canton	32	Apr 11	Apr 16	Apr 22	Apr 28	May 3	May 8	176	Oct 5	Oct 10	Oct 15	Oct 21	Oct 26	Oct 31
	28	Mar 24	Mar 30	Apr 7	Apr 13	Apr 21	Apr 27		Oct 14	Oct 19	Oct 25	Oct 31	Nov 6	Nov 11
	24	Mar 9	Mar 15	Mar 23	Mar 29	Apr 6	Apr 12		Oct 25	Oct 30	Nov 5	Nov 11	Nov 17	Nov 22
	20	Feb 19	Feb 26	Mar 8	Mar 16	Mar 26	Apr 2		Nov 4	Nov 9	Nov 16	Nov 22	Nov 29	Dec 4
	16	Feb 1	Feb 9	Feb 20	Feb 28	Mar 11	Mar 19		Nov 16	Nov 22	Nov 29	Dec 6	Dec 14	Dec 20
Norfolk* WB City	32	Mar 1	Mar 7	Mar 15	Mar 21	Mar 29	Apr 4	254	Nov 12	Nov 17	Nov 24	Nov 30	Dec 7	Dec 12
	28	Feb 15	Feb 22	Mar 2	Mar 10	Mar 18	Mar 25		Nov 20	Nov 25	Dec 2	Dec 9	Dec 19	---
	24	Feb 1	Feb 9	Feb 19	Feb 26	Mar 7	Mar 14		Dec 3	Dec 9	Dec 18	Dec 31	---	---
	20	---	Jan 1	Jan 30	Feb 9	Feb 19	Feb 27		Dec 15	Dec 24	---	---	---	---
	16	---	---	---	Jan 20	Feb 10	Feb 20		Dec 31	---	---	---	---	---
Onley	32	Mar 22	Mar 28	Apr 5	Apr 11	Apr 19	Apr 25	213	Oct 23	Oct 28	Nov 4	Nov 10	Nov 17	Nov 22
	28	Mar 6	Mar 13	Mar 21	Mar 29	Apr 6	Apr 13		Nov 5	Nov 10	Nov 16	Nov 22	Nov 28	Dec 3
	24	Feb 15	Feb 22	Mar 2	Mar 10	Mar 18	Mar 25		Nov 19	Nov 24	Dec 1	Dec 7	Dec 15	Dec 23
	20	Feb 1	Feb 9	Feb 19	Feb 27	Mar 9	Mar 16		Nov 27	Dec 3	Dec 11	Dec 21	---	---
	16	---	---	Jan 25	Feb 6	Feb 18	Feb 26		Dec 10	Dec 16	Dec 29	---	---	---
Pennington Gap	32	Apr 9	Apr 14	Apr 21	Apr 27	May 4	May 9	172	Sep 29	Oct 4	Oct 10	Oct 16	Oct 22	Oct 27
	28	Mar 26	Apr 1	Apr 10	Apr 16	Apr 25	May 1		Oct 13	Oct 18	Oct 25	Oct 31	Nov 7	Nov 12
	24	Mar 12	Mar 18	Mar 27	Apr 4	Apr 13	Apr 19		Oct 18	Oct 23	Nov 1	Nov 7	Nov 15	Nov 20
	20	Feb 17	Feb 24	Mar 6	Mar 14	Mar 24	Mar 31		Nov 2	Nov 8	Nov 16	Nov 24	Dec 2	Dec 8
	16	Feb 10	Feb 17	Feb 28	Mar 8	Mar 19	Mar 26		Nov 17	Nov 23	Dec 1	Dec 7	Dec 15	Dec 21
Quantico	32	Mar 23	Mar 29	Apr 6	Apr 13	Apr 20	Apr 26	207	Oct 18	Oct 23	Oct 30	Nov 5	Nov 12	Nov 17
	28	Mar 8	Mar 15	Mar 23	Mar 31	Apr 8	Apr 15		Nov 2	Nov 7	Nov 13	Nov 19	Nov 25	Nov 30
	24	Feb 20	Feb 27	Mar 7	Mar 15	Mar 23	Mar 30		Nov 10	Nov 15	Nov 21	Nov 27	Dec 3	Dec 8
	20	Feb 12	Feb 19	Feb 28	Mar 8	Mar 17	Mar 24		Nov 20	Nov 25	Dec 2	Dec 7	Dec 14	Dec 20
	16	Feb 2	Feb 9	Feb 19	Feb 27	Mar 9	Mar 16		Nov 30	Dec 5	Dec 12	Dec 18	Dec 31	---
Richmond* WB City	32	Mar 19	Mar 24	Mar 30	Apr 5	Apr 11	Apr 16	220	Oct 26	Oct 31	Nov 5	Nov 11	Nov 16	Nov 21
	28	Feb 28	Mar 6	Mar 14	Mar 20	Mar 28	Apr 3		Nov 7	Nov 12	Nov 18	Nov 24	Nov 30	Dec 5
	24	Feb 17	Feb 23	Mar 3	Mar 9	Mar 17	Mar 23		Nov 20	Nov 25	Dec 2	Dec 7	Dec 14	Dec 20
	20	Jan 31	Feb 9	Feb 19	Feb 27	Mar 9	Mar 16		Nov 26	Dec 1	Dec 8	Dec 16	Dec 29	---
	16	---	Jan 9	Jan 30	Feb 10	Feb 21	Mar 2		Dec 1	Dec 9	Dec 23	---	---	---

* Urban or urban station which may not be representative of open country conditions.

TABLE I CONT'D. PROBABILITY OF FREEZING TEMPERATURES FOR FIFTY LOCALITIES ON OR AFTER INDICATED DATES IN THE SPRING AND ON OR BEFORE INDICATED DATES IN THE FALL

Station	Temp (°F)	Probability -- Spring						Frost Free Days	Probability -- Fall					
		90%	80%	60%	40%	20%	10%		10%	20%	40%	60%	80%	90%
Roanoke * WB Airport	32	Apr 6	Apr 11	Apr 17	Apr 23	Apr 29	May 4	187	Oct 11	Oct 15	Oct 21	Oct 27	Nov 2	Nov 6
	28	Mar 18	Mar 24	Mar 31	Apr 6	Apr 13	Apr 19		Oct 19	Oct 24	Oct 30	Nov 5	Nov 11	Nov 16
	24	Feb 24	Mar 3	Mar 12	Mar 20	Mar 29	Apr 5		Nov 4	Nov 9	Nov 16	Nov 22	Nov 29	Dec 4
	20	Feb 10	Feb 17	Feb 26	Mar 6	Mar 15	Mar 22		Nov 18	Nov 24	Dec 1	Dec 8	Dec 16	Dec 23
	16	Jan 26	Feb 4	Feb 15	Feb 24	Mar 6	Mar 13		Nov 25	Dec 1	Dec 9	Dec 19	---	---
Rocky Mount	32	Apr 6	Apr 11	Apr 18	Apr 24	May 1	May 6	182	Oct 6	Oct 11	Oct 17	Oct 23	Oct 29	Nov 3
	28	Mar 13	Mar 20	Mar 29	Apr 6	Apr 15	Apr 22		Oct 17	Oct 23	Oct 31	Nov 6	Nov 14	Nov 20
	24	Feb 28	Mar 7	Mar 16	Mar 24	Apr 2	Apr 9		Nov 4	Nov 10	Nov 17	Nov 23	Nov 30	Dec 6
	20	Feb 10	Feb 18	Mar 1	Mar 10	Mar 22	Mar 30		Nov 13	Nov 18	Nov 25	Dec 1	Dec 8	Dec 13
	16	Jan 25	Feb 3	Feb 14	Feb 23	Mar 5	Mar 12		Nov 23	Nov 28	Dec 5	Dec 11	Dec 20	Dec 29
Saltville	32	Apr 4	Apr 9	Apr 16	Apr 22	Apr 29	May 4	186	Oct 8	Oct 13	Oct 19	Oct 25	Nov 1	Nov 6
	28	Mar 15	Mar 21	Mar 30	Apr 5	Apr 14	Apr 20		Oct 12	Oct 18	Oct 27	Nov 2	Nov 11	Nov 17
	24	Mar 1	Mar 7	Mar 16	Mar 24	Apr 2	Apr 8		Oct 25	Oct 31	Nov 9	Nov 17	Nov 26	Dec 2
	20	Feb 15	Feb 22	Mar 4	Mar 12	Mar 22	Mar 29		Nov 8	Nov 14	Nov 22	Nov 29	Dec 8	Dec 15
	16	Feb 2	Feb 9	Feb 20	Feb 28	Mar 11	Mar 18		Nov 17	Nov 23	Dec 2	Dec 10	Dec 22	---
Staunton	32	Apr 9	Apr 14	Apr 20	Apr 26	May 2	May 7	177	Oct 4	Oct 8	Oct 14	Oct 20	Oct 26	Oct 30
	28	Mar 22	Mar 28	Apr 4	Apr 10	Apr 20	Apr 26		Oct 17	Oct 22	Oct 28	Nov 3	Nov 9	Nov 14
	24	Mar 4	Mar 11	Mar 20	Mar 28	Apr 7	Apr 14		Oct 28	Nov 2	Nov 9	Nov 15	Nov 22	Nov 27
	20	Feb 20	Feb 27	Mar 8	Mar 16	Mar 25	Apr 1		Nov 8	Nov 14	Nov 22	Nov 28	Dec 6	Dec 12
	16	Feb 7	Feb 15	Feb 25	Mar 5	Mar 15	Mar 23		Nov 19	Nov 24	Dec 1	Dec 7	Dec 14	Dec 19
Stuart	32	Mar 31	Apr 5	Apr 12	Apr 18	Apr 25	Apr 30	193	Oct 11	Oct 16	Oct 22	Oct 28	Nov 3	Nov 8
	28	Mar 8	Mar 15	Mar 24	Apr 1	Apr 10	Apr 17		Oct 19	Oct 25	Nov 2	Nov 8	Nov 16	Nov 22
	24	Mar 1	Mar 8	Mar 17	Mar 25	Apr 3	Apr 10		Nov 4	Nov 10	Nov 17	Nov 23	Nov 30	Dec 6
	20	Feb 6	Feb 14	Feb 25	Mar 7	Mar 18	Mar 26		Nov 15	Nov 20	Nov 27	Dec 3	Dec 10	Dec 15
	16	---	Jan 29	Feb 14	Feb 25	Mar 9	Mar 17		Nov 23	Nov 28	Dec 6	Dec 13	Dec 23	---
Sugar Grove	32	Apr 21	Apr 26	May 3	May 9	May 16	May 21	146	Sep 15	Sep 20	Sep 26	Oct 2	Oct 8	Oct 13
	28	Apr 13	Apr 19	Apr 28	May 4	May 13	May 19		Sep 24	Sep 29	Oct 6	Oct 12	Oct 19	Oct 24
	24	Apr 2	Apr 8	Apr 17	Apr 25	May 4	May 10		Oct 11	Oct 16	Oct 24	Oct 30	Nov 7	Nov 12
	20	Mar 15	Mar 22	Apr 1	Apr 9	Apr 19	Apr 26		Oct 21	Oct 27	Nov 4	Nov 12	Nov 20	Nov 26
	16	Mar 8	Mar 15	Mar 26	Apr 3	Apr 14	Apr 21		Nov 4	Nov 10	Nov 18	Nov 24	Dec 2	Dec 8

* Urban or near urban station which may not be representative of open country conditions.

Walkerton	32	Apr 2	Apr 8	Apr 16	Apr 22	Apr 30	May 6	185	Oct 6	Oct 11	Oct 18	Oct 24	Oct 31	Nov 5
	28	Mar 12	Mar 19	Mar 27	Apr 4	Apr 12	Apr 19		Oct 20	Oct 25	Oct 31	Nov 6	Nov 12	Nov 17
	24	Mar 1	Mar 8	Mar 16	Mar 24	Apr 1	Apr 8		Nov 4	Nov 9	Nov 15	Nov 21	Nov 27	Dec 2
	20	Feb 16	Feb 23	Mar 4	Mar 12	Mar 21	Mar 28		Nov 12	Nov 17	Nov 23	Nov 29	Dec 5	Dec 10
	16	Feb 6	Feb 13	Feb 23	Mar 3	Mar 13	Mar 20		Nov 23	Nov 28	Dec 4	Dec 10	Dec 17	Dec 24
Warsaw	32	Apr 2	Apr 8	Apr 16	Apr 22	Apr 30	May 6	194	Oct 15	Oct 20	Oct 27	Nov 2	Nov 9	Nov 14
	28	Mar 12	Mar 19	Mar 27	Apr 4	Apr 12	Apr 19		Oct 25	Oct 30	Nov 5	Nov 11	Nov 17	Nov 22
	24	Feb 24	Mar 3	Mar 11	Mar 19	Mar 27	Apr 2		Nov 9	Nov 14	Nov 20	Nov 26	Dec 2	Dec 7
	20	Feb 14	Feb 21	Mar 2	Mar 10	Mar 19	Mar 26		Nov 18	Nov 23	Nov 30	Dec 6	Dec 13	Dec 21
	16	Feb 1	Feb 8	Feb 18	Feb 26	Mar 8	Mar 15		Nov 25	Dec 1	Dec 8	Dec 14	Dec 28	---
Williamsburg	32	Mar 31	Apr 6	Apr 14	Apr 20	Apr 28	May 3	194	Oct 13	Oct 18	Oct 25	Oct 31	Nov 7	Nov 12
	28	Mar 9	Mar 16	Mar 24	Apr 1	Apr 9	Apr 16		Oct 30	Nov 4	Nov 10	Nov 16	Nov 22	Nov 27
	24	Feb 24	Mar 3	Mar 11	Mar 19	Mar 27	Apr 3		Nov 12	Nov 17	Nov 23	Nov 29	Dec 5	Dec 10
	20	Feb 8	Feb 15	Feb 24	Mar 4	Mar 13	Mar 20		Nov 21	Nov 26	Dec 3	Dec 9	Dec 15	Dec 22
	16	Jan 23	Feb 1	Feb 12	Feb 21	Mar 3	Mar 10		Dec 1	Dec 6	Dec 12	Dec 22	---	---
Winchester	32	Apr 6	Apr 11	Apr 16	Apr 22	Apr 27	May 2	186	Oct 9	Oct 13	Oct 19	Oct 25	Oct 31	Nov 4
	28	Mar 21	Mar 27	Apr 4	Apr 10	Apr 18	Apr 24		Oct 21	Oct 26	Nov 2	Nov 8	Nov 15	Nov 20
	24	Mar 3	Mar 10	Mar 18	Mar 26	Apr 3	Apr 10		Nov 5	Nov 10	Nov 17	Nov 23	Nov 30	Dec 5
	20	Feb 19	Feb 26	Mar 7	Mar 15	Mar 24	Mar 31		Nov 10	Nov 16	Nov 24	Dec 2	Dec 10	Dec 16
	16	Feb 7	Feb 15	Feb 25	Mar 5	Mar 15	Mar 23		Nov 24	Nov 29	Dec 6	Dec 13	Dec 22	Dec 31
Woodstock	32	Apr 13	Apr 18	Apr 23	Apr 29	May 4	May 9	170	Sep 30	Oct 4	Oct 10	Oct 16	Oct 22	Oct 26
	28	Mar 25	Mar 31	Apr 8	Apr 14	Apr 22	Apr 28		Oct 15	Oct 20	Oct 27	Nov 2	Nov 9	Nov 14
	24	Mar 5	Mar 12	Mar 20	Mar 28	Apr 5	Apr 12		Oct 28	Nov 2	Nov 9	Nov 15	Nov 22	Nov 27
	20	Feb 20	Feb 27	Mar 8	Mar 16	Mar 25	Apr 1		Nov 9	Nov 15	Nov 23	Dec 1	Dec 9	Dec 15
	16	Feb 10	Feb 18	Feb 28	Mar 8	Mar 18	Mar 26		Nov 22	Nov 27	Dec 4	Dec 10	Dec 17	Dec 22
Wytheville	32	Apr 7	Apr 12	Apr 19	Apr 25	May 2	May 7	177	Oct 2	Oct 7	Oct 13	Oct 19	Oct 25	Oct 30
	28	Mar 20	Mar 26	Apr 4	Apr 10	Apr 19	Apr 25		Oct 14	Oct 19	Oct 26	Nov 1	Nov 8	Nov 13
	24	Mar 5	Mar 11	Mar 20	Mar 28	Apr 6	Apr 12		Oct 27	Nov 1	Nov 9	Nov 15	Nov 23	Nov 28
	20	Feb 16	Feb 23	Mar 5	Mar 13	Mar 23	Mar 30		Nov 8	Nov 14	Nov 22	Nov 29	Dec 8	Dec 15
	16	Feb 4	Feb 11	Feb 22	Mar 2	Mar 13	Mar 20		Nov 19	Nov 25	Dec 4	Dec 12	Dec 24	---

CROP LOSSES RESULTING FROM FREEZING TEMPERATURES

Every nurseryman, orchardist, and truck farmer who has grown crops in regions where freezing temperatures occur has experienced economic losses resulting from low temperature injury to the crops. This may occur in fall, winter, or spring. Thus, there is a risk involved in growing crops which are threatened by frost and freezing temperatures. There are 4 practical ways to minimize this risk. One is to discontinue growing the high-risk crops. Second, grow it when the danger of freeze is not so great. Third, the high-risk crop may be grown on lands which are not subject to as much low temperature hazard. Fourth, the crop can be grown with some man-made protection.

The average number of days between killing freeze in spring and fall for the standard 30 year record is quite stable and is called the mean growing season. The year to year variation of freeze-dates and growing season is surprisingly large, however, and since crop production for a season depends not on the average but on that season, large annual variation may occur on a farm, county, or even a region. Variations among farms, counties, and regions in the individual year may also be large. Thus, probabilities of freeze on dates other than the average date for the 50 locations given in this publication show estimates of the variability that exists.

Variation in occurrence of crop damage is further complicated by the type of crop and its physiological stage of development. Some plants are damaged by 31° F. while others are more resistant to low temperatures. For the individual plant part, injury by freezing occurs when the protoplasm coagulates or changes in some way that is not reversible. Thus, the cells and tissues die and growth ceases (1).

Many people who are concerned with freezing injury to plants associate the appearance of frost in the form of ice crystals on the surface of the leaf with a visible sign of plant injury. This is not the case with freeze resistant varieties or parts of plants in the normal season. On the other hand, low temperature damage can take place without any white frost at all. This occurs when the air is dry enough at 31° F. so that no moisture condenses on the leaf. The dew point has not been reached for the air below freezing point. Freezing which occurs under these relatively dry conditions is called "black frost." It was probably so named because of the absence of a visible white deposit and also because damaged leaves developed a dark color within a few hours after the low temperature injury (2).

A few observations of this kind of injury will lead the grower to conclude that the accumulation of white frost crystals is not a true indication of the severity of plant damage. It is the low temperature of the plant part that causes the injury, not the size or duration of the white frost deposit. The extent of the injury is determined by several factors: (1) the lowest temperature reached, (2) the duration of the low temperature, (3) the rate of temperature change, (4) the kind of plant, (5) the growth status of that plant, and (6) probably other factors such as soil moisture (1).

FREEZE PROTECTION PRACTICES

There are several weather conditions in spring and fall seasons which produce the need for some type of freeze protection. (1) The radiation freeze occurs at night when the earth's surface and adjacent air are cooled below freezing. This can be accomplished whenever the earth's surface suffers a net loss of heat due to terrestrial radiation. Clear skies, low air humidities, low wind speeds, and relatively dry soils all favor the occurrence of radiation freezes. (2) The advection freeze occurs when a mass of cold air moves over the area following a storm system. Increased wind makes protection difficult. (3) A combination of the two occurs when a cold air mass moves over the land and then the sky becomes clear and heat is lost to outer space. This can result in a severe first freeze.

The principal methods of protection against freezing injury are: (1) temporary small covers such as hot caps, and larger structures such as lath houses, (2) space heaters, (3) wind machines causing horizontal or vertical air movement, and (4) overhead or flood irrigation.

One way to protect plants is to cover them. The covering reflects the heat that radiates upwards back toward the plant. Individual covers may be used over each plant--such as a sheet of newspaper over a tomato plant--or the entire field may be covered. The cover may be almost any material that will reflect or interrupt the long wave-length radiation from the relatively warm earth to cold outer space. Paper, cloth, wooden or metal lath, plastic film, and glass have been used successfully to protect plants. (1)

The cost of this applied material is sometimes greater than the crop return when whole fields are considered. Thus, the dollar value of the risk to be taken must be compared to the cost of protection. If the cover must be put on each evening and removed each morning, the labor involved is often excessive, especially if the danger period is longer than 10 days. Crop damage from breakage must also be considered when field protection is moved twice daily.

The use of cut native vegetation or brush is a technique that gives partial protection from radiation to the north sky and winds. Branches are placed on the north side of the plant, leaving the south side exposed to the sun. These act as small, temporary wind breaks.

More permanent structures can also be used as radiation shields. Lath houses and various types of glass and plastic covered structures can be used. The decision must be made as to whether to take the plants to the structure - for example, to dig blooming azaleas and move them into a barn - or to move the temporary portable plastic greenhouse to the field--such as over a field of tomatoes. Another possibility for intensive nursery crops is to have a permanent frame and to add or take away shade as it is needed.

A second method is to burn various materials in the open field or within the larger structure. Since heat distribution is a problem in the open field many small fires are more beneficial than a few larger fires. Wood, old tires, and fuel oil are commonly used to produce large amounts of inexpensive heat. Conventional oil stoves with flues running horizontally have been used to distribute heat in temporary structures. For small areas, 25-watt electric light bulbs are a convenient method. Several types of field heaters can be used. A simple one is a 5-gallon used food can with a sliding lid. As a heat producer, the salamander or return stack heater is more efficient and is also relatively clean if air vents are adjusted properly.

The spacing of open fires or oil burners depends on how much protection is needed. This in turn depends on the actual plant temperature and the amount of wind. There is always a temperature below which it is not economically feasible to protect by means of added heat. However, it is never known how low the temperature will be at the time heat treatment is started. For example, if oil stoves are lit at night when the soil surface temperature is 36^oF., the ultimate temperature for that night may be 28 or 26 or 24^oF. More heat is needed on colder nights. Thus, distance from heat source to plant parts becomes critical. More heaters are required along the outside of a field.

The third method of freeze protection is the wind machine. It is effective only when radiation cooling is the problem and is used to mix the warm air above with the colder air near the plants. Helicopters have been used to bring this warm air down to plant level. A horizontal blade on a tower will stir the air in a similar way, but the area affected by one rotor in one location is limited. Airplane propellers on a tower are also used to move and mix air in a temperature inversion. They range in size up to 100 h.p. and one unit may protect several acres (1).

It is possible to use several of these methods in combination. For example, field heaters are made more effective by wind machines. The heat is distributed over a wider area. Also heaters can be installed in temporary structures. This approaches the cost of a plastic film greenhouse.

Sprinkler irrigation is a fourth method of protection. It is convenient because the operator usually already owns the equipment and is familiar with its operation. Sprinklers are used primarily on low-growing crops such as strawberries because the ice mass that builds up on tree fruits may result in extensive branch breakage. The source of heat is the latent heat of fusion; that is, when water freezes, it releases energy which keeps the plant parts close to 32^oF. The heat source is the actual freezing water which releases 144 BTU's of heat per pound of water. Crops have been saved in a radiation type freeze by sprinklers when the air temperature was depressed to 25^oF. That amounts to 7^oF.

of protection. Higher pressure and smaller outlets give more desirable dispersion of water into smaller droplets of a fine spray. This aids in the distribution of water. In order to constantly cover the ice encrusted plant with water, a sprinkler revolution of at least one r.p.m. should be maintained. The sprinkler irrigation should be started in advance of actual freezing and should be continued in the morning until all ice is removed from the plants.

SUMMARY

This study of low temperature probabilities in Virginia includes an explanation of the map and tables, use of the probability dates of the tables, geographical and local influences on low temperature, and the method of statistical treatment of the data. It also includes a discussion of crop losses resulting from freezing temperatures and suggests practices for protecting crops from low temperature. The tables permit consideration of low temperature probabilities at 50 stations located throughout Virginia.

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