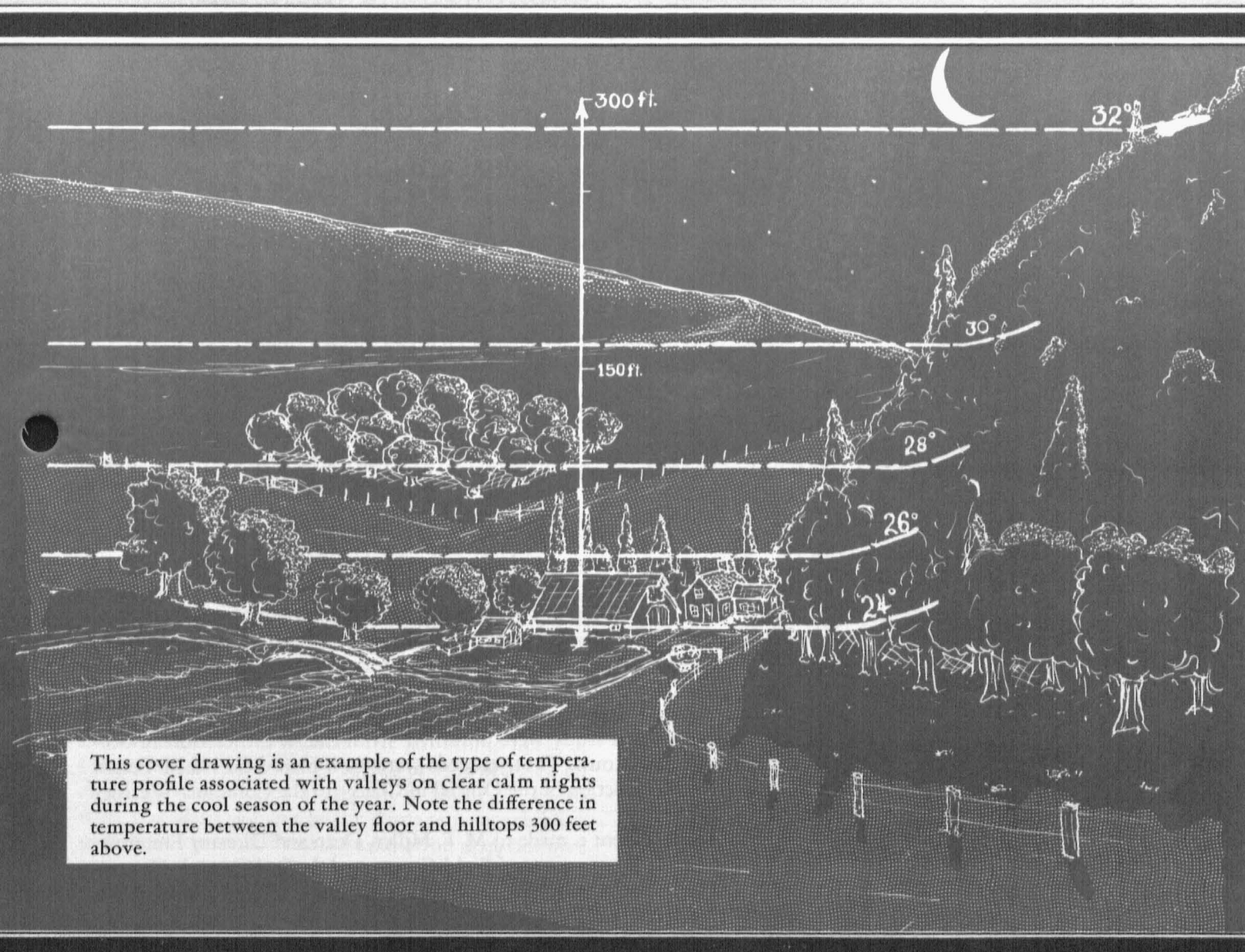
Late Spring and Early Fall Killing Freezes in Missouri

CLIMATIC ATLAS OF MISSOURI NO. 2



This cover drawing is an example of the type of temperature profile associated with valleys on clear calm nights during the cool season of the year. Note the difference in temperature between the valley floor and hilltops 300 feet above.

UNIVERSITY OF MISSOURI COLLEGE OF AGRICULTURE

AGRICULTURAL EXPERIMENT STATION

J. H. LONGWELL, *Director*

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CONTENTS

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Acknowledgment is made to M. F. Miller, Dean and Director Emeritus; J. M. Pohlman, Department of Field Crops; and A. D. Hibbard, Department of Horticulture; who are representing the Experiment Station in this cooperative investigation.

Late Spring and Early Fall Killing Freezes in Missouri

WAYNE L. DECKER

INTRODUCTION

Late fall and early spring freezing temperatures often cause plant injury. The injured plant tissue is recognized by a dark wilted appearance. Vegetation is not all injured to the same extent by the occurrence of below-freezing temperatures. The extent of injury depends upon how far below freezing the temperature drops, the length of time the temperature remains below freezing, the kind of plant, and the stage of development of the plant. Orchard and truck crop farmers have learned which of their crops are most susceptible to injury. For more information on this subject, the reader should consult a good gardening guide book or his county agricultural agent.

This Bulletin provides the producers of freeze-sensitive crops with information concerning late spring and early fall freezes. It describes the weather conditions most favorable for subfreezing temperatures, and will define the risks of late spring and early fall freezes. This information may be used in selecting garden and orchard sites, for recognition of weather conditions when protective measures should be used, and for planning operations to avoid needless hazards.

FREEZING TEMPERATURES AND PLANT INJURY

Plants are injured by freezing temperatures when ice crystals form within the plant tissues. The temperature within the tissue of sensitive plants must fall below the freezing point of the cell sap before injury will result. Since the freezing point of this liquid varies with the kind of plants and their stage of development, some plants can withstand lower temperatures than others.

The appearance of frost is often associated with plant injury. When ice crystals are observed on leaf surfaces, and plants are permanently injured, a killing frost is said to have occurred.

Low temperature injury to plants can occur in the absence of frost. That is, plant injury may result when temperatures fall below freezing during periods unfavorable for frost formation. The last killing freeze in central Missouri during the spring of 1953 occurred on April 17, when temperatures fell to about 28° F. No frost was observed, yet heavy damage to peach blossoms was reported. Frost accumulation does not give a clear definition of the extent of plant injury, since damage may result from below-freezing temperatures either in the absence or presence of frost. For this reason, the occurrence of below-freezing temperatures gives a better indication of the extent of injury than the appearance of frost. In an earlier publication,[1] temperature limits for three types of plant injury were described as follows:

Type of Freeze	*Temperature Limits*	*Type of Damage*
Light Freeze	28° to 32°	Little or no damage to most plants. Heavy damage to tender plants, and to semi-hardy plants in low lands.
Moderate Freeze	24° to 28°	Some damage to most plants. Heavy damage to fruit blossoms, tender and semi-hardy plants, particularly in low lands.
Severe Freeze	Less than 24°	Heavy damage to all plants.

FAVORABLE WEATHER CONDITIONS FOR LATE SPRING AND EARLY FALL FREEZES

Late spring and early fall freezing temperatures occur as the result of specific weather conditions. The recognition of these weather conditions by producers provides a basis for determining the need for protection against freeze damage.

In late spring and early fall, below-freezing temperatures occur only when air is moving over the

[1] "Probability of Killing Freezes in Missouri" by Wayne L. Decker, Missouri Agricultural Experiment Station, Bulletin 555, June, 1951.

central United States from Canada. Air movement from any other direction will not be cold enough to produce below freezing temperatures during this time of year. In late spring or early fall, the temperature of this cool Canadian air usually remains above freezing during the daylight hours but drops below freezing during the hours of darkness. In some cases, the Canadian air is so cold that freezing temperatures result in spite of the exposure, sky cover, or wind. The first prerequisite for freezing temperature is the presence of cool Canadian air over Missouri. Producers may be warned of such conditions by the Weather Bureau forecast. Forecasts which warn of "much cooler temperatures," "cold wave," "becoming cooler tonight," or "frost tonight" indicate the expected appearance of cool air over the area.

Danger Greater on Clear Night

Freezing temperatures are more likely to occur on clear nights. Fair skies permit the invisible heat waves, which are continuously leaving the earth's surface, to pass through the atmosphere. Each day a large amount of heat is lost from the soil and plant surfaces by these heat waves. Because of this loss of heat, the earth's surface and air near the surface cool on clear nights. The cooling process continues throughout the night with the lowest temperatures occurring near sunrise. If the air is sufficiently cool, below freezing temperatures will result.

When skies are overcast, the heat waves leaving the surface are returned by the cloud cover and heat is not lost from the surface. By this means, the cloud cover prevents the temperatures near the surface from falling and freezing temperatures are not likely to occur.

Wind May Reduce Hazard

Wind may prevent the occurrence of freezing temperatures. On clear nights, the temperature near the surface is cooler than the temperature a few feet above the surface. The wind mixes the cooler air near the surface with warmer air above it. This prevents cool air from accumulating within the plant cover, and below-freezing temperatures are not likely to be observed. One should remember that the speed of the wind is usually less at night than during the day. An afternoon breeze may die down during the night, and the mechanism for mixing the air may be lost. Producers of freeze sensitive plants should observe the wind after sundown before concluding that the wind will prevent the occurrence of freezing temperatures.

Cool Canadian air must be present over Missouri before late spring and early fall freezes will occur. If this air is so cool that its temperature is below freezing upon reaching Missouri, freeze damage will result even if the skies are cloudy and the wind is blowing. In most cases, the temperature of the air near the ground remains above freezing unless the surface is cooled. Clear skies and a near calm wind during the night will permit the temperatures near the surface to fall, and frost accumulation and the associated low temperature are often observed.

INFLUENCE OF ELEVATION AND SLOPE OF LAND ON THE OCCURRENCE OF FREEZING TEMPERATURES

Not all locations in an area have the same temperature. Temperatures are cooler in valleys than on the adjacent hillsides on clear, calm nights. Cool air, being more dense than warm air, moves down the slopes of hills, accumulating in the valleys. Due to the cooler valley temperatures, orchard and garden sites should be located on slopes. Because of less erosion and high soil fertility, truck gardens are often placed in lowlands; but is should be recognized that there is a greater risk of freeze damage in the valley location. On the front cover of this bulletin is an idealized sketch of the effect of a valley on night temperature.

With a large increase in elevation there is a decrease in temperature. If all other factors are the same, an area with a high elevation reports lower temperatures than one at a low elevation. The Ozark Plateau region of Missouri has a higher elevation than other sections of the state. This higher elevation causes cooler temperatures in the Ozark region than would be expected. Since the southeast lowlands of Missouri are 600 to 800 feet lower than the Ozark Plateau, this area may expect to be 3 to 4 degrees warmer than the upland regions. Similarly, central Missouri is some 400 feet lower than the Ozark Plateau. If both areas were at the same latitude, the temperatures in central Missouri would average nearly 2.5° F. warmer than on the Plateau. Below-freezing temperatures in late spring and early fall should occur as late or later in the Ozark region as in areas farther to the north.

SOURCE OF KILLING FREEZE DATA

Temperatures reported by weather stations in Missouri were used for determining the variability of the last spring and first fall killing freezes. Weather stations at 44 locations were selected to supply the necessary temperature information. These locations are shown in Figure 1.

A 38-year period was chosen to supply a cross section of the years of record. This base period extended from 1916 through 1953. The temperatures reported at each weather station were reviewed. The last dates of each type of spring freeze and first dates of each type of fall freeze were recorded.

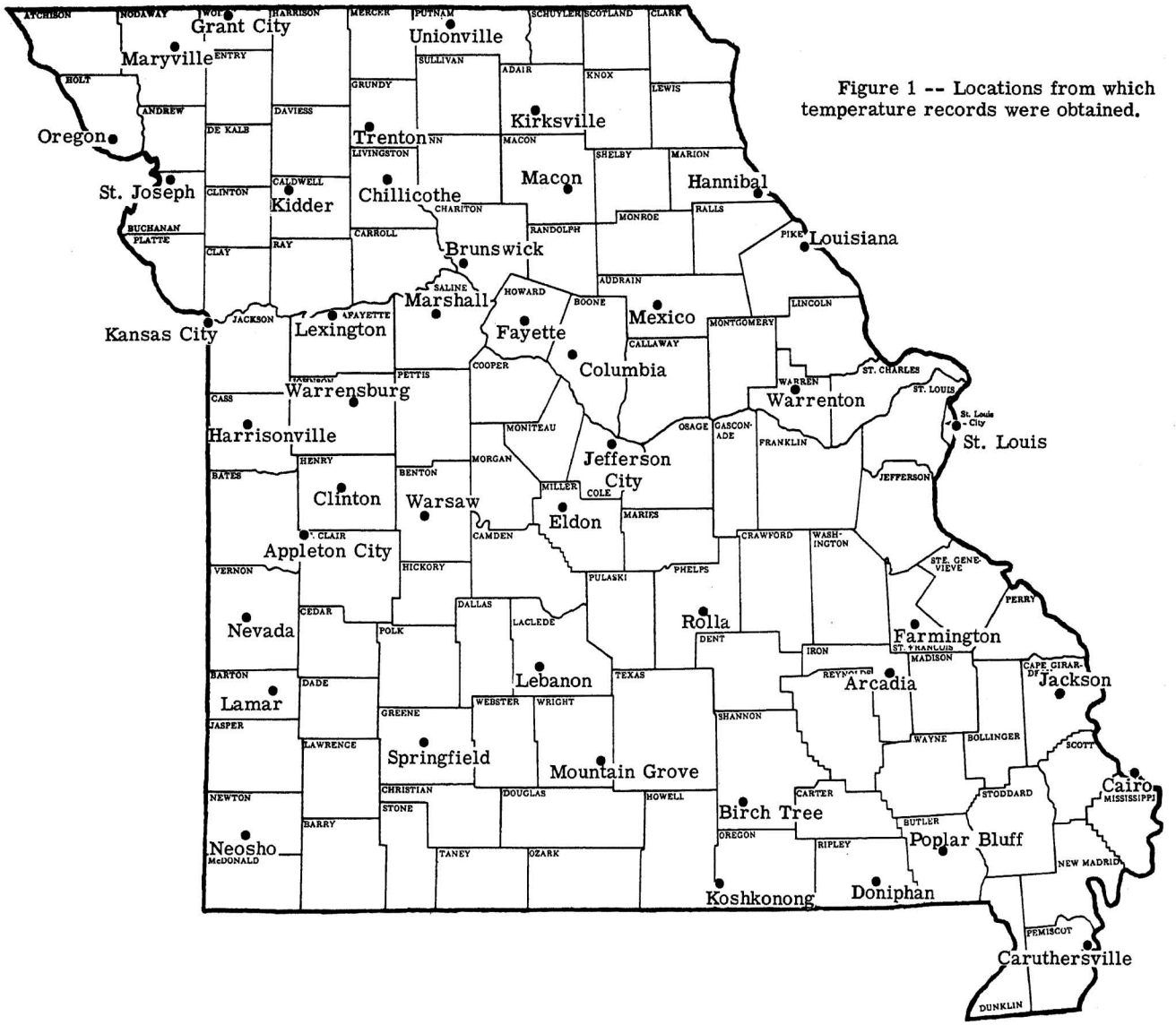

Figure 1 -- Locations from which temperature records were obtained.

EARLIEST AND LATEST DATES OF THE LAST SPRING AND FIRST FALL FREEZES

In Table 1 are listed for each location the dates of the earliest final light, moderate, and severe freezes in the spring. At Chillicothe, for example, there was no light freeze after March 29, 1941, no moderate freeze after March 11, 1946, and no severe freeze after March 4, 1942. The dates of the latest spring freezes during the 38-year period are also shown in Table 1. From this table it may be seen that the latest light freeze at Chillicothe occurred on May 25, 1925.

Table 1 shows that during the 38-year period there was a great difference between the dates of the earliest and latest final spring freezes. During some years, tender plants would have grown unhampered by freezing temperatures after early April, while in other years injury would have been sustained in late May. In general, there are 40 to 50 days between the dates of the earliest and latest final spring freezes.

The dates of the earliest and latest initial fall freezes on record are shown in Table 2. The growing season for tender plants was terminated in late September in a number of cases; while in other years it was continued until mid-November. Although in most cases the number of days between the earliest and latest initial fall freezes was 45 to 60 days, in southeast Missouri the range was 75 days for a moderate freeze and 90 days for a severe freeze.

TABLE 1 -- THE DATES OF THE EARLIEST AND LATEST FINAL LIGHT, MODERATE, AND SEVERE SPRING FREEZES DURING THE 38 YEAR PERIOD, 1916 THROUGH 1953.

	Earliest			Latest		
	Light	Moderate	Severe	Light	Moderate	Severe
NORTHWEST DISTRICT						
Chillicothe	3/29/41	3/11/46	3/4/42	5/25/25	4/27/32	4/17/51
Grant City	4/1/19	3/10/46	3/8/45	5/29/47	4/27/50	4/20/53
Kidder	3/29/41	3/10/46	3/6/19	5/29/47	5/5/44	4/18/21
Maryville	3/29/41	3/10/46	3/8/22	5/29/47	5/6/44	4/20/53
Oregon	3/27/25	3/10/46	3/8/45	5/29/47	4/21/18	4/17/21
St. Joseph	3/10/46	3/10/46	2/28/42	5/6/44	4/20/53	4/17/21
Trenton	3/29/41	3/8/22	3/4/27	5/7/31	4/22/36	4/17/21
NORTHEAST DISTRICT						
Brunswick	3/28/27	3/9/45	2/26/18	5/7/31	4/18/53	4/16/28
Hannibal	3/26/33	3/8/45	2/28/42	5/6/44	4/18/53	4/3/50
Kirksville	3/29/41	3/10/46	3/8/45	5/25/25	4/23/51	4/18/53
Macon	3/29/41	3/10/29	3/4/42	5/25/25	4/22/36	4/18/53
Unionville	4/6/41	3/26/22	3/9/45	5/29/47	5/2/25	5/2/25
WEST CENTRAL DISTRICT						
Appleton City	3/19/25	3/8/22	3/3/42	5/6/44	4/20/53	4/13/50
Clinton	3/23/32	3/8/22	2/28/42	5/13/51	4/23/51	4/14/51
Fayette	3/29/41	3/10/46	3/5/17	5/25/25	4/28/28	4/16/32
Harrisonville	3/20/25	3/9/22	3/4/42	5/9/23	4/20/53	4/20/53
Kansas City	3/10/46	3/6/19	2/25/38	5/6/44	4/17/53	4/13/50
Lexington	3/10/46	3/9/45	2/27/46	5/5/44	4/20/53	4/5/28
Marshall	3/29/41	3/10/46	3/1/42	5/25/25	4/17/21	4/14/50
Warrensburg	3/19/25	3/10/46	3/4/53	5/9/23	4/21/31	4/15/28
Warsaw	3/26/27	3/10/45	3/4/27	5/25/25	4/26/19	4/14/50
EAST CENTRAL DISTRICT						
Columbia	3/10/29	3/8/45	2/28/42	4/28/28	4/20/53	4/14/50
Eldon	3/28/48	3/9/46	3/1/42	5/25/25	4/26/19	4/17/21
Jefferson City	3/28/25	3/9/45	3/4/30	5/9/47	4/23/51	4/15/50
Louisiana	3/20/29	3/10/29	3/4/27	5/25/34	5/25/25	4/22/36
Mexico	3/27/27	3/9/45	3/3/27	5/25/25	5/27/53	5/27/53
St. Louis	3/8/45	2/28/42	2/1/38	5/2/29	4/15/28	4/5/20
Warrenton	3/29/41	3/10/29	3/1/42	5/25/25	4/20/53	4/19/49
SOUTHWEST DISTRICT						
Lamar	3/26/33	3/8/22	2/16/46	5/7/44	4/20/53	4/13/40
Lebanon	3/28/48	3/8/22	3/8/45	5/26/25	5/6/44	4/19/53
Mt. Grove	3/29/48	3/9/46	2/28/42	5/25/25	4/26/19	4/15/28
Neosho	3/29/41	3/10/46	3/4/22	5/12/52	4/22/31	4/20/53
Nevada	3/29/41	3/8/22	3/3/42	5/6/44	4/20/53	4/14/50
Springfield	3/16/25	3/4/22	2/15/46	5/6/44	4/20/53	4/12/40
SOUTHEAST DISTRICT						
Arcadia	4/4/48	3/12/46	3/2/42	5/10/47	5/7/44	4/19/53
Birch Tree	3/28/32	3/10/29	2/22/36	5/9/45	4/27/53	4/19/53
Doniphan	3/18/29	3/4/27	2/26/18	5/15/26	4/21/53	4/19/53
Farmington	3/29/41	3/9/45	2/28/46	5/25/25	4/25/34	4/17/51
Jackson	3/29/41	3/9/45	2/22/53	5/14/17	5/14/17	4/16/28
Koshkonong	3/9/46	3/2/42	2/15/46	4/26/19	4/19/53	4/5/20
Poplar Bluff	3/11/46	2/28/42	2/23/53	5/7/44	4/22/27	4/7/39
Rolla	3/28/48	3/9/46	3/3/30	5/25/25	4/22/27	4/18/53
SOUTHEAST LOWLANDS						
Cairo, Illinois	3/1/38	2/15/46	2/1/38	4/19/49	4/16/49	4/15/49
Caruthersville	3/4/27	2/16/46	1/20/31	4/19/53	4/5/20	3/31/23

TABLE 2 -- THE DATES OF THE EARLIEST AND LATEST INITIAL LIGHT, MODERATE, AND SEVERE FALL FREEZES DURING THE 38 YEAR PERIOD, 1916 THROUGH 1953.

	Earliest			Latest		
	Light	Moderate	Severe	Light	Moderate	Severe
NORTHWEST DISTRICT						
Chillicothe	9/21/18	9/28/42	9/28/42	11/16/44	11/16/44	11/30/44
Grant City	9/24/42	9/28/42	10/6/52	11/7/47	11/24/31	11/27/44
Kidder	9/24/42	9/28/42	10/5/52	11/11/21	11/24/31	11/27/44
Maryville	9/20/18	9/29/16	10/6/52	11/7/47	11/8/47	11/24/31
Oregon	9/24/42	10/6/52	10/12/17	11/8/24	11/24/31	11/27/44
St. Joseph	10/6/52	10/6/52	10/20/16	11/24/31	11/24/31	12/1/34
Trenton	9/26/28	9/28/42	10/14/37	11/8/47	11/22/44	11/28/44
NORTHEAST DISTRICT						
Brunswick	9/27/42	10/7/52	10/14/37	11/22/44	11/28/44	12/2/31
Hannibal	9/26/28	10/6/52	10/13/17	11/9/22	11/24/44	12/5/34
Kirksville	9/24/42	9/28/42	10/6/52	11/8/47	11/24/44	11/28/44
Macon	9/26/26	9/28/42	10/6/35	11/6/47	11/24/44	11/28/44
Unionville	9/21/18	9/26/26	10/6/52	11/7/47	11/12/46	11/27/44
WEST CENTRAL DISTRICT						
Appleton City	9/27/42	10/7/52	10/18/48	11/16/44	11/25/31	12/2/35
Clinton	9/27/42	10/6/52	10/7/52	11/19/28	11/23/24	12/14/23
Fayette	9/22/27	9/28/42	10/13/17	11/22/44	11/24/44	11/28/44
Harrisonville	9/24/42	9/27/42	10/19/17	11/10/44	11/24/31	11/30/44
Kansas City	10/6/52	10/19/25	10/23/37	11/24/31	11/27/44	12/14/31
Lexington	9/28/42	10/10/25	10/20/30	11/22/44	11/28/44	12/14/31
Marshall	9/28/42	10/6/35	10/13/17	11/22/44	11/26/44	12/1/34
Warrensburg	9/24/42	10/10/25	10/23/37	11/22/44	11/24/31	12/1/34
Warsaw	9/21/18	10/6/32	10/13/17	11/11/46	11/23/44	12/2/31
EAST CENTRAL DISTRICT						
Columbia	10/6/52	10/7/52	10/13/17	11/11/46	11/27/44	1/3/31
Eldon	9/27/42	10/7/52	10/13/17	11/22/44	11/28/44	12/5/34
Jefferson City	9/27/42	10/6/52	10/7/52	11/24/44	11/24/44	12/5/34
Louisiana	9/17/37	9/26/40	10/6/52	11/6/47	11/24/44	11/28/44
Mexico	9/28/42	9/28/42	10/13/17	11/6/47	11/24/44	11/28/44
St. Louis	10/6/52	10/18/48	10/28/25	11/27/44	1/9/31	1/9/31
Warrenton	9/27/42	10/6/52	10/18/48	11/10/22	11/24/44	12/5/34
SOUTHWEST DISTRICT						
Lamar	9/26/40	9/27/42	10/7/52	11/11/46	11/25/31	12/18/33
Lebanon	9/21/27	10/6/32	10/7/52	11/8/47	11/22/44	11/28/44
Mt. Grove	9/27/42	10/6/32	10/21/16	11/11/46	11/27/44	12/2/46
Neosho	9/20/38	10/6/32	10/7/52	11/8/33	11/22/44	11/29/18
Nevada	9/26/40	10/7/52	10/7/52	11/10/44	11/25/31	12/1/34
Springfield	9/27/42	10/16/43	10/23/37	11/24/31	11/25/31	1/8/31
SOUTHEAST DISTRICT						
Arcadia	9/16/16	9/19/16	10/7/52	11/8/33	11/24/44	11/24/44
Birch Tree	9/25/50	10/5/32	10/7/52	12/2/46	12/2/46	12/2/46
Doniphan	9/27/42	10/5/43	10/13/17	11/8/33	11/21/44	12/3/27
Farmington	9/21/27	10/3/52	10/7/52	11/7/40	11/24/44	11/28/44
Jackson	9/21/27	10/6/32	10/9/17	11/8/47	11/24/44	12/2/46
Koshkonong	10/7/52	10/12/46	10/29/25	11/25/31	11/28/44	12/25/39
Poplar Bluff	9/30/24	10/9/17	10/13/17	11/8/47	11/26/18	12/14/23
Rolla	9/28/42	10/7/52	10/21/52	11/22/44	11/24/44	12/21/39
SOUTHEAST LOWLANDS						
Cairo, Illinois	10/17/43	10/28/25	11/2/51	12/4/34	12/20/39	1/30/31
Caruthersville	10/13/17	10/29/52	11/2/51	12/3/31	1/31/31	1/31/31

PROBABILITIES OF THE LAST SPRING FREEZES

The risk of encountering another damaging freeze declines as spring progresses. For example, in central Missouri another light freeze will occur after April 1 nine years out of ten. By April 15, the chance of another light freeze is reduced to 1 year out of 2, and by mid-May the probability approaches zero. The probability of another moderate freeze is always less than for a light freeze. The chances of another moderate freeze approaches zero in late April. Similarly, the probability of another severe freeze is less than that of a moderate freeze throughout the spring, and by mid-April approaches zero.

Commercial and kitchen gardeners do not usually wait until the probability of another freeze reaches zero before starting spring operations. In most cases, early gardens are desirable to insure an early market, and tender garden plants are planted or transplanted before the danger of the final spring freeze has passed. Although the assumption of a risk is necessary, most producers do not know how great a risk is being taken.

For the purpose of this investigation, the dates of four risks were obtained for each type of freeze.

1. *The date of a 50 percent chance: a killing freeze will occur after this on half the years or 1 year out of 2. This date is commonly called the average date of the last spring freeze.*

2. *The date of a 20 percent chance: a killing freeze will occur after this date on 20 percent of the years or 1 year out of 5.*

3. *The date of a 10 percent chance: a killing freeze will occur after this date on 10 percent of the years or 1 year out of 10.*

4. *The date of a 5 percent chance: a killing freeze will occur after this date on 5 percent of the years or 1 year out of 20.*

Dates after which there is a 50 percent chance of a light freeze in the spring are shown in Figure 2. This map indicates that during half the years a light freeze may be expected in northern Missouri after April 20, in central Missouri after April 15, and in the extreme southeastern portion of the state after March 26 to 31. Figure 3 gives the dates after which a light freeze will occur on 20 percent of the years, Figure 4 indicates the dates after which there is a 10 percent chance of a light freeze, and in Figure 5 are shown the dates after which there is a 5 percent chance of a light freeze.

Figures 6 through 9 show the dates after which there are 50, 20, 10, and 5 percent chances of a moderate spring freeze. The dates after which there is a given chance of a severe freeze in spring are given in Figures 10 through 13.

The maps in Figures 2 through 13 may be used as indicators of the most suitable dates for beginning spring operations. The producer must first determine the type of freeze which will cause injury. In the case of tender plants, such as melons and tomatoes, a light freeze will cause injury. For semi-hardy plants, like lettuce and beets, a freeze must be of at least moderate intensity to cause extensive damage. Spinach and peas, being hardy plants, must be subjected to a severe freeze to be damaged. The producer must then determine the amount of risk he is willing to assume. If the producer decides it is feasible to take a loss or to provide protection for his crop 2 years out of 10, the map showing the dates after which there is a 20 percent chance of a killing freeze should be consulted. Planting or transplanting may be done on the date indicated for his locality on this map, or as soon as soil temperature and moisture conditions permit.

It should be recalled that garden and orchard sites in valleys may sustain damage in a higher percentage of years than indicated by these maps. Gardeners should delay operations in these locations beyond the dates indicated.

PROBABILITIES OF FIRST FALL FREEZE

In fall, there is a small probability of a killing freeze occurring before late September. The likelihood of the first freeze increases as the fall season advances, and by mid-November the chances are quite high that the first freeze will have occurred.

The same types of risks may be defined as in the case of spring freezes, except that interest is focused on the probability of a freeze occurring prior to a given date. The dates of various risks are given in Figures 14 through 25. Here is the description of each of these risks:

1. *The date of a 50 percent chance: a killing freeze will occur before this date on 50 percent of the years. This is the average date of the first fall freeze.*

2. *The date of a 20 percent chance: A killing freeze will occur before this date on 20 percent of the years.*

3. *The date of a 10 percent chance: A killing freeze will occur before this date on 10 percent of the years.*

4. *The date of a 5 percent chance: A killing freeze will occur before this date on 5 percent of the years.*

Figures 14 through 25 show the dates before which there is a 50, 20, 10, and 5 percent chance of light, moderate, and severe freezes. The producer should decide the type of freeze which will cause damage and the amount of risk he is willing to take and refer to the proper map. Plans may then be made for the suspension of operations before the date indicated on this map.

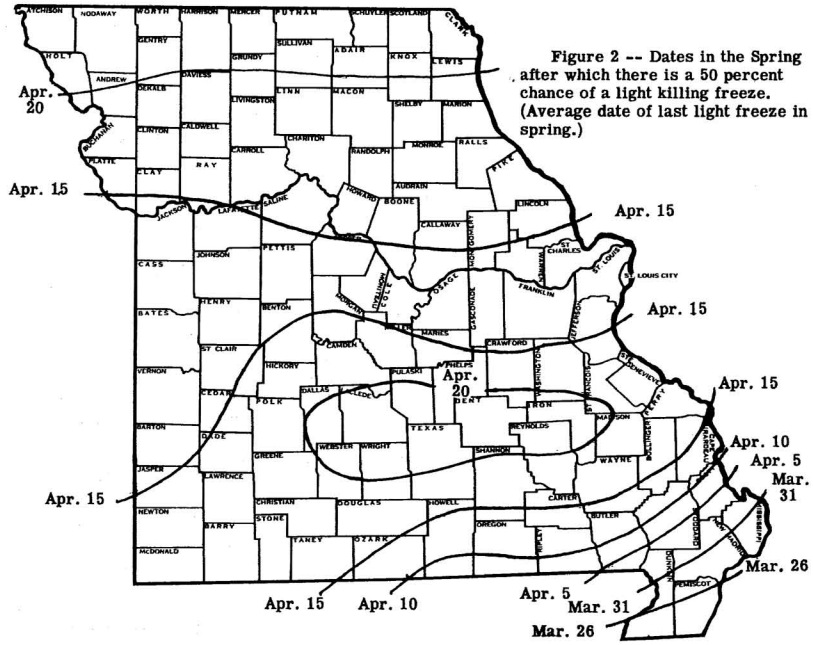

Figure 2 -- Dates in the Spring after which there is a 50 percent chance of a light killing freeze. (Average date of last light freeze in spring.)

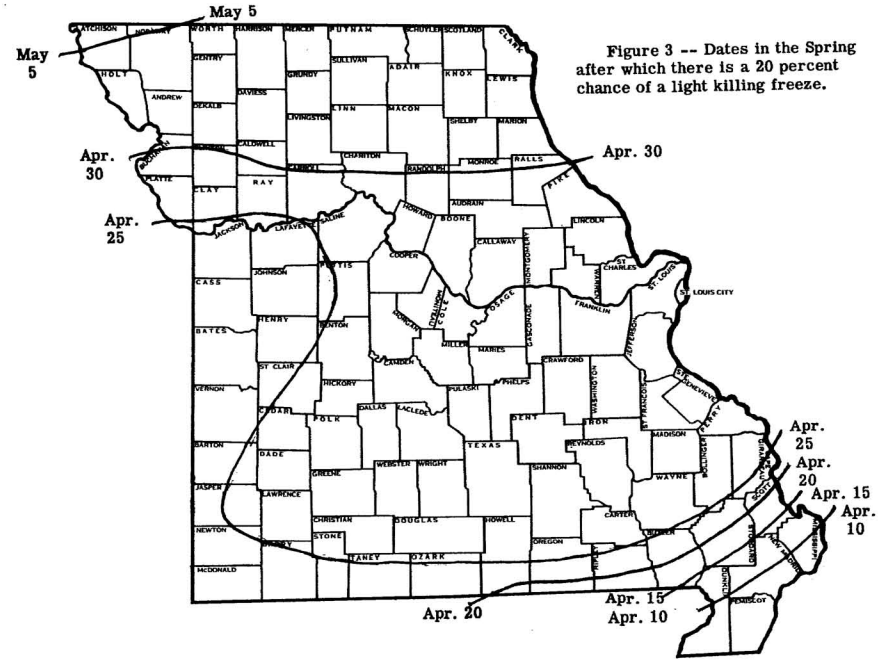

Figure 3 -- Dates in the Spring after which there is a 20 percent chance of a light killing freeze.

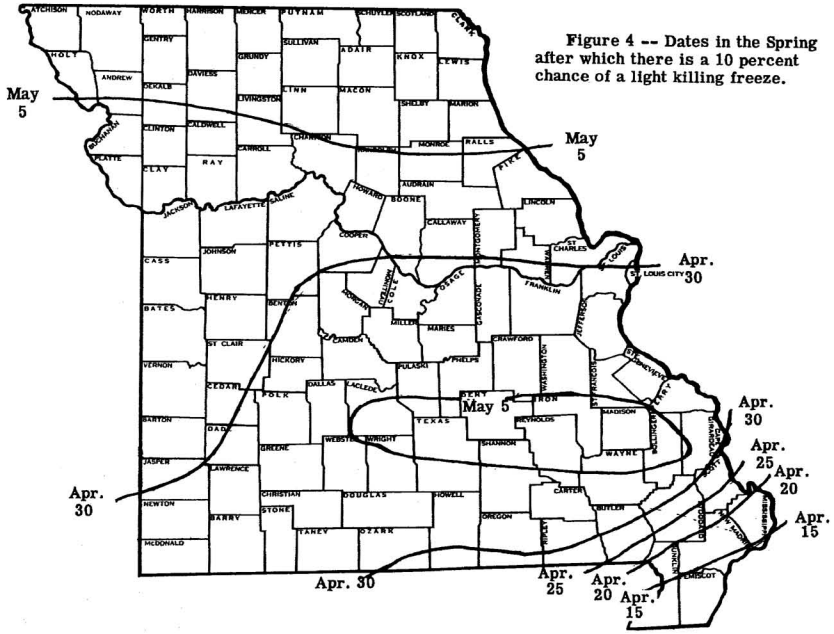

Figure 4 -- Dates in the Spring after which there is a 10 percent chance of a light killing freeze.

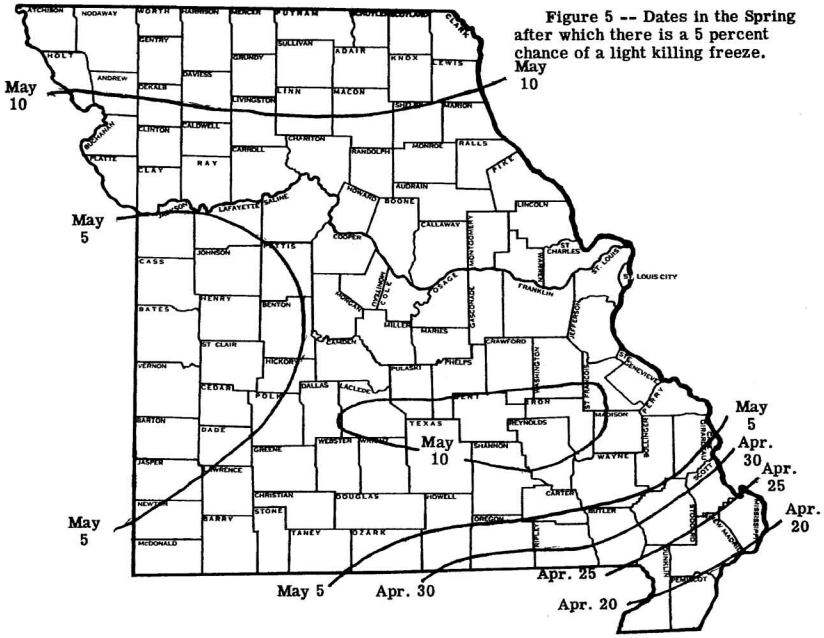

Figure 5 -- Dates in the Spring after which there is a 5 percent chance of a light killing freeze.

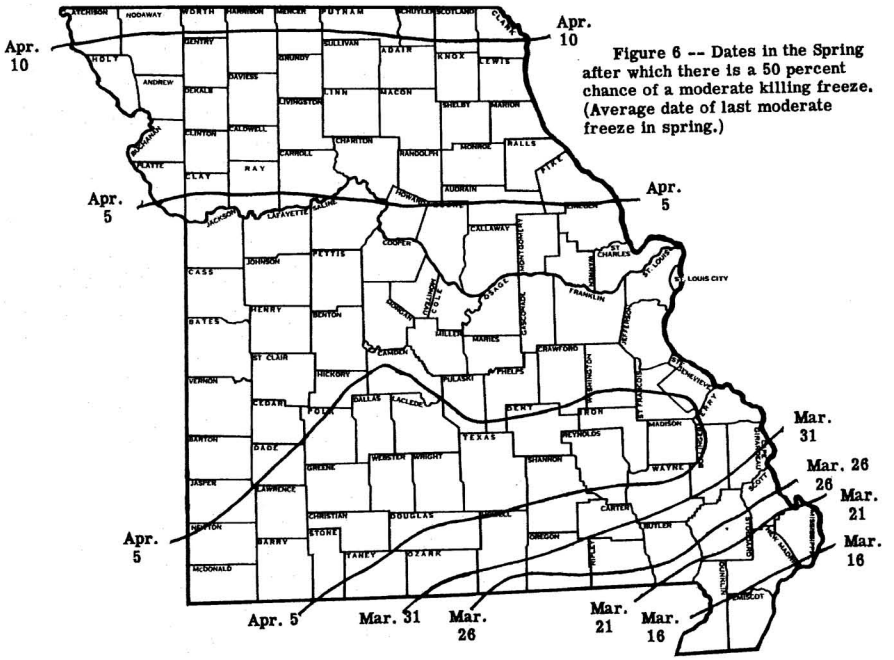

Figure 6 -- Dates in the Spring after which there is a 50 percent chance of a moderate killing freeze. (Average date of last moderate freeze in spring.)

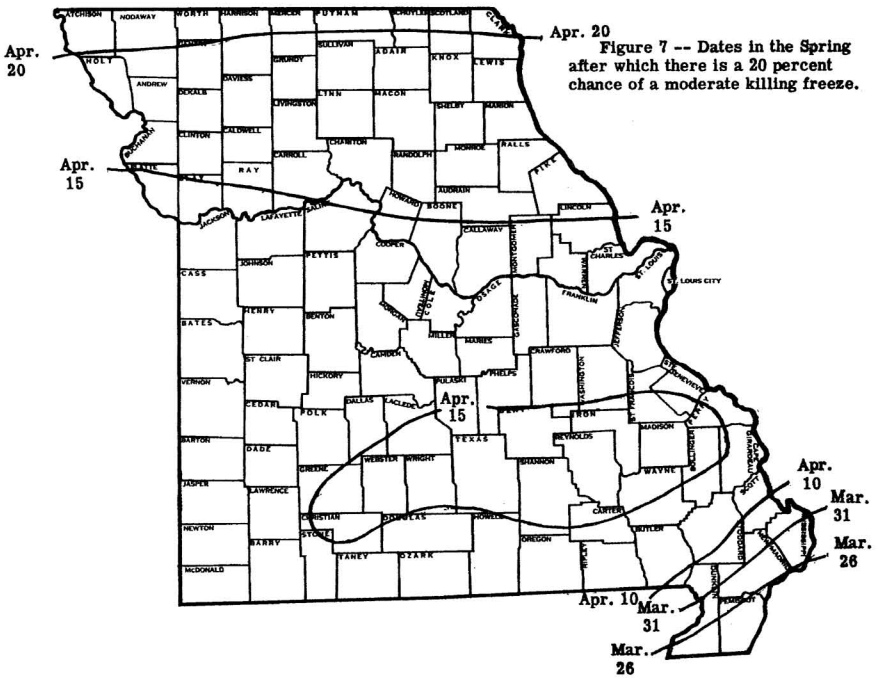

Figure 7 -- Dates in the Spring after which there is a 20 percent chance of a moderate killing freeze.

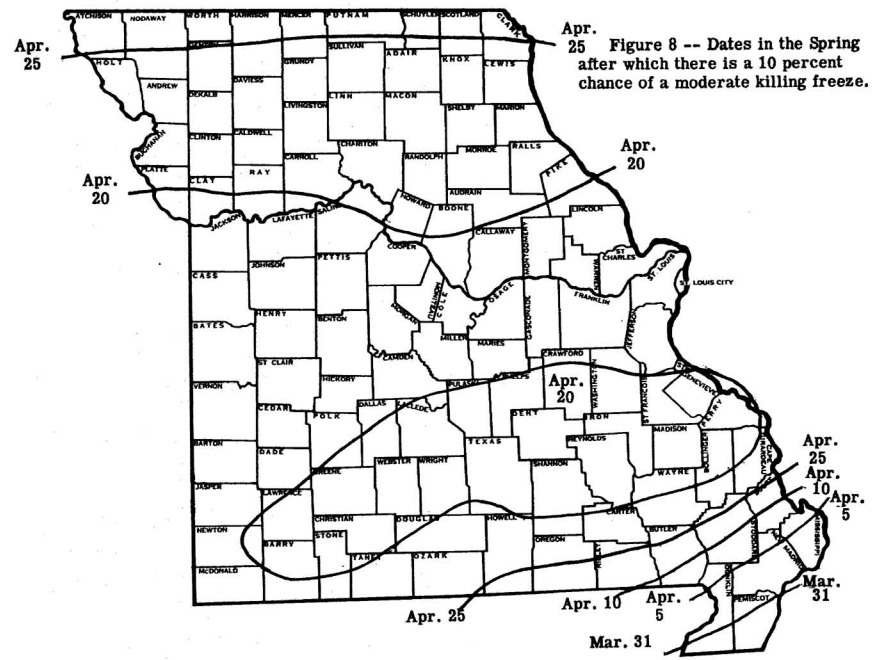

Figure 8 -- Dates in the Spring after which there is a 10 percent chance of a moderate killing freeze.

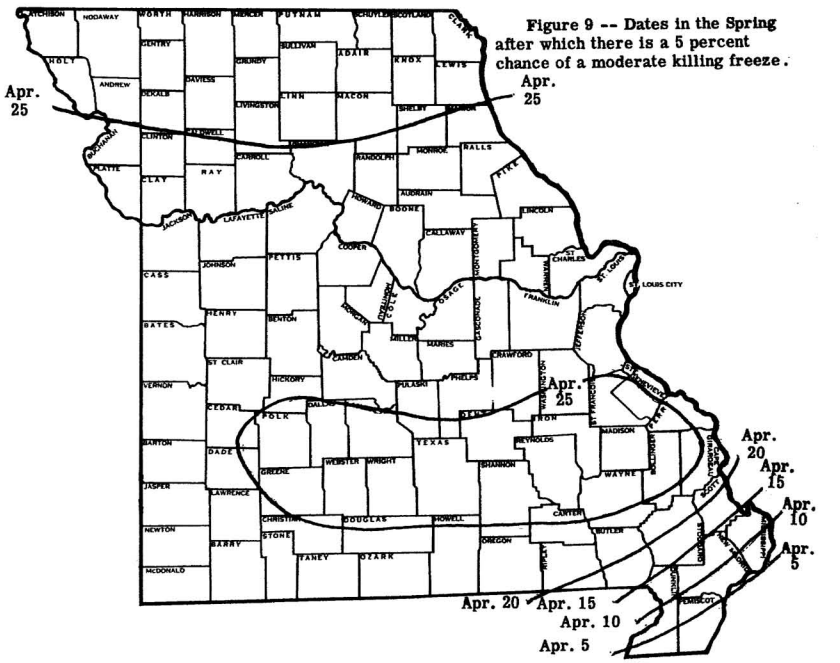

Figure 9 -- Dates in the Spring after which there is a 5 percent chance of a moderate killing freeze.

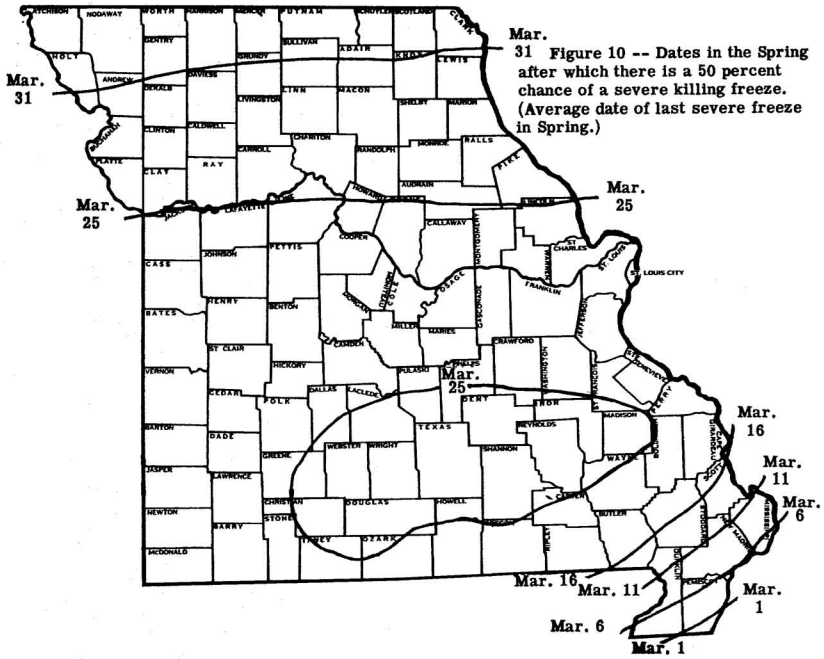

Figure 10 -- Dates in the Spring after which there is a 50 percent chance of a severe killing freeze. (Average date of last severe freeze in Spring.)

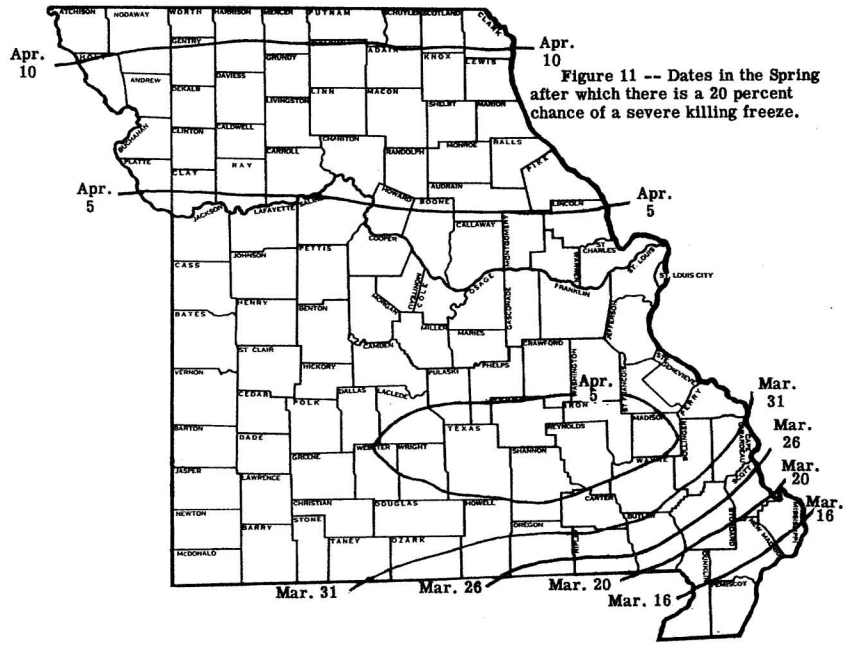

Figure 11 -- Dates in the Spring after which there is a 20 percent chance of a severe killing freeze.

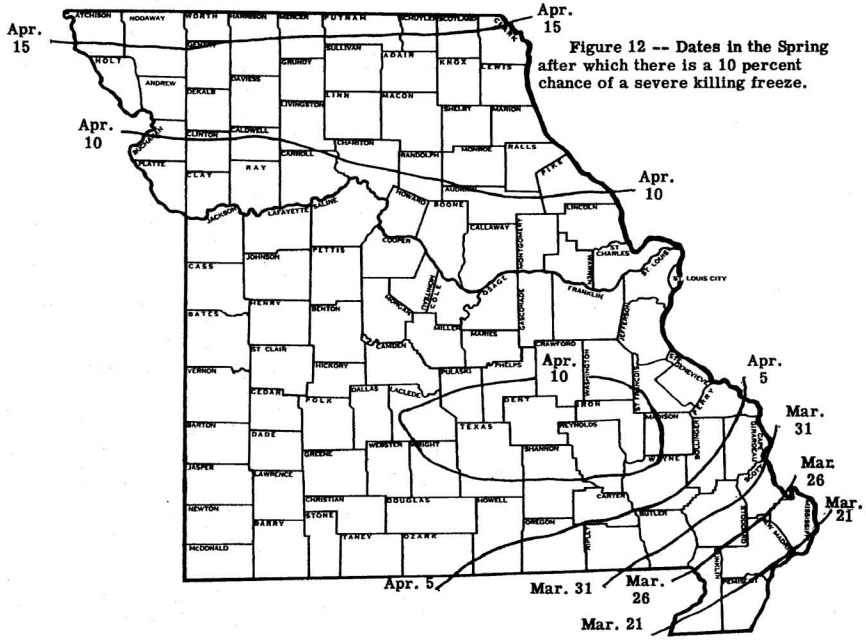

Figure 12 -- Dates in the Spring after which there is a 10 percent chance of a severe killing freeze.

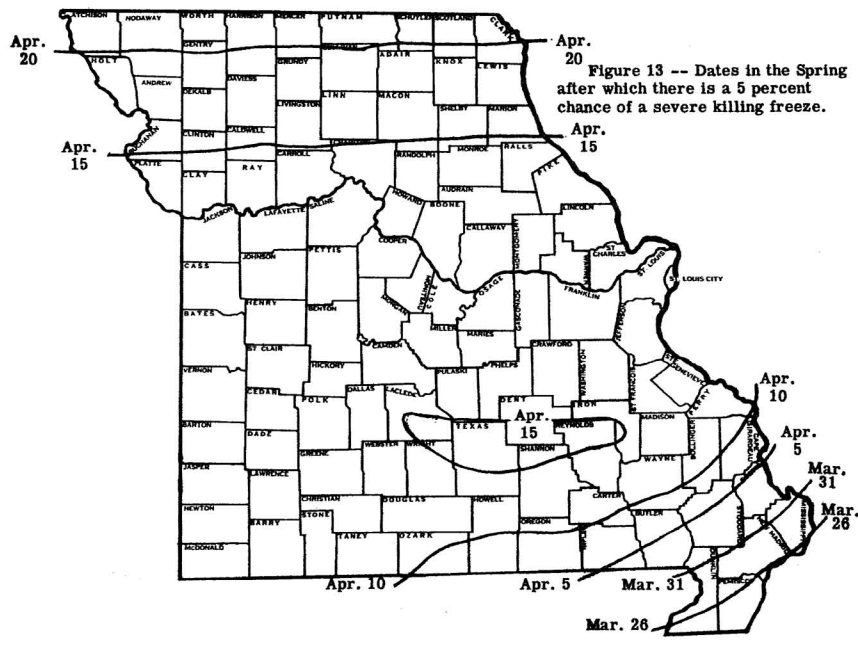

Figure 13 -- Dates in the Spring after which there is a 5 percent chance of a severe killing freeze.

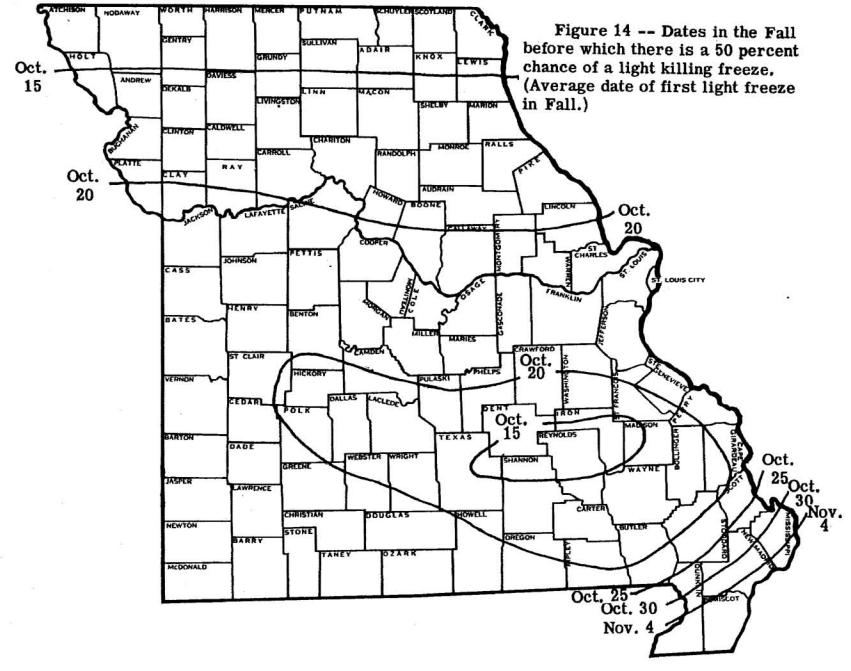

Figure 14 -- Dates in the Fall before which there is a 50 percent chance of a light killing freeze. (Average date of first light freeze in Fall.)

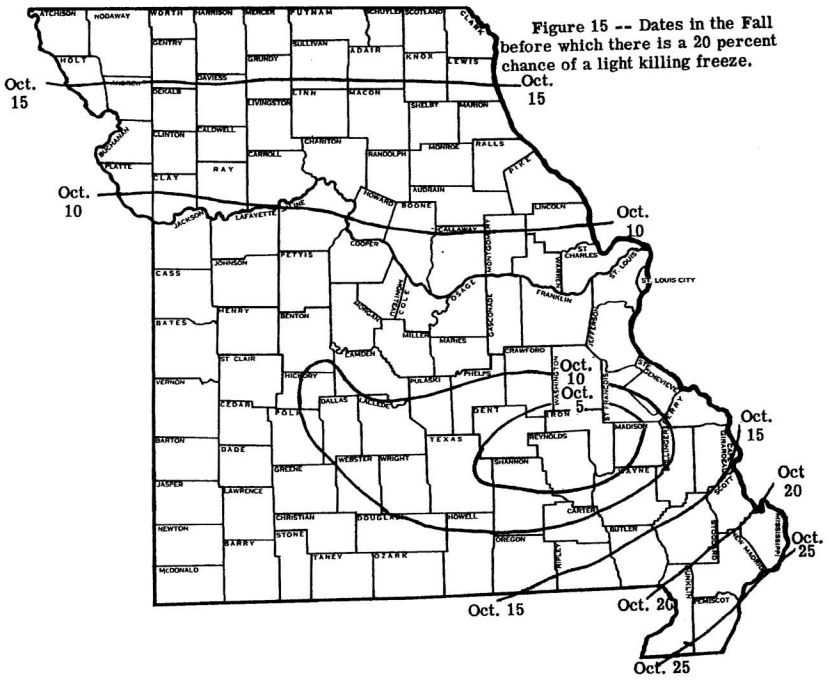

Figure 15 -- Dates in the Fall before which there is a 20 percent chance of a light killing freeze.

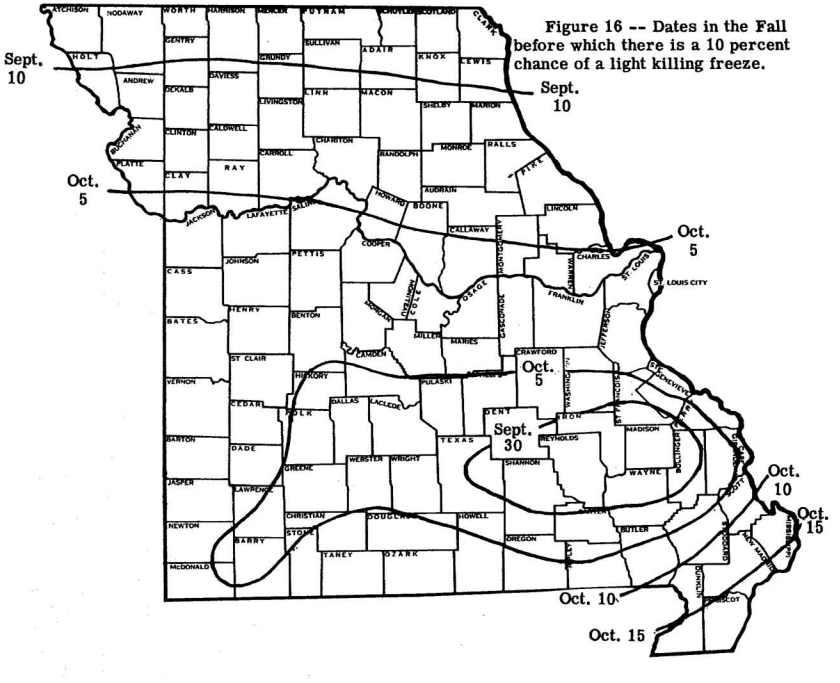

Figure 16 -- Dates in the Fall before which there is a 10 percent chance of a light killing freeze.

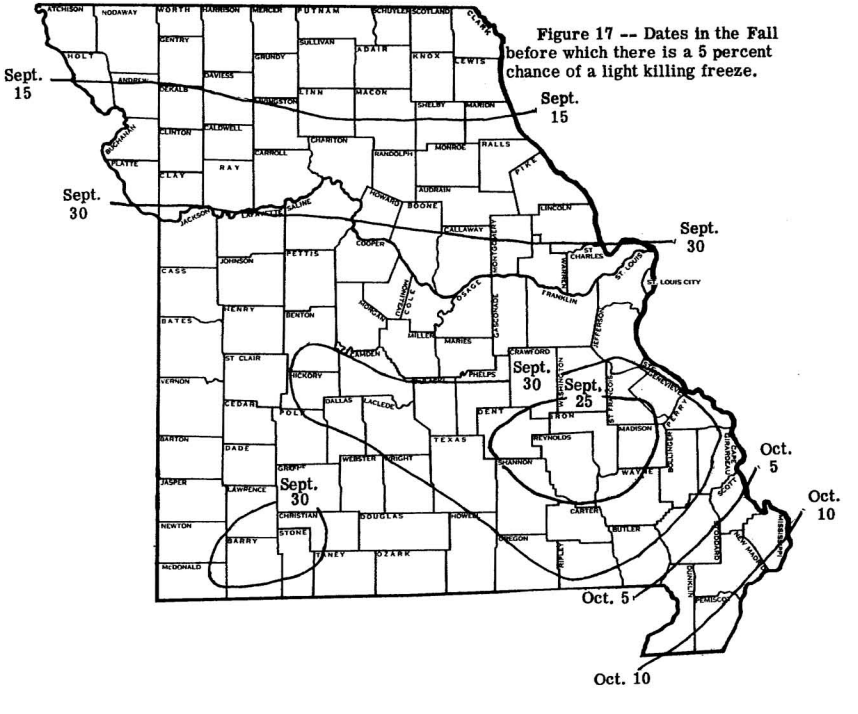

Figure 17 -- Dates in the Fall before which there is a 5 percent chance of a light killing freeze.

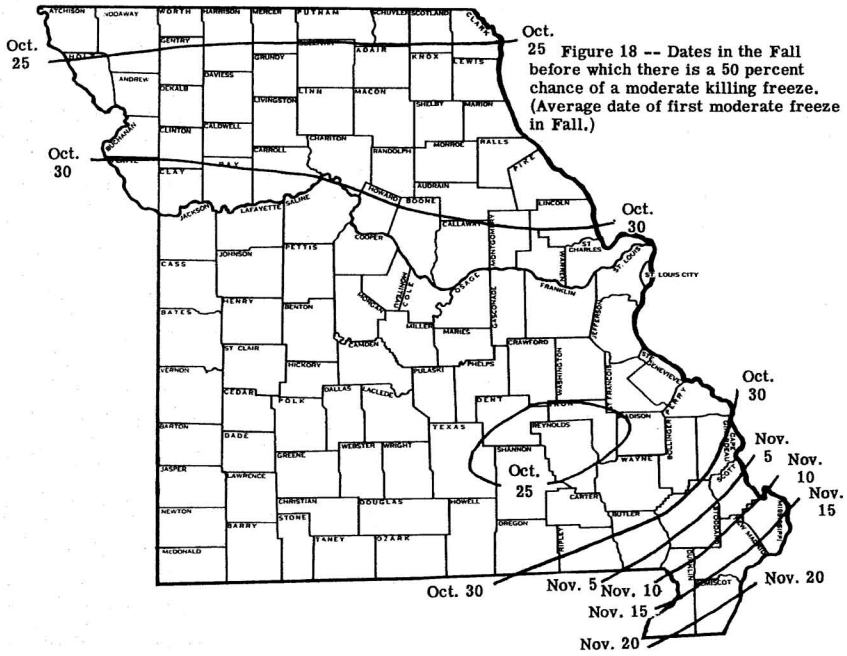

Figure 18 -- Dates in the Fall before which there is a 50 percent chance of a moderate killing freeze. (Average date of first moderate freeze in Fall.)

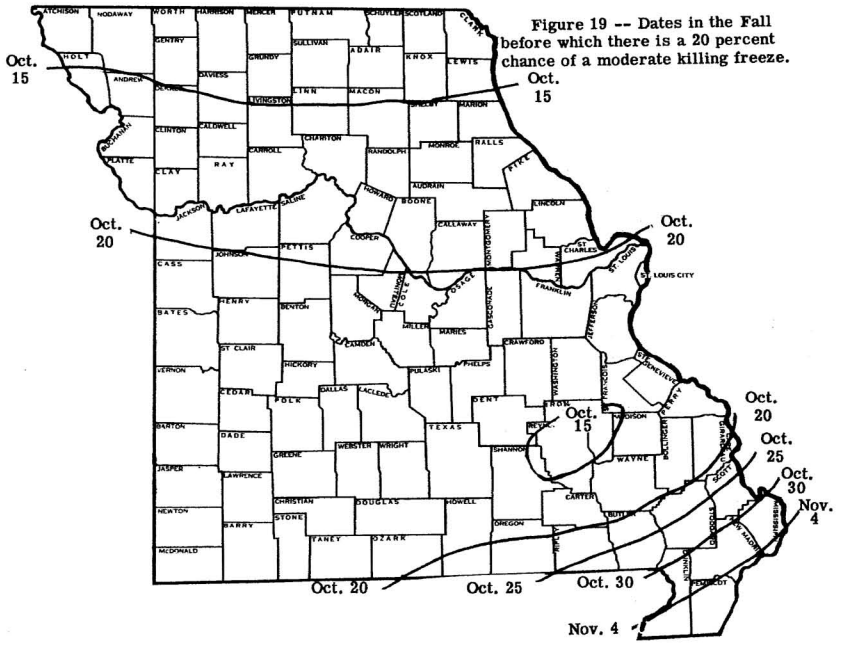

Figure 19 -- Dates in the Fall before which there is a 20 percent chance of a moderate killing freeze.

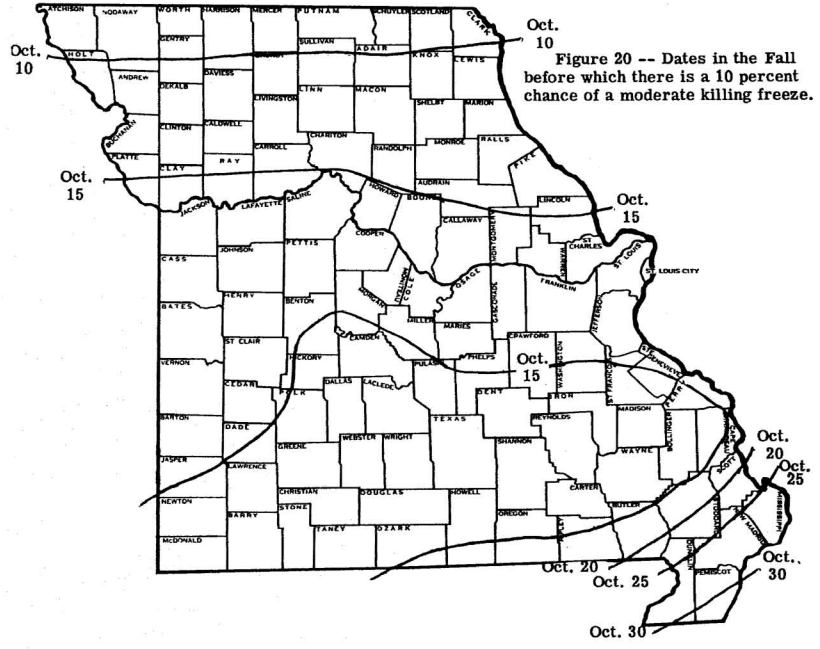

Figure 20 -- Dates in the Fall before which there is a 10 percent chance of a moderate killing freeze.

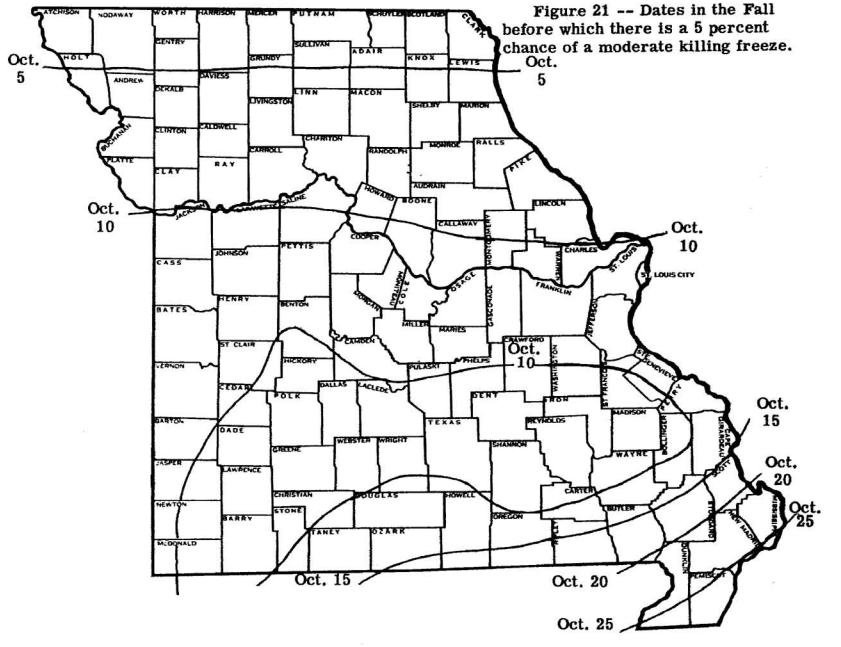

Figure 21 -- Dates in the Fall before which there is a 5 percent chance of a moderate killing freeze.

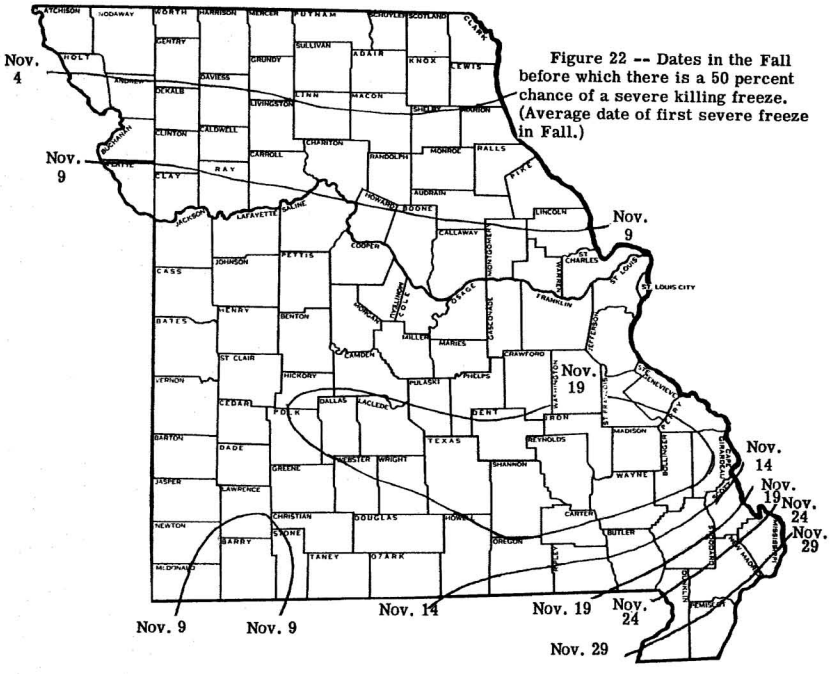

Figure 22 -- Dates in the Fall before which there is a 50 percent chance of a severe killing freeze. (Average date of first severe freeze in Fall.)

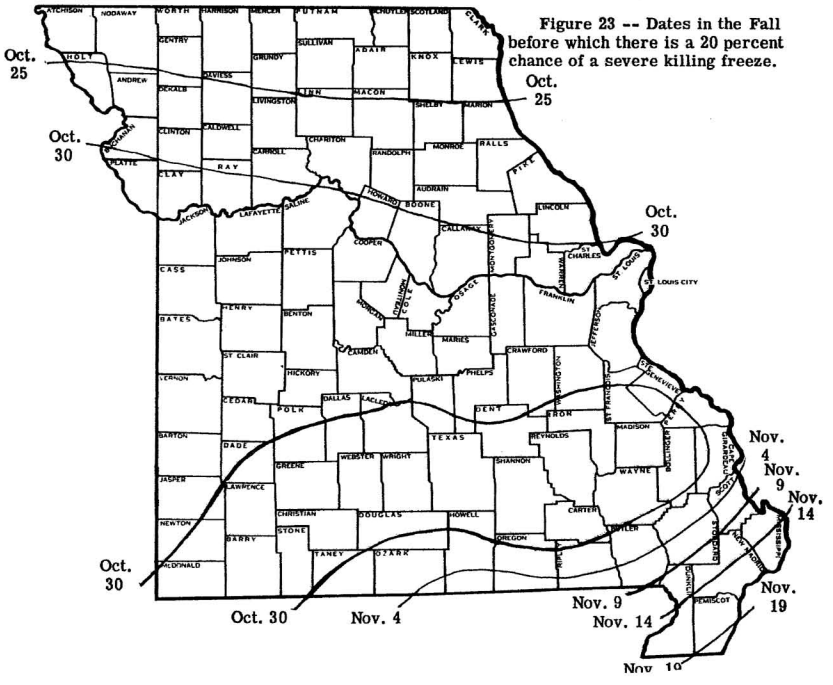

Figure 23 -- Dates in the Fall before which there is a 20 percent chance of a severe killing freeze.

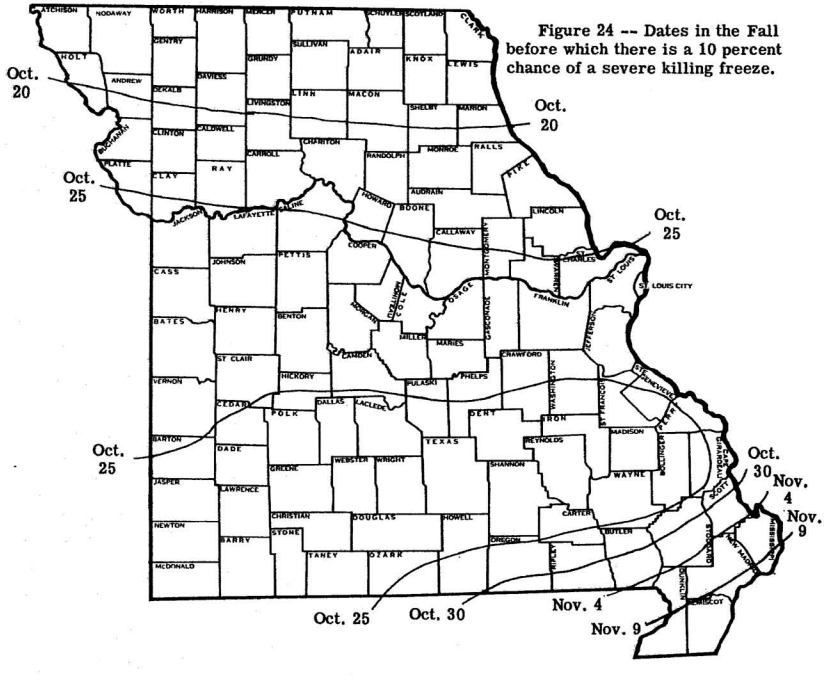

Figure 24 -- Dates in the Fall before which there is a 10 percent chance of a severe killing freeze.

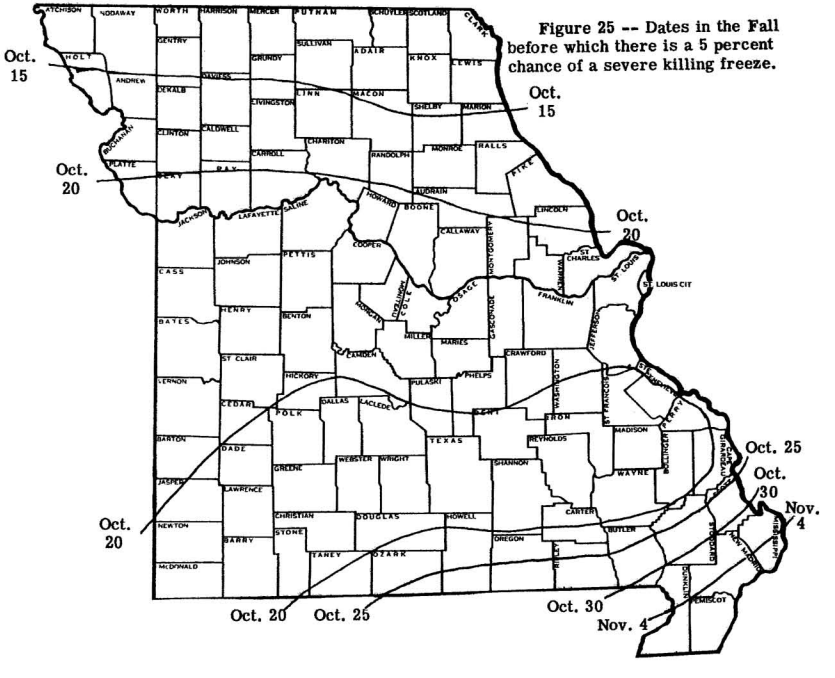

Figure 25 -- Dates in the Fall before which there is a 5 percent chance of a severe killing freeze.

PATTERN OF DATES OF LAST SPRING AND FIRST FALL FREEZES

The maps shown in Figures 2 through 25 are quite similar in appearance. The dates which appear on each map are different, but the shape of lines is, for the most part, unchanged from one map to another.

It is noted that there is a gradual change in the dates of the last spring and first fall freeze as one moves southward across the northern half of the state. In this area the lines of equal dates run east-west across the state indicating that a killing freeze is about as likely in the northwest as in the northeast.

It is noted that on all the spring maps the dates of a given probability of a freeze in the Ozark Plateau are as late as those in north Missouri. The fall maps indicate that freezes occur as early in the Ozark area as in areas much farther north. This situation is caused by higher elevation of the Ozark Plateau region. Fruit and vegetable growers in the Ozarks are reminded that so far as killing freezes are concerned, their climate is strikingly similar to areas in north Missouri.

In the southeast lowlands, the last spring freezes occur much earlier and the first fall freezes occur much later than in the remainder of the state. Extreme southeast Missouri has the lowest elevation and is farthest south of all regions of the state. This results in the early final spring freezes and late initial fall freeze, and the resulting long freeze-free growing season.

SUMMARY

1. Three types of freeze are defined. These are: a light freeze, which will only damage tender vegetation; a moderate freeze, which damages fruit blossoms and tender and semi-hardy plants; and a severe freeze, which kills most vegetation.

2. In order for late spring and early freezes to occur, air which has moved from Canada across the central United States must be present over Missouri. The likelihood of freezing temperatures will be increased on clear nights with low wind velocities.

3. Freezing temperatures are more likely to occur in valleys or depressions than on slopes or hilltops. When an entire area, such as the Ozark Plateau, is at a higher elevation, cooler temperatures will be observed than in areas with lower elevations.

4. A wide variability in the dates of the last spring and first fall freezes was observed. The difference between the earliest and latest recorded last spring and first fall freezes ranged from 40 to 60 days.

5. Maps are presented which show the dates over Missouri when there are 50, 20, 10, and 5 percent chances of killing freezes (after these dates in spring or before these dates in the fall).

6. Using these maps one can determine the date for beginning spring operations, and the date for termination of fall operations for a given risk.

7. The Ozark region has as great a risk of freezes as regions much farther north.

8. The southeast lowlands have the longest freezefree period of any of Missouri's regions.