Bulletin No. 23 April, 1900

UNIVERSITY OF IDAHO

AGRICULTURAL EXPERIMENT STATION

Department of Physics

1-Meteorological Records

2-Prediction of Frosts

By J. E. BONEBRIGHT.

DEMOCRATIC-TIMES' JOB ROOM,
Moscow, Idaho.
1900.

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Bulletins·

The regular bulletins of the Station are sent free to all who request them. Bulletins issued since the close of the fiscal year June 30, 1898:

16. The San Jose Scale in Idaho.
17. Construction and Management of Hotbeds.
18. Sugar Beet Investigations in 1898.
19. Miscellaneous Analyses.
20. Apple Scab in the Potlatch.
21. The Codlin Moth.
22. Onion Growing.

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METEOROLOGICAL RECORDS.

Explanation of Tables.

In this Bulletin will be found the monthly and yearly summaries of the more important Meteorlogical records taken by the Experiment Station of the University of Idaho at Moscow for 1898'-99 and soil temperatures for the growing seasons of 1898-'99.

The purpose of this Bulletin is to give Meterlogical summaries and deductions in which the practical farmer would be interested. Details and features of the weather interesting from a purely scientific standpoint have been omitted.

The daily readings from which these averages were made were taken at 7:00 a. m. and 7:00 p. m. All temperatures are given in Farenheit degrees. The highest and lowest temperatures for the month are given in the columns marked max. and min. The first mean temperatures are computed from the maximum and minimum temperatures and second mean temperatures are taken from the daily readings of the dry bulb. The snow-fall in inches can be determined by multiplying the record of melted snow by ten.

The barometric presure is given in inches and daily barometer readings were reduced to 30° F. The range of the barometer is the difference between the highest and lowest barometric pressures for the month.

In order to give an idea of the weather for a period of years a five years summary is given. In this summary the maximum temperature is the highest temperature recorded during the five years and the minimum temperature is the lowest temperature taken for the five years.

Five year averages have been made of the mean temperatures, rainfall, melted snow, total precipitation, barometric pressure and range. Under conditions of weather the number of daysclear, fair and days cloudy are given. With this summary are given the latest killing spring frosts and the earliest killing fall frosts during the same period. These records show the latest and earliest killing frosts which have occured during the five years, the time between killing frosts being considerably greater in any one year.

The averages of soil temperatures are given at depths of 1 in., 3 in., 6 in., 9 in., 1 ft., 2 ft., 3 ft., 4 ft., 5 ft., and 6 ft. for each week during the growing season from April to September inclusive.

Moscow, Idaho.

Year.	Temperature.				Precipitation in inches			Barometer		Condition of Weath'r		
1898	Max.	Min	First Mean	Second Mean	Rainfall	Melted Snow	Total	Mean Inches	Range Inches	Days Clear	Days Fair	Days Cloudy
Jan.	39	-4	23.4	24 9	.45	17.50	17.95	27.273	.517	7	0	24
Feb.	55	18	35 6	36.1	1.91	1.50	3 41	27.249	1 442	9	2	17
Mar.	59	5	30.8	31 3	.35	1.45	1 80	27.393	.733	12	3	16
April	75	27	51.1	46 1	1.02		1.02	27 347	.834	16	7	7
May	78	28	50.2	52.7	2.09		2 09	27 263	.520	15	6	10
June	86	32	57.5	59.7	1.31		1 31	27.308	.674	21	4	5
July	95	34	64 3	65 8	.79		.79	27 328	.457	27	0	4
Aug.	100	39	69 6	69 5	1.29		1.29	27 296	.409	23	4	4
Sep.	94	31	58.6	58.2	1 30		1.30	27 308	.534	18	5	7
Oct.	66	28	44 1	43 2	.83		.83	27 403	.541	13	7	11
Nov.	50	19	31.8	31.8	1.36	1 29	2.65	27.328	.824	2	9	19
Dec.	48	2	25.6	24 8	.80	.01	.81	27.516	1 011	11	0	20
Sum.	845	257	542.6	544 1	13.50	21.75	35 25	328.112	8.496	174	47	144
Mean	70.4	21.4	45 22	45.34	1.12	1.81	2.94	27 343	.708	15	4	12

Latest killing frost in spring, May 30th.
Earliest killing frost in fall, September, 27th.

Moscow. Idaho.

Year	Temperature				Precipitation in Inches			Barometer		Condition of Weather		
1899	Max.	Min.	First Mean	Second Mean	Rainfall	Melted Snow	Total	Mean Inches	Range Inches	Days Clear	Days Fair	Days Cloudy
Jan.	50	—16	30.1	28.9	2.10	3 0	2.10	27. 318	1. 260	4	4	23
Feb.	49	—17	25.5	26.0			3.00	27. 352	.905	11	1	16
Mar.	51	16	34.7	33 5	.41		.41	27. 239	.807	13	4	14
Apr.	70	27	42 5	41.8	2.95		2 95	27. 292	.700	10	7	13
May	72	27	47.7	47.0	2.12		2 12	27.248	.643	14	5	12
June	75	34	55.7	57.1	1.24		1.24	27,230	.546	18	2	10
July	93	41	65.4	71.8	.47		.47	27. 218	.305	28	0	3
Aug.	83	38	57.8	57.7	2.38		2 38	27.172	.438	18	3	10
Sept.	84	39	59.8	56.3	1.38		1.38	27 267	.498	24	1	5
Oct.	78	11	45.1	43.3	2.28		2 28	27.250	.962	13	3	15
Nov.	58	32	43.7	41.7	4.13		4 13	27.152	.781	7	4	19
Dec.	44	17	32.5	32.2	.66	.35	1.01	27. 278	.886	11	1	19
Sum	810	249	540.5	537.3	20. 12	3.35	23.47	327.046	8.731	171	35	159
Mean	69	21	45 0	44.8	1. 67	.28	1.96	27 254	.728	14	3	13

Latest killing frost in spring, May 17.
Earliest killing frost in fall, October 2nd.

Moscow. Idaho.

Yrs.	Temperature				Precipitation in Inches			Barometer		Condition of Weather		
1895 to 1899	Max.	Min.	First Mean	Second Mean	Rainfall.	Melted Snow	Total	Mean Inches	Range Inches	Days Clear	Days Fair	Days Cloudy
Jan.	50	-16	17.0	28.0	.61	.94	1 55	27.383	.814	27	13	115
Feb.	62	-17	22 0	32 2	.98	1.18	2 16	27.319	.811	42	17	81
Mar.	68	0	31.0	34.9	.88	.71	1 59	37.364	.662	59	15	81
April	78	26	52.0	45 6	1 21	.03	1 25	27.376	.707	67	31	52
May	92	28	60.0	39.6	2 12	12	2 24	27.335	.622	85	17	53
June	96	32	64.0	58 2	1 58		1 58	27.328	621	104	16	30
July	97	34	61.4	66.9	.60		.63	27.290	.408	140	1	14
Aug.	100	32	64.4	68.1	1.13		1.13	27 262	.436	122	20	13
Sept.	94	30	54.4	56 5	1 69		1.63	27 298	.582	106	8	36
Oct.	80	11	46.4	45.0	2.12		1 05	27.337	.762	91	18	46
Nov.	67	-14	35.6	35.4	5 0)	.8)	3.40	27.291	807	22	20	108
Dec.	56	-1	31.3	31.0	1.10	.59	1 45	27.380	.856	36	20	99
Sum	940	146	545 5	541.4	19.02	4.37	19.66	327.963	8.088	901	196	723
Mean	78.3	12.1	45.4	45 1	1.58	3.64	1.63	27.330	.674	75	36	60

Latest killing frost in spring during fiveyears occurred May 30th, 1899. 8

Earliest killing frost in fall during five years occurred September 6th, 1899. 5

Moscow, Idaho.

Soil Temperatures for the Growing Season of 1898.

For Weeks Ending

Depth.	April 9	April 16	April 23	April 30	May 7	May 14	May 21	May 28	June 4	June 11	June 18	June 25	July 2
6 feet	42	41	42	43	43	45	45	48	48	47	48	49	50
5 feet	42	40	41	42	43	44	45	48	47	47	49	50	51
4 feet	41	40	41	43	44	44	46	49	48	49	50	51	52
3 feet	40	40	42	44	45	46	47	51	49	50	52	53	54
2 feet	40	42	43	46	47	49	49	52	50	55	56.	59	55
1 foot	39	45	44	47	47	52	50	52	53	58	58	57	57
9 in.	40	45	44	48	46	53	59	51	54	61	59	57	58
6 in.	40	45	43	46	45	53	50	51	54	63	59	58	58
3 in.	39	43	42	45	41	52	50	54	54	60	60	55	56
1 in.	39	42	41	45	40	52	49	56	53	62	60	54	55

For Weeks Ending

Depth.	July 9	July 16	July 23	July 30	Aug. 6	Aug. 13	Aug. 21	Aug. 27	Sept 3	Sept 10	Sept. 17	Sept. 24	Oct. 1
6 feet	51	51	52	53	54	55	55	56	56	57	56	56	56
5 feet	52	52	53	54	55	56	57	57	57	57	57	56	56
4 feet	54	54	55	55	56	58	59	59	59	58	58	57	57
3 feet	55	56	56	56	58	60	61	60	60	54	58	58	57
2 feet	59	59	58	59	62	64	64	63	61	59	59	59	57
1 foot	94	62	60	63	67	68	66	64	61	58	59	58	56
9 in.	65	62	59	64	67	69	66	65	60	57	59	57	53
6 in.	67	60	58	64	66	68	66	63	58	55	57	56	51
3 in.	68	59	56	61	66	58	64	61	55	53	56	54	48
1 in.	65	56	56	62	65	66	53	60	54	52	54	53	47

Moscow, Idaho.

Soil Temperatures for the Growing Season of 1899.

For Weeks Ending

Depth	April 8	April 15	April 22	April 29	May 6	May 13	May 20	May 27	June 3	June 10	June 17	June 24	July 1
6 feet	41	41	41	42	42	42	43	44	45	45	46	46	48
5 feet	40	40	41	41	42	42	43	43	44	45	46	46	49
4 feet	40	40	41	41	42	42	43	44	45	46	47	48	50
3 feet	39	40	40	41	41	42	43	44	46	46	47	49	52
2 feet	39	41	41	42	41	45	44	46	47	48	50	52	56
1 foot	39	42	42	42	41	46	45	48	50	49	52	56	61
9 in.	40	41	41	43	40	47	45	49	51	48	53	56	62
6 in.	40	40	39	42	39	45	43	48	51	49	54	56	60
3 in.													
2 in.	42	37	38	39	41	42	41	49	52	51	54	56	61

For Weeks Ending

Depth	July 8	July 15	July 22	July 29	Aug 5	Aug 12	Aug. 19	Aug. 26	Sep. 2	Sep. 9	Sep. 16	Sep. 23	Sep. 30
6 feet	49	49	50	51	52	53	54	54	54	53	53	53	53
5 feet	48	50	51	52	53	54	54	54	54	54	53	53	54
4 feet	51	52	53	54	55	56	55	55	55	54	54	54	54
3 feet	53	54	55	56	55	57	56	56	55	55	55	25	55
2 feet	56	58	59	59	55	59	58	57	56	56	56	56	56
1 foot	60	63	64	62	60	61	57	57	55	58	57	57	57
9 in.	61	64	65	63	63	61	57	57	55	59	56	57	57
6 in.	60	63	64	62	63	59	56	56	52	59	53	55	66
3 in.													
1 in.	66	64	64	60	63	57	49	52	49	60	52	53	53

PREDICTION OF FROST.

The fruit growers of Idaho, especial.y those who live in vallies often experience serious losses by late spring frosts. If warned in time it is usually possible to prevent the frost, but owing to local conditions and the effect of valley and mountain atmospheric currents it often becomes impossible to predict from an evening temperature, a frost during the night.

It is the purpose of this article to describe a piece of electrical apparatus which will give warning when the temperature has dropped to a certain limit.

The prevention of frosts by smudging is well known to most fruit growers, but for those who may have had little experience in smudging the following paragraph is given.

Prevention of Frost.

There are several different methods of preventing frost, but the most practical is the smudge or smoking fire. The object of the smudge is to form a smoky vapor cloud which prevents the radiation of heat from the ground and thus keeps the temperature above the frost point. As no appreciable amount of heat is derived from the smoke, the smudging, which prevents the air and earth from losing heat, must be begun at a temperature above freezing. If the work were begun at a temperature of 40° F. the ground could be protected for several hours. In order that the smoke should cover the ground the smudges should be placed from one to two rods apart on the windward side of the spot to be protected. A good smudge can be made from a pitchy pine stump or log. In the stump vertical and horizontal auger holes are bored so that they meet each other at right angles. A little coal oil is poured in the vertical hole and a match applied to oil and wood at the horizontal opening. The holes act as a chimney causing a current of air to pass upward through the stump. The stump should be four feet or more in height and at least one foot in diameter and of a pitchy character and not too dry. The horizontal hole should be near the ground. If the stump is large it will serve two or three nights. As it burns it may become dry and begin to blaze in which case a little water should be thrown on it, for the object is to produce a smoky cloud and not to use the heat from the blaze. Damp straw or manure will make a good smudge. During the season in which the damaging frosts occur it is desirable to keep the stumps or straw ready for use at any time and for this reason the stumps are to be preferred since they are not affected by the weather. A more detailed treatment of smudging can be found in Farmer's Bulletin No. 104 entitled "Notes on Frost." A copy of the bulletin can be secured by addressing the Director of Experiment Stations, Washington, D. C.

Low Temperature and Frost·

A warning of a low temperature during the night is not necessarily a prediction of frost. Thus a warning of 40° F. near sunrise and especially if the sky were clouded would not mean frost, while on the other hand the same temperature at an early hour in the night with a clear sky and no wind could be taken as a warning of frost before morning. And in order to make use of the heat remaining, smudging should be begun. These remarks can only be taken for average conditions for much depends upon local features, such as elevation, slope of the land, bodies of water, and cold air currents. With a little experience and a knowledge of his ground the practical man can always be on the safe side.

In order to protect against frosts, a warning should be given when the temperature has fallen not less than 8° or 10° F. above freezing. For this purpose a night watch is often employed. Thermostats have been used for the same purpose. Neither method is desirable as the night watch adds to the labor and expense of raising the crop and the thermostats have not proven very reliable. See page 141.

The apparatus described in the following pages will give warning, by the ring of a bell, when an exposed thermometer has fallen to a given temperature. The thermometer can be adjusted for any temperature, and can be placed anywhere in the orchard or field. The other parts can be put in the house with the warning bell in a convenient place. The entire cost of the apparatus is from five to seven dollars. From the following description, any electrician can make the apparatus, and a person not acquainted with electrical methods can put it in place.

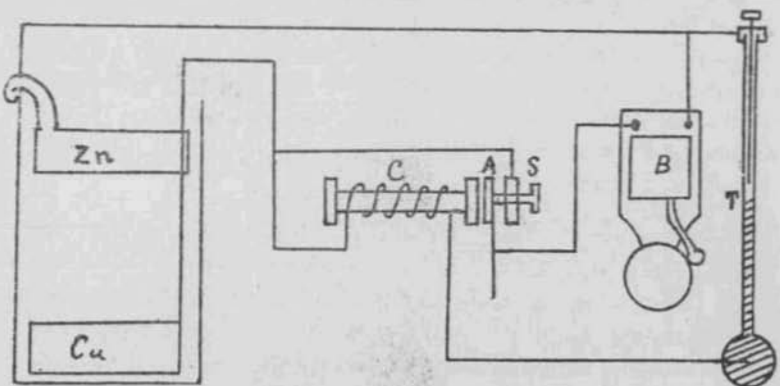

Fig. I. Electrical Apparatus.

Description of Apparatus.

The apprratus consists of a battery, relay coil, alarm bell, and thermometer. The battery used is the common crow foot cell used in telegraphing, size 6 in. by 8 in.

The relay C (Fig. I.) is composed of two coils. Each coil has an iron core 1-¼ inches long, ¼ in. in diameter and is wound with No. 24 B. and S double cotton covered magnetic wire, to a depth of ¼ of an inch. The coils are wound right and left handed and are placed horizontally.

The armature A. consists of an upright piece with a cross bar of soft iron which is so held that is is attracted by the iron cores of the coils when magnetized. An adjustable spring holds the armature A. against the screw S. when no current is flowing through the coil C. The maker should put on the base of the coil binding posts marked with the connections as given in Fig. I. A fifty cent door bell will answer for the alarm.

The thermometer consists of a glass stem eight or ten inches long with an internal diameter of approximately 1-25 of an inch, (1cm) attached to a bulb which has a diameter of 1 inch, (25cm) The bulb and two or three inches of the lower part of the tube are filled with mercury and the tube is graduated for every ten degrees from 30° F. to 100° F. Electrical connection with the mercury is made by a platinum wire blown in the glass. On the top of the stem is a brass cap with a No. 30 B. and S. bare copper wire passing through it and making contact with the mercury. The thermometer can be tested at any time by comparing it with an accurate Fahrenheit thermometer. It is made large in order to give free action to the mercury around the wire in the tube.

To put the Apparatus in Place.

To prepare the battery place the copper and zinc in a glass jar as in the cut and put copper sulphate crystals (blue vitrol) in the jar to the depth of an inch. Fill the jar with water, being sure to cover the zinc and connect the wire from the copper to the zinc. At the end of twenty-four hours the battery will be ready for use. The battery can be prepared for immediate use by filling it to the zinc with water and then covering the zinc with the solution surrounding the zinc of a similar battery which is in good running condition.

The thermometer should be freely exposed not more than two or three feet above the ground in that portion of the orchard most liable to frost, usually the lower ground.

The lower point of the copper wire in the tube of the thermometer should be set opposite the number indicating the temperature for which the instrument is to give warning, usually 40° to 45° F. A copper wire No. 16 B. and S. connects the wire in the stem of the thermometer to one post of the bell and to one pole of the battery, another wire connects the mercury in the bulb with the proper binding post of the coil and a third wire is run from the armature of the relay to the remaining binding post of the bell. The remaining pole of the battery is then connected to the properly marked post of the coil. It is well to test the connections by seeing that the bell rings when the thermometer circuit is broken.

The action of the instrument is very simple. When the wire in the stem of the thermometor is in contact with the mercury a current of electricty will pass through the relay coils causing the armature to be attached to the iron cores. The battery furnishes a continuous current and will keep the armature in this position until the circuit is broken. When the circuit is broken by the mercury falling below the lower point of the wire in the thermometer the armature will be drawn by the spring against the screw S. which puts the bell in a circuit with the battery. This condition is shown in the cut. The wires used in connecting up the appratus should be insluated by fastening them to wooden supports. It should be noticed that the bell will give warning of the breaking of one of the wires leading to the thermometer. In case the thermometer is more than 150 feet from the battery, two cells should be connected in series, i. e., the copper of one cell connected with the zinc of the other. In any case where one cell is not strong enough, two in series should be used.

Since the instrument can be set for any temperature it can be put to practical use in the green houses, incubators, and in any place where a warming of low temperature is desired.

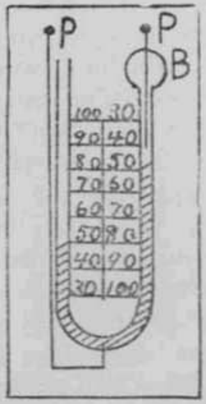

Fig II Differntial Thermometer.

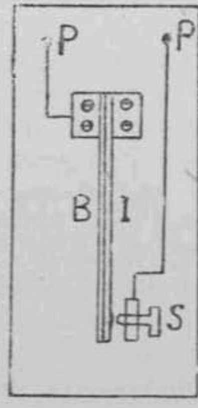

Fig III. Thermostat.

Differential Thermometer.

The difierential thermometer consists of a glass tube with one end open and the other closed with a bulb. The lower part of the tube is filled with mercury and the bulb contains alcohol. As the temperature rises the alcohol expands and the mercury rises in the open tube. When the alcohol contracts the atmosphere forces the mercury into the closed tube. The instrument is usually provided with two scales with the orders reversed as shown in the figure. By having a platinum wire blown in the bend of the tube and putting a wire in the open tube this thermometer can be substituted for the thermometer of Fig. 1. If the instrument is to give warning of one temperature only and is not to tō beadjustable the coil of Fig. 1. can be dispensed with by having a platinum wire blown in the bulb of the differential thermometer with the lower end of the wire opposite the required temperature. In this case the battery bell and differential thermometer are connected in series, i. e., so that the current flows when the mercury touches the wire blown in the bulb of the thermometer.

Thermostat.

Figure III. represents one form of the thermostat of which there is a great variety. It consists of brass and steel rods fastened together. The brass expands or contracts more with a given change of temperature than the steel and thus the rod bends as the temperature changes. In the figure "I" is the brass rod and "B" the steel rod. With a lowering of the temperature the rod will bend toward the right until it touches the screw S which is set at the required temperature. It is connected in series with the battery and bell. A very slight derangement will make the thermostat useless and for practical uses and accurate results it is not so desirable as the thermometers.

The instruments described above can be seen at the University. A set of the apparatus with the differential thermometer is now in use in the University Green House.

The writer would be pleased to correspond with any one wishing further information on this subject.