A METHOD OF PROPHESYING THE LIFE DURATION OF SEEDS

J. F. GROVES, UNIVERSITY OF CHICAGO

Since former explanations of the loss of vitality of seeds in storage conditions have proven incorrect, we have been led to surmise that a gradual coagulation of the proteins in the embryo may offer such an explanation. It has been shown by Chick and Martin[1] that proteins do not have a fixed temperature point for coagulation, but that coagulation may occur at any temperature provided the time of exposure be sufficiently great. Buglia[2] has applied the following time temperature formula to protein coagulation: T=a-b log Z, in which T= temperature cent., Z=minutes of exposure, and *a* and *b* constants. Lapeschkin[3] applied this formula to the coagulation of proteins in active plant cells and found a close agreement in theoretical and found values where time duration was short.

In this investigation constant temperatures were obtained by the use of the thermostat shown in figure 10. An external water bath contains a vessel of smaller dimensions which is connected with a water-cooled reflux condenser. Mixtures of ethyl and methyl alcohol and water used to provide desired temperatures and the seeds, in closed test-tubes, are suspended through closed perforations.

After quantities of seeds were exposed to a given temperature for various lengths of time, they were sterilized in an aqueous solution of silver nitrate and placed in sterile petri dishes for germination. Daily records were kept as in table I. Increased time of heating shows a delay in germination as well as a fall in germination percentage which is also true of seeds stored for a long time at room temperature.

Table II shows the life duration at various temperatures as found by experiment and the calculated life duration according to the formula. The constants *a* and *b* were found by the method of least squares from the found values of T and Z, and from these T was calculated for the various values of Z. The found values agree quite closely with a curve plotted for the theoretical values.

The temperature coefficient of life duration of wheat is found to be 7 or 8 for each 10 degrees change of temperature. Goodspeed[4] working with barley found a coefficient of life

1. American Jour. of Physiology, 40:404, 1910; 43:1, 1911.
2. Zeitschr. fur Chemi. and Industrie die Kolloide, 5:291, 1909.
3. Ber. Bot. Gessels, 703-704, 1913.
4. Botanical Gazette, 51:220-224, 1911.

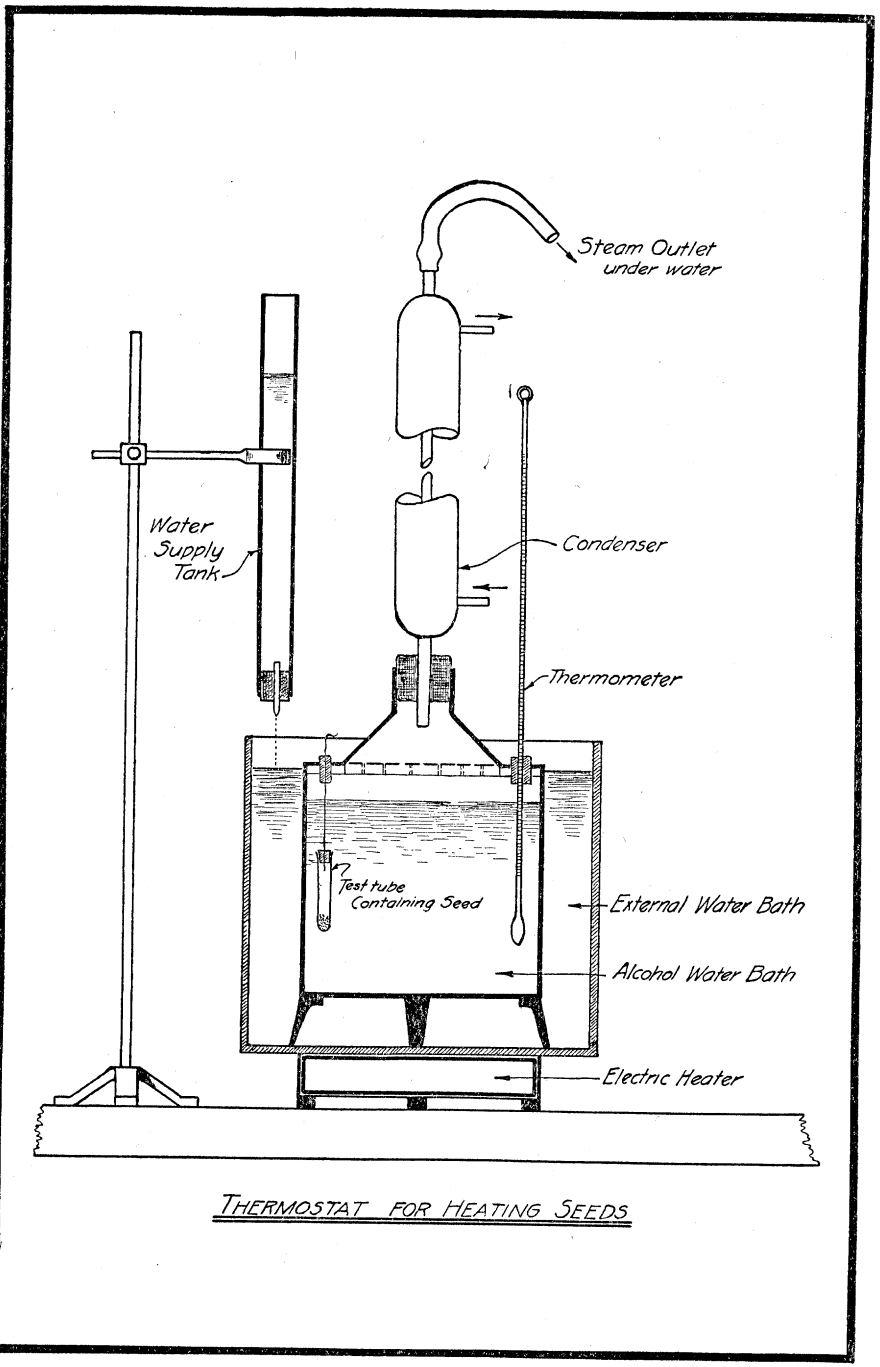
Steam Outlet
under water
Water
Supply
Tank
Condenser
Thermometer
Test tube
Containing Seed
External Water Bath
Alcohol Water Bath
Electric Heater
THERMOSTAT FOR HEATING SEEDS

Figure 10

duration of about 11, but since he did not control the water content, we are not justified in making a comparison. Loeb[5] working with sea urchin eggs found a coefficient of 500 to 1,000, while Moore[6] working with hydroids found a coefficient of about 1,000. The high water content in these cases probably materially affects the value. It should be noted that we are not dealing with a homogeneous system, but with a colloidal system and that it is not remarkable that the Van't Hoff temperature law for the rate of reaction does not apply.

Since here is a close agreement between the calculated and found values it seems probable that the time temperature formula for protein coagulation can be applied as a formula for the temperature-life duration for seeds. In order to establish the general application of this principle much more work is needed and several influencing factors are to be considered as here-to-fore outlined by Crocker and Groves[7]. The work shows possibilities of throwing light on the nature of the process of loss of vitality in seeds and of leading to a quantitative statement of the significance of various storage conditions, especially moisture content and temperature, upon the longevity of seeds.

This work was done under the direction of William Crocker, University of Chicago.

TABLE I

RECORD SHEET NO. 21, TURKISH RED WHEAT

Temp. 87.5. Moisture 12%, April 10, 1914.

Time in days	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
Control	0	2	2	4	3	3	0	0	0	0	0	0	0	0	0	0	0	0
	92	92	92	93	95	95	98	98	98	98	98	98	98	98	98	98	98	98
7 min.			0	15	12	7	8	7	8	7	5	3	3	4	4	4	3	2
			2	5	27	41	49	55	61	64	67	70	72	72	72	72	73	74
8 min.					4	8	8	7	8	7	5	3	1	5	1	1	1	0
					5	10	25	30	35	41	47	52	54	54	58	59	59	60
9 min.						2	4	4	5	4	5	4	5	2	3	6	5	4
						2	4	8	10	11	18	25	28	32	34	35	37	38
10 min. (Percent partially germinated										1	3	4	6	4	3	3	4	5
(Percent Germinated										0	0	0	0	4	5	9	11	11
11 min.												1	1	0	0	1	2	1
												1	1	2	4	4	4	5
12 min.													2	2	2	2	2	2
													0	0	0	2	2	2
13 min.																0	0	0

5. Archiv. Ges. Physiol. 124:411.
6. Archiv. Entiv. Mech. 29:145-287.
7. Proc. Ntl. Acad. of Sci., Vol. I, p. 152, 1915.

TABLE II.

GERMINATION RECORD TURKISH RED WHEAT

Theoretical temperatures calculated by formula: T=a-b log Z.

Notation: T=Temperature, Z=Time in minutes, a and b are constants.

Value found for a—98.88. Value found for b—11.78.

Trial No.	Duration in Minutes	Found Temperature	Calculated Temperature
A	7	89.2	88.9
B-C	8	87.7	88.2
D-E-F	9	87.5	87.6
G	10	87.5	87.1
H	15	84.4	85.0
I	18	84.4	84.1
J	45	78.9	79.4
K-L	50	79.1	78.9
M	50	78.5	78.9
N	120	75.8	74.4
O	315	71.3	69.5
P*	8 years	20	20.9

*Data from White's Experiment. Proc. Royal Soc. London, 81, 417, 1909.