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Botany. – *"The influence of temperature on the growth of the roots of Lepidium sativum"*. By Miss E. TALMA. (Communicated by Prof. F. A. F. C. WENT).

(Communicated in the meeting of April 28, 1916)

While I was engaged on an investigation of the influence of temperature on the growth of roots, I. LEITCH [1]) published "Some experiments on the influence of temperature on the rate of growth in *Pisum sativum*". This paper reached me a short time ago, as did almost simultaneously an abstract of a paper by LEHENBAUER. [2])

Although my investigations are not yet entirely completed, the above circumstances have induced me to publish a brief, preliminary account of the results obtained. SACHS mentions in his researches [3]) that probably a simple relation exists between root growth and temperature, but nevertheless his investigations have produced no data on this point.

In connection with BLACKMAN's views [4]) and the work on the influence of temperature on a number of vital processes, which has followed his publications, it was to be expected that an investigation according to a more modern method than that employed by SACHS, should yield some new results in the case of growth also.

The experimental object was *Lepidium sativum*; the seeds were soaked in water for one day, and then placed on vertical glass plates, covered with filter paper, in such a way that the rootlets grow down straight along the filter paper. On the third day the roots are placed in a thermostat: they have then attained a length of at least 8 m.m., so that it is possible to place a mark on an adult portion of the root. In the thermostat the temperature can be kept constant to within 0.3—0.4°, should the experiments last longer than 3 hours.

In order to avoid curvature of the roots, great care must be taken to provide fresh air and sufficient moisture, especially at higher temperatures.

Experiments in which the germination process also took place at a constant temperature, could not be made on account of the inadequate arrangements of the laboratory; perhaps they may yet be possible in the near future. Germination therefore took place at

1) Annals of Botany. January 1916. Vol. XXX. N°. CXVII. p. 25.
2) Bot. Centrallblatt, Bd 129. N°. 25. p. 662.
3) Pringsheim's Jahrbücher f. wiss. Botanik. Bd. 2. 1860 p. 338.
4) Annals of Botany. 1905, vol. XIX p. 281.

TABLE I.

Number of seedlings	Temperature during 3½ hours	Growth in m.m. expressed as mean
38	0°	0.1
88	10	1.46
44	15.7	2.31
96	20	3.2
29	22.7	3.53
26	23	3.73
54	25	4.15
60	26	4.25
140	27	4.76
50	28	4.82
20	29	4.45
67	30	4.27
72	32.5	3 61
44	35	2.45
21	39.6	0.98
49	40	0 86

TABLE II.

Number of seedlings	Temperature during 7 hours	Growth in m.m.	2 × value of growth in 3½ hours
59	20°	6.16	6.4
116	27	8.8	9.52
58	28	7.35	9.64
20	29	8.45	8.9
25	30	7.5	8.54
37	32.5	5.4	7.22
27	35	2.65	4.9
34	40	0.941	1.72

widely oscillating temperatures; the roots were of unequal length, but in the experiments made hitherto the rate of growth was found to be independent of the length, at least when the latter was between 13 and 25 m.m. In experiments which last for more than 7 or less than $3^1/_2$ hours it is not impossible, that the initial length may have some effect on growth.

The rate of growth was determined macroscopically at temperatures between 0° and 40° during $3^1/_2$ and 7 hours and the results have been represented by tables and curves.

In table I successive columns indicate: 1. the number of seedlings in the experiment, 2. the temperature at which the experiment was carried out during $3^1/_2$ hours, 3. the growth in m.m. expressed as the mean, calculated in the usual manner.

The same data, shown in table I for $3^1/_2$ hours, are shown in table II for observations of 7 hours' duration. In addition the latter table has a fourth column, giving the calculated growth increment for 7 hours in the thermostat, if the rate of growth in the second period of $3^1/_2$ hours had been the same as in the first period of $3^1/_2$ hours.

The tables show that for experiments of $3^1/_2$ hours' duration the optimum lies at 28°. Whilst at temperatures below 27° the rate of growth gradually diminishes, irregularities occur at higher temperatures; exterpolation according to BLACKMAN does not seem possible.

Furthermore growth was observed at 0°; there is no sudden cessation of growth; SACHS' representation of the minimum is therefore not correct. Probably something of this kind also applies to the maximum.

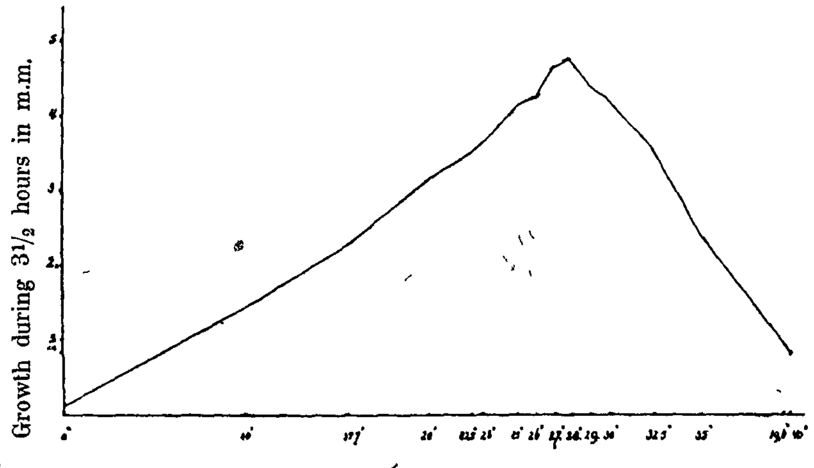

Fig 1

Experiments at temperatures above 40° have not yet been made; it is probable that the value recorded for the rate of growth at 40° must already in part be attributed to the time which elapses between the determination of the initial length and the establishment of thermal equilibrium. Such observations above 40° will have to be made microscopically.

The results become still clearer by graphic representation in figs. 1 and 2. Here the abscissae indicate temperature, the ordinates the growth in m m. In fig. 2 the curves from 27° onwards have been drawn on a larger scale, in order to make more evident the falling off of the rate of growth at higher temperatures, with increased duration of the experiment. The dotted line in fig. 2 records the

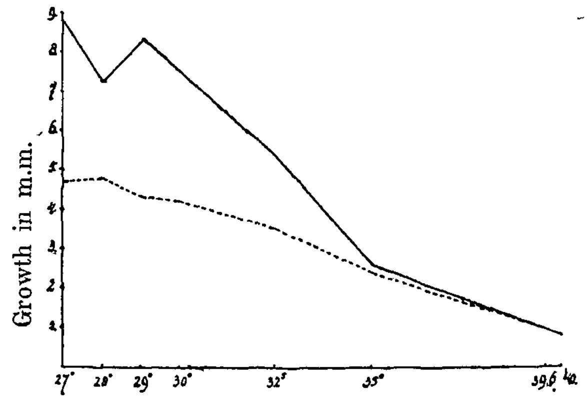

Fig 2

TABLE III.

Temperature coefficients for experiments of 3½ hours
$\frac{10^\circ}{0^\circ} = \pm 14$
$\frac{20^\circ}{10^\circ} = 2.2$
$\frac{26^\circ}{16^\circ} = 1.9$
$\frac{30^\circ}{20^\circ} = 1.3$
$\frac{35^\circ}{25^\circ} = 0.6$
$\frac{40^\circ}{30^\circ} = 0.21$

growth in experiments lasting $3^1/_2$ hours; that drawn in full represents the growth in experiments of 7 hours. At and above 35° practically no growth takes place in the second period of $3^1/_2$ hours.

In conclusion the temperature coefficient has been calculated for intervals of 10°, relating to the observations during $3^1/_2$ hours.

We see, as has been indicated by COHEN STUART [1]) in his study of the subject, that VAN 'T HOFF's rule at most applies only over a small range; for the rest the coefficient falls with rise of temperature.

Utrecht, April 1916. *Botanical Laboratory of the University.*

Astronomy. — "*Determination of the constant of Precession and of the Systematic Proper motions of the stars, by the comparison of* KÜSTNER's *catalogue of* 10663 *stars with some zone-catalogues of the "Astronomische Gesellschaft"*". By C. DE JONG. (Communicated by Prof. E. F. VAN DE SANDE BAKHUYZEN).

(Communicated in the meeting of April 28, 1916).

1. *Introduction.*

The research, the results of which will here be given in an abbreviated form, originated in a subject for a prize essay which the University of Leiden gave out in 1914, that of determining the constant of precession and the systematic proper motions by a comparison of KÜSTNER's Catalogue of 10663 stars (Veröff. Bonn N°. 10) with Zone-Catalogues of the "Astronomische Gesellschaft". The essay which I wrote, was awarded the prize by the Faculty of Natural Science in Leiden. Prof. E. F. VAN DE SANDE BAKHUYZEN then suggested to me to continue the research and make it into a complete whole by using all the available material, i.e. that for which the difference of epoch with KÜSTNER is not too small, and reducing it in a strictly systematic manner; this suggestion I followed willingly.

It is indeed of importance to derive the constant of Precession and the elements of the motion of the sun from the above mentioned material; it is the only combination of catalogues with, at all considerable difference of epoch in which, for both, the magnitude-error has been eliminated or determined with sufficient accuracy. For the zone-catalogues of the Astr. Ges. two determinations of the error in

1) C. P. COHEN STUART. A study of temperature coefficients and VAN 'T HOFF's rule. Proc. Kon. Akad. van Wet. Amsterdam, 1912.