

THE EFFECT OF PRESSURE ON GROWTH.

F. M. ANDREWS, Indiana University.

Numerous experiments have been carried out to show the effect of air pressure on plants. Among these may be mentioned the work of Bert¹. Later Wieler² studied the question of reduced pressure of oxygen and Jentz³ of increased oxygen pressure. Some of these facts are also set forth by Pfeffer⁴. Czapek⁵ also points out a number of interesting researches on this subject.

The points to be mentioned briefly here, however, refer to the effect of water pressure on plant growth. That the roots of plants grow when submerged in water is common knowledge but when the pressure of the water is increased there is an effect which varies with the intensity of the pressure. The writer noticed long ago that centrifuging caused the roots of corn seedlings to become translucent due to the fact that part of the water surrounding the seedlings was forced into the roots. For example, the roots of the control or uncentrifuged seedlings retained their normal color in water, but those which were centrifuged and subjected to a force equivalent to a column of water 30 meters high, became clear in 15 minutes.

The combined action of centrifugal force and water pressure was observed in another experiment. In this case control seedlings of corn which were 3 cm. long grew 2 mm. in water in four hours at 24°C. The centrifuged corn seedlings of the same size and under exactly the same conditions grew only 1 mm. in four hours, under a water pressure of 30 meters. Numerous other experiments performed in this way using both smaller and greater amounts of water pressure verified these results.

In another series of experiments the seedlings of corn were subjected to water pressure without the action of centrifugal force. Corn seedlings 3 cm. long and used as controls grew, on the average, 2.1 mm. in four hours at 24°C. in this set of experiments. The corn seedlings 3 cm. long and which were subjected to a pressure of 30 meters of water grew 1.5 mm. in four hours at 24°C. The effect of pressure in this case which was equal to a column of water 30 meters in height amounted, therefore, to a growth check of .6 mm. in four hours.

A third series of experiments was performed to test out the effect of extremely high pressures on the growth of seedlings. Corn seedlings 2 cm. long were exposed to water pressure of 50 atmospheres at a favorable temperature for five minutes. At the end of this time the roots so treated were clear. These seedlings and other corn seedlings 2 cm. long used as controls were planted in sawdust. In 24 hours the

¹ Bert, P. *Compt. rend.* 1877 Tome 84 p. 1130.

² Wieler, A. *Die Beeinflussung des Wachsens durch verminderte Partiärpressure des Sauerstoffs.* Unters. a. d. Bot. Institut z. Tübingen 1833 Bd. I. p. 189.

³ Jentys, Stefan. *Ueber den Einfluss hoher Sauerstoffpressure auf das Wachstum der Pflanzen.* Unter a. d. Bot. Institut z. Tübingen 1886 Bd. II p. 419.

⁴ Pfeffer, W. *Pflanzenphysiologie* Zweite Auf. Bd. I. p. 548; Bd. II p. 133-134.

⁵ Czapek, F. *Biochemie der Pflanzen* 1905 Bd. II, p. 396 and the literature quoted in the above references.

controls were 4 cm. long while the seedlings from the pressure test were 3.6 cm. long. They continued to show some difference for three days after which time all were of the same average size and vigor.

Corn seedlings 2 cm. long were subjected in the second experiment to 100 atmospheres pressure under the same conditions. After 24 hours the controls averaged 4 cm. in length while the experimental seedlings were 3.2 cm. long on the average. In five days all were equal in size and vigor. Other experiments showed these seedlings to have become clear in three minutes.

In a third experiment corn seedlings 2 cm. long were placed in a water pressure of 200 atmospheres for five minutes. They became clear in about two minutes. When planted the controls averaged 4.2 cm. while the experimental seedlings averaged 2.8 cm. In seven days all seedlings averaged the same size and were equal in vigor.

In a fourth series of experiments corn seedlings 2 cm. long were placed in a water pressure of 400 atmospheres for five minutes. Experiments showed that they became clear on the average in one-fourth of a minute. In 24 hours the controls averaged 4.1 cm. in length while the test plants were 2.5 cm. long. In 12 days all seedlings were equally large and vigorous.

Finally corn seedlings 2 cm. long were placed in a water pressure of 600 atmospheres. As nearly as could be determined they became clear on the average in 10 seconds. In 24 hours the controls averaged 4.3 cm. and the test plants averaged 2.3 cm. in length. In 18 days all seedlings were of equal size and vigor. The high pressure recorded in the last five experiments was obtained by means of a Geneva Society high pressure pump which will produce pressures up to 1000 atmospheres. Melsens⁶ states that yeast will live under a pressure of 8000 atmospheres. Corn seedlings can withstand great pressure and recover in a comparatively short time. It is to be noticed, however, that the time of recovery is delayed according to the intensity of the pressure.

⁶ Melsens, *Comp. rend.* 1870. Bd. 70 p. 831.