# A BRIEF NOTE ON THE ACTION OF THE TOP OF A PLANT UPON THE ABSORPTION OF WATER BY THE ROOT

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(With one text-figure)

SACHS, in his classical work, has observed how much water the top of *Nicotiana latissima* could absorb and how much sap could exude from the stump when it was separated from the base of the stem. Exudation of 15 cc. of sap from the basal stump and the absorption of 200 cc. of water by the shoot during five days were ascertained. The water absorption by the top of the plant is 15 times as much as that by the stump and therefore this disproportin between them may tell us something about the relations of water economy in plant life. RENNER (1911) has removed the top of a plant and the stump was connected with a suction pump. He estimated the suction force of the plant shoot developed by transpiration at 10–20 atm. by noting the proportional relation between the amount of water absorbed by the transpiring top of the plant and that by the decapitated plant root under the application of a suction pump to the stump. RENNER (1929) has also removed the tops of sunflower seedlings and attached calibrated narrow glass tubes to the stumps in which the exudation of water could be determined from the movement of water meniscus in the tubes, the water surrounding the roots being replaced by glucose solutions of varied concentrations. The suction force of the stumps was estimated at about 1.6–4.2 atm. using a concentration of glucose solution in which no further exudation of water from the stumps happend. JOST (1916) and KÖHNLEIN (1930), however, could find no proportionality between the amount of water exuded from the stump of the decapitated plant and the intensity of the suction by a pump. The latter has also estimated the suction force of stumps of maize at 2.5 atm. using a similar method to RENNER's (1929). LACHENMEIER (1932) suggested that the increase of transpiration causes the increase of water absorption by the plant root and lately KRAMER (1932, 1933) came to the conclusion that the role of the plant root in the absorption of water had been greatly over-emphasized and that it is important only as an absorbing filter surface.

As seen from the literature stated above, it seems it should be taken into consideration that the suction force of the top of the plant developed by transpiration, may play some important rôle in the absorption of water by the plant root. The experiments reported in the present work were conducted to ascertain the action of the top of the plant upon the water absorption by the plant root under varied atmospheric moisture condition. Material and method are similar to those used before and described in the previous paper[1] of which details are omited here.

In the previous paper the writer has reported the fact that the decapitated plant stopped water absorption in a sucrose solution of a more diluted concentration than the intact plant did in a solution of some certain concentration and that a very slight absorption was again recognized. This difference of the suction force between the intact and the decapitated plant mainly results from an additional action of the shoot of the former. This relation may be expressed by the following formulae :

$$S_i=S_d+T \qquad \text{or} \qquad T=S_i-S_d$$

where $S_i$ is the suction force of the intact plant, $S_d$ is the suction force of the decapitated plant and T is the suction force of the top of the plant developed by transpiration.

Originally the suction force of the intact plant ($S_i$) is very dependent upon the degree of transpiration, accordingly the existence of some certain proportionality between the atmospheric moisture and the transpiration should be taken into consideration. Now to ascertain the suction force of the intact plant under varied atmospheric moisture the critical concentration of a sucrose solution, in which no water absorption can happen, was estimated. The results are shown in the following table and each $\Delta$-valus was estimated by the cryoscopic method.

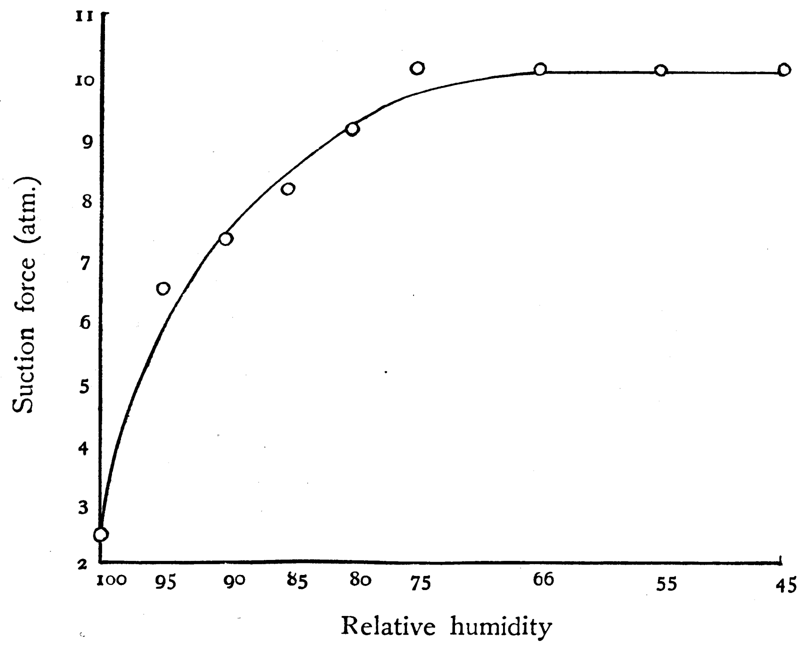
| Relat. humidity (%) | 100 | 95 | 90 | 85 | 80 | 75 | 65 | 55 | 45 |
|---|---|---|---|---|---|---|---|---|---|
| Conc. of sol. ($\Delta$) | 0.33 | 0.67 | 0.75 | 0.81 | 0.89 | 0.99 | 0.99 | 0.99 | 0.99 |
| Osmotic press. (atm.) | 3.98 | 8.07 | 9.03 | 9.76 | 10.72 | 12.04 | 12.04 | 12.04 | 12 04 |

The decapitated plant root stopped the absorption of water in the sucrose solution of $\Delta=0.13$ (1.57 atm), accordingly the suction force of the shoots (T) derived from the formulae stated above applying this value to them is shown in the following table.

1) Japan. Jour. of Bot. Vol. VII, 1934.

| Relat. humidity (%) | 100 | 95 | 90 | 85 | 80 | 75 | 65 | 55 | 54 |
|---|---|---|---|---|---|---|---|---|---|
| Suction force of shoot (atm.) | 2.41 | 6.50 | 7.47 | 8.19 | 9.15 | 10.47 | 10.47 | 10.47 | 10.47 |

The experimental results stated above are represented in the following graph.




One can see a certain proportionality between the suction force of the top of the plant developed by transpiration and the atmospheric moisture, because in the relatively moistened air some inverse proportion was recognized between them, but under a drier atmospheric condition the suction force of the plant shoot was almost constant in spite of the decrease of the atmospheric moisture. Under these conditions, it seems needful to take into consideration that the closing of stomata and the depression of transpiration resulting from it may play some part in this relation.

In another experiment, it is very interesting to note that the suction force of the intact plant shoot of which the stem and leaves were covered with vaseline was estimated at 2.4 atm. which is also the same as that of the saturated atmospheric condition.

From the experimental results stated above the suction force of the top of plant under the varied atmospheric moistures are 2—8 times as much as that of the root itself, accordingly the suction force of the top of plant on the absorption of water by the root should be taken into consideration as a very important factor, but the suction force of the root itself is not to be ignored as by KRAMER (1932, 1933) who regarded it as a mere absorbing filter surface, because it is estimated at about 1.57 atm.

Seasonal fluctuation of the suction force was also recognized. The values determined in summer time, which are shown in the previous paper, were a little larger than those which were estimated in winter.

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