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The regulating influence of transpiration and suction tension on the water and salt uptake by the roots of intact *Vicia faba* plants

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mechanism of the salt uptake (reviews of ARISZ (1945), NIELSEN (1951), BURSTRÖM (1951) and SUTCLIFF (1953)). The relation between transpiration to ion uptake and the energy supplied is not clear. Both total respiration and high suction tension may be no reason, therefore, for the result that uptake is greater at high transpiration tension than at low transpiration tension against salt uptake. Enhancing the suction tension by increasing the conductivity of the solution or increased turgescence of the root cells by increasing the suction tension in the xylem vessels (see also (7)).

Uptake at high as well as at low transpiration. This seems probable for both active and countersuction. According to other investigators. In order to get a better view of the mechanism (see (1953; LUNDEGARDH; 1953; 1954) always injurious, but not always, caused an inhibition of the uptake. Use of the long periods of time in the medium showed the result to be reversible.

In sucrose solution which was used as a mannitol solution,

view on the influence of the general validity of the results. A number of different experiments, in general, the same. This phenomenon is not unique. Using inhibitors of transpiration, water uptake and salt uptake. There was no reason to expect a transpiration stream for the uptake given above is not clear. At there is a passive mechanism of the author. A continuous connection between the results confirmed the results. However, a definite result without any reduction

in water uptake. A counter suction with sucrose did not give the results expected. In one experiment the water uptake was not influenced at all, while in another the water uptake was irreversibly reduced, accompanied by a reduction of the chloride uptake.

Investigating the influence of water uptake on anion uptake with *Vicia faba* plants, which were pretreated in a different way (BROUWER, 1953b), it appeared that the salt content, and in particular, the content of the ion investigated, determines the uptake of this ion to some degree. HELDER (1952) showed that in some cases utilisation assigns a limit to the uptake. If this limit is already reached at low transpiration we may expect that an increase in transpiration does not further promote the uptake. It is likely that this is the case if the ion content of the plant is high and the utilisation is limited. Hence a greater uptake by enhancing the transpiration can not be realised.

The resultant uptake from the medium is the difference between the entrance of ions into the root and leakage into the medium. Now the question arises whether the unchanged uptake is the result of a greater entrance into the root, an equally greater efflux from the shoot and subsequent leakage into the medium, or of an unchanged entrance of ions. The efflux from the shoot is discussed by ALBERDA (1948) and others and was demonstrated by PHILLIS and MASON and by MOORE (1945).

As indicated by the experiments of HOAGLAND and BROUWER the relative importance of the accumulation in the root system is dependent on the salt status. The latter will also influence the reaction of the salt uptake upon an increased water uptake.

Finally it may be stated, that the phenomenon described in this paper can only be expected if the transport of ions in the root tissue is the limiting factor in the uptake process.

A well-rounded picture of all these processes will only be possible if we are able to determine uptake, accumulation, transfer to the shoot and eventually efflux from the shoot at the same time.

SUMMARY

In the above a survey is given of the experiments on the water uptake described in preceding papers. It appeared that the water uptake is dependent on the suction tension in the xylem vessels and the water conductivity of the root tissue between medium and vessels.

Important stress is laid upon the water conductivity of the tissue, this conductivity being not the same under various circumstances. It is shown that the water conductivity increases on enhancing the suction tension in the xylem vessels. As to the different root zones it appeared that in this case the conductivity of the tip zone did not alter, whereas the conductivity of the basal zones strongly increased.

Moreover, such an increase in conductivity could be caused by enhancing the osmotic suction of the outer solution.

Both the increased suction tension in the xylem vessels and the

osmotic suction in the outer solution, cause a decreased turgescence of the root tissue. It is assumed that this decrease in turgescence is the direct cause of the enhanced water conductivity.

Applying various inhibitors in different concentrations it could be stated that water uptake and water transport are completely passive processes. In spite of this the water transport is controlled by the living protoplasm, because of the fact that inhibitors in high concentrations reduced the water uptake. It is assumed that this is caused by changes in the structure of the protoplasm.

Besides, the anion uptake of the various root zones is investigated. An apparatus to make possible these measurements is described.

At low water uptake the maximum anion uptake is found in the apical root zones, the basal zones showing a rather small anion uptake in this case. Increasing the water uptake the anion uptake increases, this increase being most important in the basal zones.

Moreover, on using respiration inhibitors in various concentrations it appeared to be possible to inhibit the anion uptake without reducing the water uptake. On the other hand an osmotic counter suction in the outer solution reduces water uptake without diminishing the anion uptake. Both processes water uptake and anion uptake, therefore, are related to one another, but this is not a direct relation. Comparing the water uptake and the anion uptake of the different root zones at low and high suction tension in the xylem vessels, it appears that the water uptake increases more than the anion uptake. The water conductivity of the different zones, however, increases to the same ratio as the anion uptake.

An explanation of this phenomenon can be obtained via the respiration. The respiration of the different root zones and also the salt respiration is the same at low and high water uptake. Accepting the hypothesis that the respiration delivers the energy for the anion uptake there is reason to assume that the driving force of the salt uptake is the same at low and high water uptake values, therefore, also at low and high anion uptake values. As a consequence of this fact the anion uptake at high suction tension in the xylem vessels is as much facilitated as the water uptake, or in other words the conductivity for water and anions is increased to the same degree. It is assumed that this is a reasonable explanation as to the influence of the water uptake on the salt uptake. Moreover, such an influence can only be expected if the resistance to the salt transport is the limiting factor in the salt uptake process.

A number of experiments are described dealing with the ratio between the total uptake and the amounts bound in the root tissue. The latter is more or less independent of the water uptake.

Anatomical studies show that the whole root up to at least 20 cm from the root tip, has a non-suberized epidermis and an endodermis in its primary stage. The difference between the various root zones, therefore, must be ascribed to physiological features such as a difference in age.

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