The Effect of Puncturing on Transpiration in *Codiaeum variegatum* (L.) A. Juss. (Euphorbiaceae)

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ABSTRACT *Transpiration is important phenomena occur in all plants. The present study is to evaluate the effect of puncturing on transpiration. Transpiration is one of the most crucial non- avoidable process in plants. Above 95% of water is lost from plants through transpiration. The relationship between puncturing on plants with transpiration was monitored here by using Ganong's potometer. Puncturing significantly disturbed the rate of transpiration indicating that it resulted in the capillary rise of water and releasing in the suction pressure which developed in the leaves.*

Keywords: *Codiaeum variegatum, Ganong's potometer, Puncturing, Transpiration.*

INTRODUCTION

Transpiration is the process of water movement through a plant and its evaporation from areal parts such as leaves stems and flowers .Water is necessary for plants but only a small amount of water taken up by the roots is used for growth and metabolism [1]. Transpiration occurs through the stomatal apertures, and can be thought of as a necessary "cost" associated with the opening of the stomata to allow the diffusion of carbon dioxide gas from the air for photosynthesis [2].

Mass flow of liquid water from the roots to the leaves is driven in part by capillary action, but primarily driven by water potential differences [3].. If the water potential in the ambient air is lower than the water potential in the leaf airspace of the stomatal pore, water vapour will travel down the gradient and move from the leaf airspace to the atmosphere [4]. This movement lowers the water potential in the leaf airspace and causes evaporation of liquid water from the mesophyll cell walls [5]. This evaporation increases the tension on the water menisci in the cell walls and decreases their radius and thus the tension that is exerted on the water in the cells. Because of the cohesive properties of water, the tension travels through the leaf cells to the leaf and stem xylem where a momentary negative pressure is created as water is pulled up the xylem from the roots [6]. In taller plants and trees, the force of gravity can only be overcome by the decrease in hydrostatic (water) pressure in the upper parts of the plants due to the diffusion of water out of stomata into the atmosphere [7]. Water is absorbed at the roots by osmosis, and any dissolved mineral nutrients travel with it through the xylem. The cohesion-tension theory explains how leaves pull water through the xylem. Water molecules stick together, or exhibit cohesion. As a water molecule evaporates from the surface of the leaf, it pulls on the adjacent water molecule, creating a continuous flow of water through the plan [8].

MATERIALS AND METHODS

Actively growing leafy twigs of *Codiaeum variegatum* (Euphorbiaceae) with same number of leaves, collected from three year old field grown plants were used for this study. The twigs that were cut under water, was fitted onto the wide mouth of the Ganong's potometer apparatus that was filled with water, through a one holed cork. The apparatus was made air tight, by smearing grease around the cork. The downward bend end of the apparatus was dipped in a beaker containing water (Figure 1) [9]. Four such experimental set up was established for the study. Of these, two sets were taken as control whereas the other two sets was taken as experiment, for the study on the effect of puncturing. The twigs fixed onto the experimental apparatus were punctured at the base of the twigs, with 9 injection needles of medium size. The needles were kept intact with the region of xylem tissue (Figure 2).

The experimental set up was placed in sunlight. An air bubble was inserted into the bend tube, after which the tip was dipped in the beaker containing water. The movement of air bubble inside the graduated horizontal tube was noted for every 30 minute. The air bubble was brought back to the original position with help of water released from the reservoir part of the apparatus, every 30 minutes as needed. The observation was made for 2 hours on the same day. On the next day, experiment was setup with leafless twigs. The twigs that were cut under water, was fitted onto the wide mouth of the Ganong's potometer apparatus that was filled with water, through a one holed cork. The apparatus was made air tight, by smearing grease around the cork. The downward bend end of the apparatus was dipped in a beaker containing water. The leafless twigs attached to two apparatus served as control; whereas the leafless twigs attached to the other two apparatus were punctured with needles as described above. The experimental set up was placed in sunlight. An air bubble was inserted into the bend tube, after which the tip was dipped in the beaker containing water (Figure 3 and 4). The movement of air bubble inside the graduated horizontal tube was noted for every 30 minute. The air bubble was brought back to the original position with help of water released from the reservoir part of the apparatus, every 30 minutes. The observation was made for 2 hours on the same day.

RESULTS AND DISCUSSION

A significant increase in the water absorption was noted in the punctured plant over the control. Yet plant showed wilting after one hour. But the control plant showed wilting only after 2 hours. In order to understand the effect of puncturing on the rate of absorption leaves were removed on the second set of experiment. Here also rise in water column was observed in the punctured twig. Whereas unpunctured leafless twig showed no rise in water column. As a result of puncturing in the basal region of stem some drop of water was oozed out. It might have increased the rate of water absorption by capillary movement of water. It was proved in the second set of experiment after removing the leaves of a same sized shoot. Then also absorption of water was more in the punctured shoot over the control (without leaves and puncturing). lt may be also due to the capillary movement of water up to the puncturing (Table I&II)..

The punctured twigs wilted earlier since the suction pressure developed in the leaves (mesophyl cells and intercellular spaces) to pull water from below was released due to puncturing. Hence sufficient water could not reach the leaves in that noon time. So these plants wilted very earlier than the control. The present study shows suction pressure developed in the leaves are responsible for ascent of sap or movement of water to the any height of the experimental plant [10].

The rate of absorption of water from wet, warm, and well-aerated soil is controlled largely by the rate of transpiration. During the night, however, when the rates of both transpiration and absorption are low, the rate of absorption of soil water is higher than the rate of transpiration. Hence trees tend to refill with water during the night. The lag of absorption behind transpiration during the day occurs because of the resistance to water movement present in the soil, roots, and leaves. When environmental conditions favor high rates of transpirational water loss, the roots function primarily as passive absorbing organs and the rate of absorption of water is controlled largely by the rate of transpiration. This is especially true when the soil is wet, warm, and well aerated [11].

Likewise the studies on transpiration, water absorption, and internal water balance of cotton plants as affected by light and changes in saturation deficit was conducted by Ehrler et al., [12]. Their studies reveals that, In controlled environment studies of cotton plants (*Gossypium barbadense* L.) a light-induced acceleration of transpiration upset the water balance established in the dark because of a lag in water absorption. A plant-water deficit could be generated either by sudden illumination at a given saturation deficit of the air, or by raising the sd in conjunction with illumination, without different effects.

Figure 1: Ganong's potometer experiment using leafy shoots of ***Codiaeum variaaegatum*** without puncturing (control)

Figure 2: Ganong's potometer with punctured leafy shoot

Figure 3: Ganong's potometer with leafless shoot without puncturing (right) and with puncturing (left)

Figure 4: Ganong's potometer with leafless shoot with puncturing.

Table I: Rate of water absorbed in Ganong's potometer by ***Codiaeum varigatum*** twig after puncturing from 10 'O 'clock in the morning on a sunny day.

Types of Twig	Water level in the Ganong's potometer			
	10:30 AM	11:00 AM	11:30 AM	12:00 PM
Normal Twig (Control) (40 leaves)	6.6	7.5	11.8	19.4
Punctured Twig (39 leaves)	12.4	14.4	16.1	22.1

Table II: Rate of water absorbed by twigs without leaves after puncturing.

Types of Twig	Water level in the Ganong's potometer			
	10:30 AM	11:00 AM	11:30 AM	12:00 PM
Normal Twig without leaves	No change in the water level			
Punctured Twig without leaves	4.2	5	5	5

CONCLUSION

The present study is to evaluate the effect of puncturing on transpiration. Above 95% of water is lost from plants through transpiration. The relationship between puncturing on plants with transpiration was monitored here by using Ganong's potometer. Puncturing significantly disturbed the rate of transpiration indicating that it resulted in the capillary rise of water and releasing in the suction pressure which developed in the leaves. Transpiration is the process of water movement through a plant and its evaporation from aerial parts, such as leaves, stems and flowers. Water is necessary for plants but only a small amount of water taken up by the roots is used for growth and metabolism. It also provides around 80% of the cooling effect of a shade tree and is a result of the evaporative cooling effects of transpiration.

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