Effect Of pH Stress On Transpiration Of Plants Using A New Instrument: AM Transpirator

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Abstract

Transpiration is a physiological process by which water vapour loss from the aerial parts of plants. Transpiration are 3 types i.e. stomatal, cuticular & lenticular. Stomata is a minute pore present in leaf through which maximum Transpiration takes place. About 80-90% of Transpiration takes place though stomata. The amount of Transpiration controlled by opening and closing of stomatal pore. Transpiration can be influenced by various factors such as light intensity, temperature, wind speed and soil etc. In this work there is an attempt has been made how AM Transpirator useful in detection transpiration and how pH affect transpiration and cell sap of root affect the pH of the solution. From the tabulation and graph it was concluded that the amount of transpiration is maximum in wind, moderate in sunlight and minimum in shade and the T/A value in all three conditions are almost equal to 1. This AM Transpirator used to study transpiration and T/A. It can be air tightened and handled easily and it is a low cost alternative of T/A apparatus. Its portable size is helpful in field work. Due to its low cost it can be used as a teaching model in schools of developing country for teaching transpiration and absorption. At higher alkaline condition the rate of transpiration is low and at high acidic condition the rate of transpiration is more. After transpiration pH of alkaline as well as acid water reduced. This may happen due to interaction of cell sap present in root. The pH of neutral water unaltered after transpiration. This data will be helpful in soil conditioning and phytoremediation program. The change in pH and solution may be due to cell sap and membrane transport, which needs further investigation.

Keywords: Transpiration, AM Transpirator, pH stress, environmental condition on transpiration.

Introduction

Transpiration is a physiological process by which water vapour loss from the aerial parts of plants. Transpiration are 3 types i.e. stomatal, cuticular & lenticular. Stomata is a minute pore present in leaf through which maximum Transpiration takes place. About 80-90% of Transpiration takes place though stomata. The amount of Transpiration controlled by opening and closing of stomatal pore. Transpiration can be influenced by various factors such as light intensity, temperature, wind speed and soil etc. Gardner *et.al.*(1963) found that in wilted plants the rate of transpiration is approximately proportional to available soil water content. Li jing-min *et.al.*(2011) suggested that the rate of transpiration can depends upon the opening and closing of micro pore and the diameter of the micro pore. Kramer *et.al.*(1937) derived the relationship between the rate of transpiration and rate of absorption in different types of plants, which includes tree, shrub, shrub and succulent species. Geo. F. Freeman *et.al.*(1908) found that the rate of transpiration is differing in plants of same species. Hagishima *et.al.*(2007) found that the rate of transpiration is more in the plants having low height as compare to the plants having more height of the same species of plants.

Generally, an equilibrium is maintained in between amount of water absorbed and amount of water lost in the form of transpiration. T/A apparatuses is used to demonstrate the relationship between amount of Transpiration and absorption in different environmental conditions. Practically main problems associate with

T/A apparatus is that it is difficult to achieve airtight condition, there is a chance of water evaporation from graduated side tube. This instrument is cost around RS/-500 INR and it is generally broken by students. To overcome such practical problems, we develop a low cost easy handled alternative of T/A apparatus and we have named it as AM Transpirator which costs around RS/-40 INR only. In this instrument achieving airtight condition is very easy. Here there no chance of evaporation from side tube so evaporation factor doesn't interfere with the result as in T/A apparatus. This instrument consists of a flat bottom wide test tube where a scale is fitted. A cork with small hole is fitted to the mouth of test tube. The size of AM Transpirator is smaller than T/A apparatus.

In this work there is an attempt has been made how AM Transpirator useful in detection transpiration and how pH affect transpiration and cell sap of root affect the pH of the solution.

Materials and Methods

Here a rooted plant was taken as material for detection of T/A using AM Transpirator and the effect of pH stress.

Procedure

1. Procedure for AM Transpirator:

Fill up the AM Transpirator with water.

Small rooted plant was introduced into the tube through the cork.

Airtight was made with Vaseline.

Note the initial level of water on the scale present on the tube as V1.

The whole is weight on a digital balance to note initial weight as W1.

The apparatus was kept under different environmental condition such as sunlight and shade to observe rate of transpiration and absorption by giving 60 minutes' interval.

After 60 min interval final weight of the apparatus taken as W2 & final volume of the water was recorded as V2.

Than T/A value was calculated.

2. Procedure for pH stress on transpiration:
   Different pH solution (5,6,7,8,9) was made using 1N NaOH & 1N HCL with help of a Hanna type pocket pH meter.
   Fill up the AM Transpirator with water with above different pH.
   Small rooted plant introduced into the tube through the cork.
   Airtight was made with Vaseline.
   Same plant used for different pH.
   The whole is weight on a digital balance to note initial weight as W1.
   The apparatus was kept under sunlight to observe rate of transpiration and absorption by giving 30minutes interval.
   After 30minutes interval final weight of the apparatuses taken as W2.
   After transpiration completed pH of the water was noted using pH mete and recorded as final pH.
   After complete of every experiment roots of the plants washed with normal water.

Results

The result of transpiration and value of T/A using AM Transpirator reflected in table-1.

The results of how PH affects the transpiration reflected in table-2.

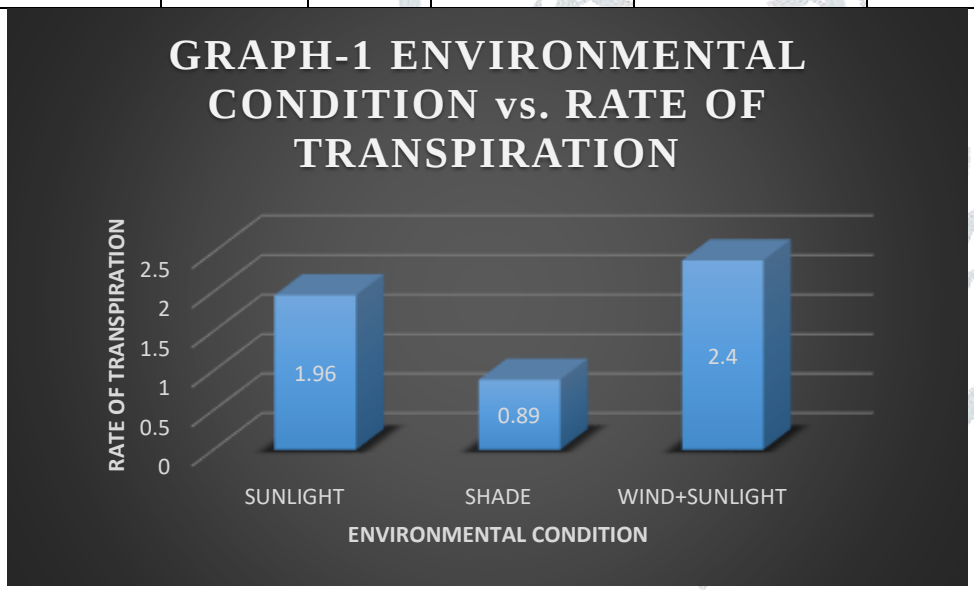
Comparison of transpiration reflected in graph number-1 and effect of PH on transpiration reflected on graph number-2.

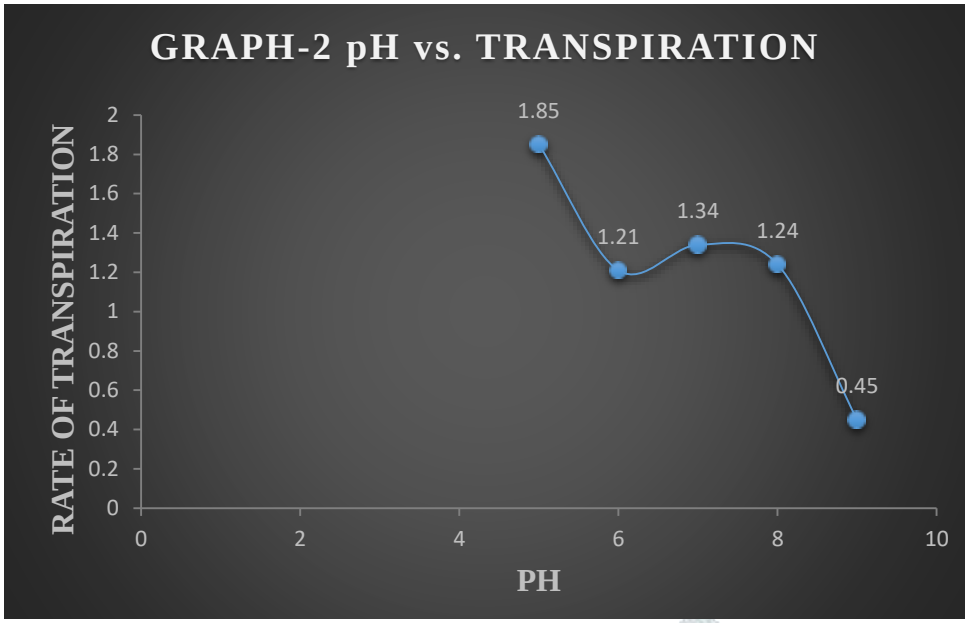
Table No-1: Rate of transpiration and value of T/A under different environmental condition:

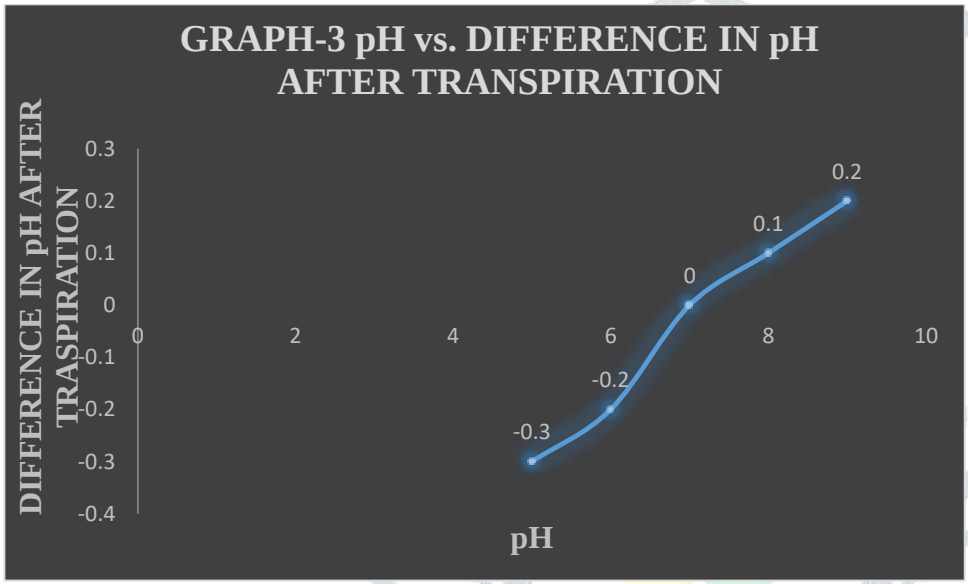
ENVIORNMENT	INITIAL WEIGHT W1	FINAL WEIGHT W2	INITIAL VOLUME V1	FINAL VOLUME V2	AMOUNT OF TRANSPIRATION T=W1-W2	AMOUNT OF ABSORPTION A=V1-V2	**T/A**
SUNLIGHT	111.45	109.49	11	9.1	1.96	1.9	1.03
SHADE	109.49	108.60	9.1	8.2	0.89	0.9	0.98
WIND+SUNLIGHT	108.60	106.20	8.2	6.0	2.40	2.2	1.09

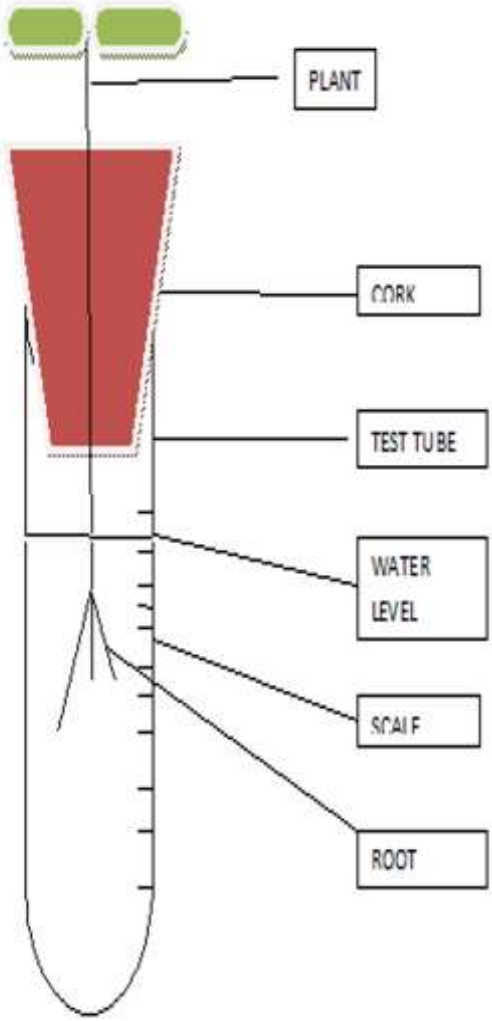
Table No-2: Effect of PH stress on transpiration of plants:

pH	INITIAL pH	FINAL pH	DIFFRENCE IN pH	INITIAL WEIGHT OF THE APPRATURES W1	FINAL WEIGHT OF THE APPRATURES W2	TRANSPIRATION T=W1-W2
9	9.0	8.8	0.2	108.74	108.29	0.45
8	8.0	7.9	0.1	107.05	105.81	1.24
7	7.0	7.0	0	105.85	104.51	1.34
6	6.0	6.2	-0.2	109.06	107.85	1.21
5	5.0	5.3	-0.3	106.93	105.08	1.85




GRAPH-2 pH vs. TRANSPIRATION
RATE OF TRANSPIRATION
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
0.2
0
1.85
1.21
1.34
1.24
0.45
0
2
4
6
8
10
PH


GRAPH-3 pH vs. DIFFERENCE IN pH AFTER TRANSPIRATION
DIFFERENCE IN pH AFTER TRASPIRATION
0.3
0.2
0.1
0
-0.1
-0.2
-0.3
-0.4
-0.3
-0.2
0
0.1
0.2
0
2
4
6
8
10
pH



AM Transpirator

Adjusting pH of the solution

Transpiration using AM Transpirator

Conclusion:

From the tabulation and graph it was concluded that the amount of transpiration is maximum in wind, moderate in sunlight and minimum in shade and the T/A value in all three conditions are almost equal to 1. This AM Transpirator used to study transpiration and T/A. It can be air tightened and handled easily and it is a low cost alternative of T/A apparatus. Its portable size is helpful in field work. Due to its low cost it can be used as a teaching model in schools of developing country for teaching transpiration and absorption.

At higher alkaline condition the rate of transpiration is low and at high acidic condition the rate of transpiration is more. After transpiration pH of alkaline as well as acid water reduced. This may happen due to interaction of cell sap present in root. The pH of neutral water unaltered after transpiration. This data helpful in soil conditioning and phytoremediation program. The change in pH and solution may be due to cell sap and membrane transport, which needs further investigation.

References

[1] Gardner, W. R., and C. F. Ehlig. 1963. The influence of soil water on transpiration by plants. Journal of Geophysical Research, 68(20): 5719-5724.

[2] Geo. F. Freeman. 1908. A method for the quantitative determination of transpiration in plants. Botanical Gazette, 46(2): 118-129.

[3] Hagishima, Aya, Ken-ich Narita, and Jun Tanimoto. 2007. Field experiment on transpiration from isolated urban plants. Hydrological Processes: An International Journal, 21(9): 1217-1222.

[4] Kramer, Paul J. 1937. The relation between rate of transpiration and rate of absorption of water in plants. American Journal of Botany, 10-15.

[5] Li, Jing-min, et al. 2011. A bio-inspired micropump based on stomatal transpiration in plants. Lab on a Chip, 11(16): 2785-2789.