Pakistan J. Bot. 2 (1): 55–62

DETERMINATION OF INTERNAL WATER BALANCE IN *EUCALYPTUS* UNDER FIELD CONDITIONS

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Abstract

Method for the determination of internal water balance for *Eucalyptus* under field conditions was standardised. For relative turgidity determination cutting leaf-discs and floating on water in a covered Petri dish for 6 hrs seems to be best for measuring the degree of water balance in *Eucalyptus*.

Introduction

In the fast growing economy of Pakistan, the importance of forests hardly needs emphasis. Amongst different exotic introductions, *Eucalyptus* seem to hold prominence in view of their adaptation to relatively dry conditions (Boden 1968). At present, a large number of *Eucalyptus* species are available with the Forest Department (Pryor 1967). However, under dry conditions success of a variety/ species depends largely on its ability to maintain favourable internal water balance. It is therefore necessary that new varieties/species be physiologically tested before they are released for general plantation.

In the past, determinations of osmotic pressure, diffusion pressure deficit (DPD), water saturation deficit and relative turgidity have been proposed as a measure of internal water balance in plants (Walter 1931, 1955; Stocker 1929 and Weatherley 1950). The lack of general acceptance of the many methods has restricted a detailed study of plants. However, determination of the relative turgidity has gained wider acceptance amongst Plant Physiologists working with ecophysiological problems. Relative turgidity expresses the initial and the fully saturated weight of the plant tissue on percentage basis under field conditions.

The following studies propose to standardize relative turgidity technique (Weatherley 1950) for water balance studies under field conditions.

Materials and Methods

(a) *Plant material:* The source of plant material was *Eucalyptus gomphocephala* A.D.C. growing in the Botanical Garden of the Pakistan Forest Institute, Peshawar.

(b) *Method:* Relative turgidity as proposed by Weatherley (1950) is expressed as under:

$$\%\text{Relative turgidity} = \frac{\text{Fresh wt} - \text{Oven dry wt}}{\text{Turgid wt} - \text{Oven dry wt}} \times 100$$

Relative turgidity is determined on the excised leaf discs. Standardised technique has to be evolved before we can expect reproducible results. Relative turgidity values may be affected by different variables and in the present study these variables were examined. Thirty leaf discs of 0.5 cm (unless specified otherwise) were excised between 8-0 A.M. to 9.0 A.M. with a leaf-punch from amongst equal member of healthy adult leaves taken from all the four sides of the tree. Care was taken to avoid mid-ribs in the discs. Ten discs were collected at random from the lot to form one replication and there were three such replications. Weight was determined on a Mettlar balance. The discs were floated on water and then removed at 2-hr intervals, blotted out surface-moisture and weighed immediately till constant weight was obtained. The experiments were performed in September-October, 1969.

Results

(a) *Comparative saturation period to attain equilibrium in leaf discs and full leaves:* Three saturation chambers were used: (1) Leaf discs were floated on water in a covered pair of Petri dish, (2) full leaf with cut-petiole was immersed in 400 ml capacity beaker and placed under Bell-jars and (3) the leaf discs were floated on water in Petri dish.

Table 1 shows that leaf discs floated on water and covered with other pair, were faster in attaining equilibrium than the rest of the treatments. In case of full leaf, turgidity was not attained even after 24 hrs.

(b) *Optimum absorption period by leaf discs:* Leaf discs were floated on water in Petri dishes. Observations on the water uptake were made after every 1 hr interval.

Fig. 1 shows that the leaf discs became turgid in 6 hrs after placement.

(c) *Effect of leaf discs size on water uptake:* The different size of discs viz. 1.2, 0.5 cm dia were tried.

Table 2 shows that there was no significant difference on the water uptake in relation to the size of the discs.

TABLE 1

Percentage of water uptake by leaf discs and leaf in saturation chambers / initial weight as 100

A. Leaf discs floated on water in covered Petri dish

Time of observation (hrs)	Percentage of water uptake by leaf discs		
	Replication (R)		
	R1	R2	R3
8.30	100.0	100.0	100.0
10.30	105.9	106.2	107.2
12.30	106.6	107.0	108.4
14.30	106 8	107 7	108.6
16.30	106.8	107 9	108.8
18.30	106.9	107.7	108.8
20.30	106.9	107.8	108.9
24.00	—	—	—
30.00	—	—	—

B. Leaf discs floated on water in open Petri dish

8.30	100.0	100.0	100.0
10.30	104.9	105.2	105.3
12.30	105.6	105 7	106.3
14.30	107.1	109 7	107.3
16.30	107 9	109 8	108.5
18.30	108.1	110.3	108.8
20.30	108.2	111.8	109.3
24.00	—	—	—
30.00	—	—	—

C. Leaf immersed in water in beakers

8.30	100.0	100.0	100.0
10.30	102.3	102.5	102.6
12.30	102.9	103.1	102.8
14.30	103.5	103.6	103.7
16.30	104.1	103.9	104.3
18.30	104.9	104.6	105.1
20.30	105.7	105.6	105.8
24.00	107.8	108.3	108.7
30.00	108.6	109.3	109.2

TABLE 2

Effect of leaf disc size on water uptake

Disc size (cm)	Replicates	Initial weight of discs taken as 100	Final weight of discs	% water absorbed
0.5	1	100	105.8	5.8
	2	100	106.0	6.0
	3	100	105.9	5.9
1.2	1	100	106.2	6.2
	2	100	106.3	6.3
	3	100	106.0	6.0

Required value of t for 2 d.f. at 5% level =4.303
Calculated value =0.607 (N.S.)

TABLE 3

Effect of light intensity on water uptake

Light intensity	Replicates	Initial wt of discs	Final wt after water absorbed	% water absorbed
Full day light	1	100	107.2	7.2
	2	100	107.5	7.5
	3	100	107.3	7.3
Under diffused light	1	100	107.4	7.4
	2	100	107.5	7.5
	3	100	107.6	7.6

Required value of t at 5% level =4.303
Calculated value =0.602 (N.S.)

TABLE 4
Effect of age of the leaf on water uptake

Age of the tissue	Replicates	Initial wt of discs	Final wt of discs	% water absorbed
Young	1	100	108.0	8.0
	2	100	107.9	7.9
	3	100	107.8	7.8
Old	1	100	107.6	7.6
	2	100	107.8	7.8
	3	100	107.5	7.5

Required value of t at 5% level =4.303
Calculated value =0.304 (N.S.)

(d) *Effect of light intensity on water uptake by leaf discs:* Leaf discs were cut and floated on water in Petri dish. In one case, the dishes were placed in the open full day light intensity. In other, the Petri dishes were placed in the laboratory under diffused light.

Table 3 shows that there was no significant difference on the relative uptake of water by discs.

(e) *Effect of age of the leaf on the water uptake by leaf discs:* Leaf discs from the young and the adult leaves were excised. Their relative water uptake was compared by floating the leaf discs on water in Petri dishes.

Table 4 shows that the young leaves absorb comparatively more water although the differences were not significant.

Discussion

These studies have clearly brought out that in *Eucalyptus* species, the optimum saturation can be achieved within a period of 6 hrs by floating leaf discs on water in Petri dishes and covered with the other pair. However, the discs continue to absorb water even after 6 hrs. In view of the results of Weatherley (1950), Barrs and Weatherley (1962) where it was pointed out that an initial rapid water uptake phase exists, 6 hr period seems to be sufficient (Fig. 1).

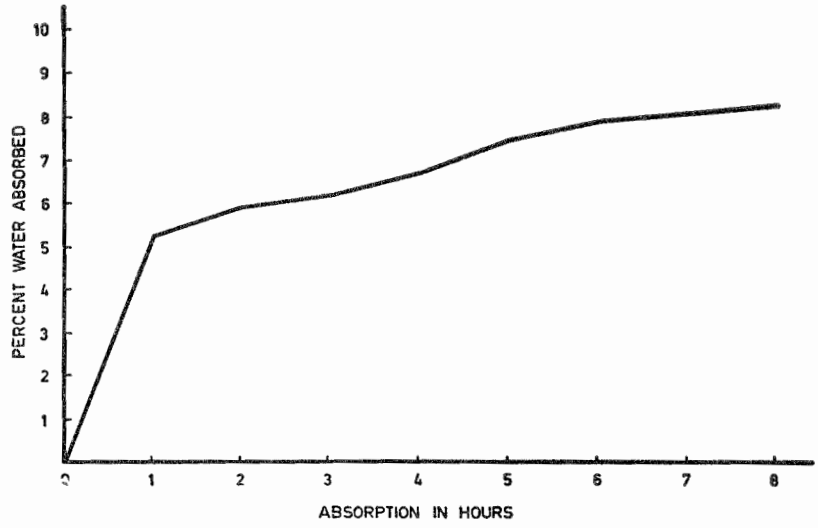

Fig. 1. Optimum absorption period in leaf-discs of *E. gomphocephala*.

Data presented in Tables 2 and 3 have clearly shown that a slight variation in light and size of discs have no appreciable effect on the relative uptake of water by discs. In view of the convenience in the tissue used; time required for saturation, it seems that the relative turgidity technique by floating leaf discs on water in Petri dishes is suitable for water balance studies in field conditions.

According to Pryor (1967) *Eucalyptus* can provide a return much greater in volume than that from the existing forest plantations for the same amount of water consumed provided improved silvicultural methods are adapted and the intensive management is supported by active relevant research in physiological studies and tree improvement by breeding and selection. For the selection of suitable species for introduction in West Pakistan, the best practical way is to select species from homoclimes (Quadri 1968). Even such species will need elimination trials to find out the best ones for particular zones in West Pakistan for their growth performance and physiological adaptability. So, with the later object in view, the method for determining the internal water balance in *Eucalyptus* was standardised. Application of the above coupled with studies on transpiration behaviour in *Eucalyptus* in Experimental Plantations may help in correlating the actual growth behaviour observed in the field and thus time can be saved for recommending large scale plantations of suitable species of *Eucalyptus*. Further work in this direction is in progress.

Acknowledgment

The authors are grateful to Mr. Rafiq Ahmad Chaudhry, Assistant Forest Economist, Pakistan Forest Institute, Peshawar for his help in the statistical analysis of the data and to Mr. Mohammad Iqbal Sheikh, Silvicultural Research Division, Lahore for some literature on *Eucalyptus*.

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