



Evaluation of relative water content in some selected herbaceous plants along the Kosi Watershed, Kumaun Himalaya

Bhawna Pandey, Mahima Garkoti, Ravindra Kumar, Naveen Chandra, Dhani Arya*

Department of Botany, Soban Singh Jeena University Campus, Almora, Uttarakhand, India

Abstract

The study provides insight into the relative water content of various plant species found along the Kosi watershed. Measurements of relative water content (RWC) are commonly used to assess the water status of plants. A little change in water availability can cause significant changes in plant productivity and/or species composition. These changes affect their physiological mechanisms and enable them to adapt and maintain their diversity. Relative water content is proportional to cell volume, and represents the balance between water supply to the leaf and transpiration rate. This affects the plant's ability to recover from stress. The objective of the present study was to evaluate the RWC of some selected plant species that were found along the Kosi Watershed. It was found that plants with higher RWC values are generally better hydrated and may be more resilient to stress conditions, while those with lower values may be experiencing some degree of water stress.

Keywords: relative water content, water contents, Kosi watershed, Himalaya

Introduction

Riverine vegetation is often mistaken for having continuously flooded and/or retained water conditions. However, they often experience significant hydrologic variations (Mitsch WJ 2000; WK 2002) [17, 28]. A little adjustment in water availability can cause significant changes in plant productivity and/or species composition (Mitsch WJ 2000; Rood 2002; B. W. Touchette *et al.* 2008) [17, 21, 26, 27]. Rivers are intermittently exposed and/or seasonally flooded, resident vegetation must tolerate highly unstable water conditions (Bradley 2002; Gerla 1992) [7, 13]. A water deficit, on the other hand, can grow during periods of very low precipitation or drought, typically extending the duration and heightening the degree of water stress (Touchette and Frank 2009) [26, 27]. These hydrologic variations affect their physiological mechanisms and enable them to adapt and maintain their diversity. Photosynthesis is the fundamental physiological processes for growth and productivity (Lawlor, 1995) [9]. Excess water availability primarily affects the growth of leaves and roots, resulting in stomatal closure, degrade chlorophyll content, leaf senescence and yellowing which restrict the ability of leaves to capture light and ultimately a decline in photosynthetic rate (Blum 1996; Kuai *et al.* 2014) [5, 14]. The main cause of this decline is hypoxia (low concentration of oxygen in the soil). An excess of water reduces the concentration of oxygen in the soil, which affect the nutrient and water intake, synthesis and translocation of growth regulators, respiration and photosynthesis which decreases the diversity of plants (Ferreira, J. L., Coelho, C. H. M., Magalhães, P. C., Sant'Ana, G. C., & Borém 2008; Sairam *et al.* 2008) [11, 22].

The effects of water stresses have been investigated by a number of workers (Akhtar, iqra and Nazir 2013; Muhammad Arslan Ashraf 2012; Naidoo 1985) [1, 18, 19, 20]. (Ferrer, J. L. R., Magalhaes, P. C., Alves, J. D., Vasconcellos, C. A., Nwlson, D. F., Fries, D. D., ... & Purcino 2005) [12] says that the decrease in water absorption,

transpiration and respiration decreases the growth of plants. (Boyer 1976) [6] states that leaf water potentials that induce stomatal closure also inhibit chloroplast activity. (Naidoo 1983) [19, 20] reported lowering of tissue water potential and increased stomatal resistance caused by chloroplast injury due to prolonged flooding. Plant water relations can be studied at different levels, viz., relative water content and osmotic regulation. Relative water content is proportional to cell volume, and represents the balance between water supply to the leaf and transpiration rate (Farquhar, G. D., Wong, S. C., Evans, J. R., & Hubick 1989; Schonfeld *et al.* 1988) [10, 23]. This affects the plants ability to recover from stress (Lilley and Ludlow 1996) [15].

Relative water content is a measure of percentile water content within plant cells at full turgor (Taiz, L. and Zeiger 2006) [25]. If the relative water content reduces it has a negative effect on stomatal conductivity and photosynthetic efficiency and is therefore directly related to plant growth and development (Alexieva *et al.* 2001; Atteya 2003; Cornic 2000) [2, 3, 8]. High RWC is the result of effective osmotic regulation, in which the plant cell actively maintains a suitable solute concentration to drive the uptake of water. Less elastic cell wall limit water uptake and result in reduced RWC because the cells would not be able to expand and become turgid. In healthy plants, osmotic regulation and the elasticity of cell walls work together to maintain turgor pressure and a high RWC, which are crucial for various physiological processes, including growth and nutrient intake. Normal values of RWC range between 98% in turgid and transpiring leaves to about 40% in severely desiccated and dying leaves (Lugojan, C., & Ciulca 2011) [16]. The present study was done to evaluate the relative water content of some selected herbaceous plants found along the Kosi watershed.

Material and methods

Leaf samples of plants were collected from the Kosi region of the Kosi watershed (N29°38. 125' E079°37. 601'). The

selected plant species for the evaluation of RWC is: *Persicaria barbata*, *Xanthium strumarium*, *Agretina adenophora*, *Dysphania ambrisoides*, *Ranunculus pygmaeus*, *Hydrocotyle sibthorpioides*, *Bassia hyposifolia*, *Verbascum thapsus*, *Gnephaliium polycarp*, and *Persicaria capitata*. To assess plant RWC, the upper and fully expanded leaf of each plant was excised at the base of the petiole. Three samples of leaves were collected from each plant from 11 a.m. to 12 p.m. The leaf samples were immediately put in polythene bags and transferred to the laboratory as quickly as possible in order to minimize water losses due to evaporation. The samples were also weighed immediately as fresh weight (FW) with the help of an electronic balance. The leaf samples were then transferred to a petri-dish with distilled water at room temperature for 4 hours. After 4 hours, the fully turgid leaves were removed from Petri dishes, and the leaf surfaces were blotted with filter paper to remove the excess moisture before the determination of the turgid weight (TW). The turgid leaf samples were then kept in an envelope and oven-dried at 70°C for 2 hours, after which dry weight (DW) was

determined. Relative water content was calculated using the standard equation (Barrs 1968) [4].

$$RWC\% = \frac{\text{fresh weight} - \text{dryweight}}{\text{turgid weight} - \text{dryweight}} \times 100$$

Results and Discussion

The result from the experiment was illustrated by Table 1 showing RWC of different plant species. It was observed that *Bassia hyposifolia* has the greatest RWC i.e, 96.6% followed by *Hydrocotyle sibthorpioides* i.e, 95.1%. There was a very slight variation seen in RWC of *Agretina adenophora* and *Persicaria barbata* which is 89.28% and 88.58% respectively. *Persicaria capitata*, *Ranunculus pygmaeus*, *Gnephaliium polycarp*, and *Xanthium strumarium* has a RWC of 85.16%, 83.3%, 82.07%, 80.54% respectively. *Dysphania ambrisoides* and *Verbascum thapsus* was the lowest value of RWC i.e, 75.80% and 79.25% respectively.

Table 1: List of different plant species along with their relative water content values.

Plant species	RWC %	RWD %
<i>Persicaria barbata</i>	88.58	11.42
<i>Xanthium strumarium</i>	80.54	19.46
<i>Agretina adenophora</i>	89.28	10.72
<i>Dysphania ambrisoides</i>	75.80	24.2
<i>Ranunculus pygmaeus</i>	83.3	16.7
<i>Hydrocotyle sibthorpioides</i>	95.1	4.9
<i>Bassia hyposifolia</i>	96.6	3.4
<i>Verbascum Thapsus</i>	79.25	20.75
<i>Gnephaliium polycarp</i>	82.07	17.93
<i>Persicaria capitata</i>	85.16	14.84

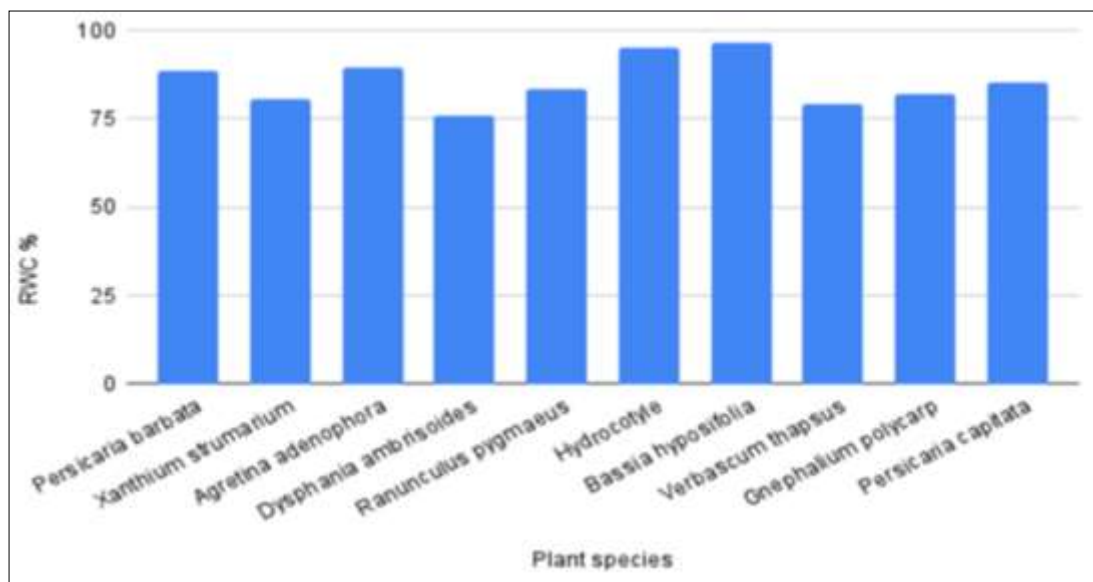


Fig 1: Graph showing different plant species along with their relative water content values

The high value of RWC of *Bassia hyposifolia* and *Hydrocotyle sibthorpioides* followed by *Agretina adenophora* and *Persicaria barbata* shows that they maintain a high level of hydration in their cells, which was crucial for various physiological processes, including photosynthesis, nutrient uptake and cell expansion. High value of RWC contributes to turgor pressure, which helps in maintaining the rigidity and structural integrity of plant cells

and tissues. This was important for plant growth and stability. High value of RWC can be a sign of relief from water stress or favourable environmental conditions. *Persicaria capitata*, *Ranunculus pygmaeus*, *Gnephaliium polycarp*, and *Xanthium strumarium* has a moderate water content. The low value of RWC of *Dysphania ambrisoides* and *Verbascum thapsus* shows that the plant is experiencing some degree of water stress and is often associated with

wilting, reduced photosynthesis and overall poor health of plant. The RWC value also helps in calculating the RWD (Relative Water Deficit), which is 100-RWC (Shimshi 1973) [24]. The higher the value of RWC, the lower will be its RWD. Table 1 shows that the RWD value of *Bassia hyposifolia* and *Hydrocotyle sibthorpioides* is very low among all the plant species studied indicating their high value of RWC.

Conclusion

From the above discussion we can conclude that RWC values provide insight into the hydration status of different plant species. Plants with higher RWC values are generally better hydrated and may be more tolerant to stress situations, while those with lower values may be facing some degree of water stress. They attempt to overcome such adverse conditions by making an osmotic adjustment by maintaining the balanced state with respect to relative water content, which help the plants to overcome the adverse environmental conditions. Thus plant water relation parameters are very important to know the water stress index of a plant. Higher value of RWC, leads to improved photosynthetic characteristics, and membrane stability.

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Conflict of interest

No potential conflict of interest was reported by the authors.

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