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CONTRIBUTION OF LATEX CATIONS TO THE WATER RELATIONS AND LATEX YIELD IN *HEVEA BRASILIENSIS*

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The latex cationic composition and their contribution to osmotic potential were studied in eight *Hevea* clones (RRII 43, RRII 118, PB 311, RRII 105, GT 1, RRII 308, RRIM 600 and Gl 1) during the peak yielding (October - November) and summer (February - March) seasons. The differences in the concentrations of potassium (K), calcium (Ca) and magnesium (Mg) in the latex were significant among the clones. K and Mg contents in the latex were influenced significantly by seasonal effect and varied differently among clones. All the clones showed low osmotic potential during the summer stress season compared to the peak yielding season. The contribution of K to osmotic potential was found to have significant seasonal and clone x season effects and in the latex it ranged between -2.4 to -3.14 bars during October-November and -2.4 to -3.00 bars during February- March. The clone GT 1 having lesser variation in the latex K content during the peak yielding and stress seasons showed the highest osmoregulation.

Keywords: Cations, *Hevea brasiliensis*, Osmotic potential, Osmotic regulation, Water relations

INTRODUCTION

Harvesting of latex from *Hevea* trees is carried out by tapping the tree bark. While tapping, the latex vessels are opened up and the latex exudes from the vessels by hydrostatic pressure. There is pressure drop in the laticifers and therefore water from the surrounding cells enters into the laticifers resulting in the dilution of the latex and continuous flow of latex. This leads to osmotic imbalance in the laticifer tissue, ultimately leading to bursting of lutoid particles present in the latex which accelerates coagulation of latex. Latex flow from the tree is influenced by plant-water relationship (Buttery and Boatman, 1976). Latex yield during rainy and summer seasons is influenced by osmotic potential of B and C-sera of latex (Satheesan *et al.*, 1982). It was reported that high yielding clones that had high rubber yield during summer have maintained a high osmotic concentration in the C-serum of latex. The capacity of the tree to overcome the fluctuation in osmotic environments in latex influences its performance during summer periods (Raghavendra *et al.*, 1984).

The osmoticum of *Hevea* latex is maintained mainly by carbohydrate components (d'Auzac and Jacob, 1989). Osmolytes other than the organic solutes present in the latex are the mineral components. The minerals present

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in the latex may also act as activators/ cofactors of enzymes in the rubber biosynthetic pathway. Many of the key latex biosynthetic enzymes require magnesium (Mg) as cofactor (d'Auzac, 1965). Magnesium is therefore considered as one of the physiological factors related to rubber yield (d'Auzac and Jacob, 1989). The high level of Mg and Mg/Pi ratio was reported to be associated with early coagulation of latex at the tapping panel (Beaufils, 1957). Potassium (K) is another major mineral element in the latex. The importance of latex K in bringing down the Mg/Pi ratio was reported in *Hevea* (Beaufils, 1954). The role of phosphorus and potassium in latex stability has been reported by Philpot and Garth (1953). Potassium is involved in the activation of tonoplast pyrophosphatase and pyruvatekinase (Jacob *et al.*, 1989). Yield and rate of flow were found to be enhanced by K application (Watson, 1989). Moreover, K is one of the major osmotica of latex and it is reported as one of the factors for the changes in osmotic potential under water stress in *Hevea* (Karyudi, 2004). The contribution of inorganic ions to the water relations in *Hevea* is so far not been studied in detail. The present study was conducted to understand the seasonal status of Mg, Ca and K in the latex and its contribution to water relation leading to latex yield in *Hevea* clones.

MATERIALS AND METHODS

Eight clones of *H. brasiliensis* (RRII 43, RRII 118, PB 311, RRII 105, GT 1, RRII 308, RRIM 600 and Gl 1) in the eighth year of tapping in the experimental field of Rubber Research Institute of India, Kottayam, were used for the study. The experiment was conducted in randomized block design with five replications. The observations were made during the periods of October - November (peak yielding season) and February - March (stress season). All the trees were under S/2 d2 system of tapping.

Latex samples from individual trees were collected in ice. Five grams of latex extracted with 2.5% trichloroacetic acid (TCA) and used for the estimation of inorganic ions. Mg and Ca were estimated using an atomic absorption spectrophotometer (GBC Avanta, Australia) and K was estimated using a Technicon auto analyzer (AA3, Bran+ Luebbe).

C-serum was collected through centrifugation of latex samples at 23,000 rpm for 45 min at 4 °C. Osmotic potential of the latex serum was determined using PSΨPRO Water Potential System (Wescor, USA). Osmotic potential recorded in mega Pascal (MPa) were converted to bars and then to osmotic concentration expressed as mOsmol/kg (Karta Rani and Varshney, 2006) by using the following relationship.

-1MPa = -10 bar

-1 bar = 40 mOsmol/kg

In order to work out the contributions of cations to osmotic potential, the concentration of cations was converted into moles and osmolarity was worked out by multiplying the concentration of ions in moles with 1.84 (Taiz and Zeiger, 1991). The osmotic potential was calculated by multiplying the osmolarity with 2.48 (Kramer and Boyer, 1995). Osmoregulation was worked out as the differences in osmotic potential between the stress and peak yielding seasons. Latex yield from all the clones was recorded during the periods of observation. Two-way analysis was performed and the data are presented based on that.

RESULTS AND DISCUSSION

Clonal variation in cations in the latex during the two seasons (period) studied is given in the Table 1. As reported earlier (George *et al.*, 2006), ionic composition of the latex showed significant variation among the *Hevea* clones. The latex Ca content showed both clonal and seasonal variations and was low compared to other cations studied. However, the Ca level was found to be high during February - March in all the clones. There was significant clonal variation and clone x season interaction effect in the latex Mg content. Mg level in the latex was reported to be associated with premature coagulation of latex at the tapping panel (Beaufils, 1957). This clonal and clone x season effect might influence the variation in premature coagulation of latex on the tapping panel during different seasons. The K content, a major ionic component in the latex, was high in the latex of all clones during October-November period. In the present study, latex K levels showed clonal and seasonal variations. Significant effect of clone x season was also observed with respect to the latex K content.

Osmotic concentration of C-serum of latex varied among the clones which had significant seasonal and clone x season effects (Table 2). It was reported that osmotic concentration influences the latex flow in *Hevea* trees (Satheesan *et al.*, 1982; Raghavendra *et al.*, 1984). Contributions of cations to osmotic potential were worked out from its concentrations in the latex. The contribution of latex Mg and Ca content towards the water relation components was found very negligible compared to K. The role of K in latex osmotic potential has significant clonal and clone x season effects (Table 2).

The total latex produced during October - November period was significantly high (Table 3). The K contribution to osmotic potential ranged between -2.4 to -3.14 and -2.4 to -3.00 bars during October - November and February - March periods respectively. Among the *Hevea* clones, GT 1 showed the highest osmoregulation which may be due

Table 1. **Clonal and seasonal variations in cationic composition in the latex**

Clone	October - November			February - March		
	K (mg/100g)	Ca (µg/100g)	Mg (mg/100g)	K (mg/100g)	Ca (µg/100g)	Mg (mg/100g)
RRII 43	212.43	68.75	56.39	161.98	117.17	29.36
RRII 118	208.11	91.48	32.50	211.56	100.12	37.43
PB 311	239.77	79.00	60.20	259.21	96.77	73.58
RRII 105	240.56	62.05	76.73	231.67	96.05	57.71
GT 1	257.68	55.38	45.44	257.13	67.77	38.68
RRII 308	268.05	59.03	60.89	254.94	80.36	68.01
RRIM 600	270.05	71.36	78.27	197.38	90.83	78.09
GI 1	254.69	65.46	59.38	251.47	89.48	67.86

K CD (P = 0.05) clone - 26.57; season - 13.284 ; clone x season = 37.57
Ca CD (P = 0.05) clone - 4.67; season - 7.34; clone x season - NS
Mg CD (P = 0.05) clone - 12. 59: season - NS; clone x season = 17.8

Table 2. **Osmotic concentration and contribution of K to osmotic potential in different *Hevea* clones**

Clone	October - November		February - March	
	Osmotic concentration (mOsmol/kg) †	Contribution of K to osmotic potential (bar) ‡	Osmotic concentration (mOsmol/kg) †	Contribution of K to osmotic potential (bar) ‡
RRII 43	456.10	-2.489	475.11	-2.477
RRII 118	448.32	-2.429	524.32	-2.429
PB 311	397.09	-2.765	525.36	-3.025
RRII 105	405.36	-2.948	531.18	-2.714
GT 1	344.58	-3.008	511.80	-3.001
RRII 308	384.85	-3.136	466.71	-2.903
RRIM 600	400.86	-3.099	480.23	-2.304
GI 1	390.10	-2.973	458.72	-2.972

†CD (P = 0.05) clone – NS; season - 23.84; clone x season - 67.43

‡CD (P = 0.05) clone - 0.26; season – NS; clone x season - 0.37

Table 3. **Latex yield and osmoregulation in different *Hevea* clones**

Clone	October - November		February - March		Osmoregulation during seasons
	Latex yield (ml)	Osmotic potential (bar)	Latex yield (ml)	Osmotic potential (bar)	
RRII 43	61.8	-11.4 ± 0.37	28.1	-11.88 ± 0.43	-0.48
RRII 118	158.7	-13.21 ± 0.37	70.6	-13.11 ± 0.75	-0.10
PB 311	181.0	-9.93 ± 0.29	131.7	-13.13 ± 0.70	-3.20
RRII 105	149.1	-10.13 ± 0.5	91.0	-13.28 ± 0.31	-3.15
GT 1	116.9	-8.61 ± 0.66	47.3	-12.8 ± 0.33	-4.19
RRII 308	130.4	-9.62 ± 0.38	90.8	-11.67 ± 0.38	-2.05
RRIM 600	89.5	-10.02 ± 0.97	40.7	-12.00 ± 0.73	-1.98
GI 1	30.0	-9.75 ± 0.49	16.5	-11.47 ± 1.2	-1.72
CD (P=0.05)	49.46	1.4	36.31		

to a stable contribution of K to osmotic adjustment. RRII 105 and PB 311 are the other clones showing higher osmoregulation potential (Table 3).

CONCLUSION

Compared with Mg and Ca ions, K was the major cation found in the latex of the *Hevea* clones studied. Apart from other solutes present in the latex, K has significant role to maintain the osmotic potential in *Hevea* latex. The contribution of K to osmotic potential in the latex was between -2.4 to -3.14 bars. The cationic composition of latex showed clonal, seasonal and clone x season effects. Latex K ions act as activator/ cofactors in several metabolic pathways leading to rubber biosynthesis. There is no seasonal effect in the contribution of K ions to osmotic potential but a significant clonal variation and influence of clone x season interaction was evident. This might be one of the reasons for its influence on latex stability and hence to latex production. There was marked difference in latex osmoregulation among clones. The clone GT 1 showed the highest osmoregulation followed by the clones RRII 105 and PB 311. In the present study the major involvement of K in water relations was confirmed.

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