Internat. J. Plant Sci. Vol.2 No.1 January 2007 : 161-168

Changes in sugar metabolism in response to chilling in *Shorea robusta* seedlings

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(Accepted :November, 2006)

SUMMARY
Aerial parts of the chilling sensitive young sal seedlings showed reduced / absolute cessation in dry mass accumulation as well as synthesis of total sugar due to corresponding low activity of its metabolic enzymes, sucrose synthase (SS) and sucrose phosphate synthase (SPS) in response to constant chilling exposure for 5 months {*i.e.* November to March, 9-14.1°C (night temperature)} in field conditions. Almost 332% and 249% reduction in accumulation of dry mass was estimated in leaves and shoots of chilling exposed seedlings in compared to protected (in greenhouse) seedlings (Temperature 30-32°C, Relative humidity 70-76%) and, this contention was also supported by 77% and 60% reduction in total sugar content of these tissues during same growth periods. On the other hand, roots of both chilling exposed (field) & protected (greenhouse) seedlings exhibited relatively high levels of dry mass and total sugar accumulation. The chilling exposed seedlings also showed striking weakening in the sucrose synthesizing enzyme system. The low temperature during November to March resulted in reduced activities of SS & SPS enzymes almost by 80-85% in leaves of field grown seedlings compared to protected (greenhouse) seedlings, which results in the reduced accumulation of total sugar / dry mass in these tissues. Our results indicated that, substantially low levels of dry mass and total sugar content along with drastic loss in its metabolic enzymes, SS and SPS, in chilling sensitive sal seedlings finally leads to irreversible cell damage and injury in leaves and shoots of these seedlings which is indicated by severe (80-86%) mortality of these seedlings.

Key words : *Shorea robusta*, sugar metabolism, sucrose synthase, sucrose phosphate synthase, chilling injury.

Sal is a dominant tropical tree which occupies 14.2% of the total forest area of India (Joshi 1980). It is estimated that, aerial growth of most (80-86%) of the young sal seedlings was absolutely arrested during winter season with the fall of temperature below 14.1°C (night temperature) and this contention was also evidenced by severe reduction in dry mass accumulation in the aerial parts of these seedlings during November to March (Keshavkant 2000, Keshavkant and Naithani 2001). Similar conclusions were also drawn for several tropical and subtropical plants when exposed to low / non-freezing temperatures ranging from 0-15°C (Zhou *et al*. 2003). The reduction in the rate of dry mass accumulation during chilling period was certainly not due to the direct effect of chilling temperature but perhaps due to non availability of photosynthate due to damaged aerial parts (source) (Zhou *et al*. 2003, Fernandez *et al*. 2003). The very common symptoms of chilling injury includes conspicuous discoloration leading to necrosis of leaves and shoot tissues, similar findings have also been reported for flavedo tissues in response to low temperature (Lafuente *et al*. 2003). Temperature dependent phase changes in the cellular membranes have been postulated as the primary response of sensitive species to chilling temperatures and these are thought to lead to accumulation of toxic intermediates thereby leading to cellular damage (Steponkus *et al.* 1993, Uemura *et al.* 2003, Kirakosyan *et al.* 2003).

Low temperature induced alteration in several physiological and metabolic processes affect carbohydrate status in hardy plants (Labate *et al.* 1990). This involves both quantitative and qualitative changes in the free sugar content of these plants (Wanner and Juntilla 1999). In chill tolerant plants the most commonly accumulated free sugar in response to low temperature, is sucrose (Palonen *et al.* 2000). However, lesser amount of glucose and fructose are frequently accumulated at low temperature (Renaut *et al.* 2004). Tolerance of the plants to chill has been attributed to the increasing concentration of soluble carbohydrates during the period of exposure (Yoshida *et al.* 1988, Tabaei-Aghdaei *et al.* 2003).

Treatment of hexose prior to chilling increases the resistance of rice *(Oryza sativa)* saplings to chill-induced

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