Drought Related Physiological Constraints in Rubber Cultivation in India and Some Management Strategies

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Climate change as a result of global warming can influence the growth and productivity of natural rubber. In the changing climate scenario, even traditional rubber growing areas are also experiencing drought stress and it is alarming in the early stage of establishment of rubber plantations. The immediate effect of drought stress in young plants is drastic reduction in photosynthesis followed by reduced growth. Photosystem II activity and carboxylation processes are highly sensitive to water deficit stress. High solar radiation led to an imbalance between the light and dark reactions of photosynthesis and this caused increased diversion of electrons for the production of reactive oxygen species (ROS). ROS production in the tissue can lead to the oxidative damage of the cellular membrane integrity by peroxidising the lipids and proteins and bleaching the pigments. To prevent excess light falling on the leaves, partial shade is therefore advised in nursery plants. The general visual drought symptoms in young plants are chlorophyll beaching and yellowing of leaf lamina followed by the secondary symptoms like premature senescence and leaf dropping ultimately leading to drying of the plant.

Most of the studies on mechanism of drought tolerance in rubber plants were carried out in young plant. The stress tolerance traits in one year old plants were analyzed by various photosynthetic parameters. There was a significant reduction in photosynthetic oxygen evolution rate, maximum potential quantum yield of photosystem II (PS II), effective quantum yield of PS II (ΦPS II) and photosynthetic electron transport rate in the leaves of drought imposed plants (Annamalainathan *et al.*, 2006). However, the clones, such as RRII 430 and RRIM 600 showed relatively small inhibitions in ΦPSII and photosynthetic rate as compared to other clones. This is attributed to their inherent tolerant characters. Gas exchange and fluorescence studies also revealed that the clone RRII 430 is more likely to endure drought stress than the other RRII 400 series. Water use efficiency is another parameter studied in many clones. RRIM 600 and RRII 430 are physiologically better adapted and can withstand water stress for a relatively longer period of time.

In grown up trees the drought induced yield reduction was more pronounced in non-traditional areas than traditional rubber growing regions in India. The summer yield depression in tradition areas was reported to be 30-50% of annual yield in the clone RRII 105. In Konkan region, a very drought prone area in India where rubber is cultivated, rubber yield during summer months was only 10% of the total yield obtained for the whole year (Chandrashekar *et al.*, 1990).

The impact of uncertain weather pattern will be more pronounced during the early establishment and growth of young rubber plants. Monsoon season is the ideal planting season in the traditional rubber growing region in South India. In recent years uncertainty in rainfall and high temperature are making difficult for scheduling various farm operations like planting. Occurrence of unexpected dry spells and bright sunny days with high temperature during monsoon season increased casualty in young plantations. Increasing temperature and soil

moisture deficit during summer in traditional rubber growing areas are major constraints for survival of young plants. In a recent survey conducted in central part of Kerala it was observed that in addition to the recommended management practices like mulching and shading, life saving irrigation was being increasingly practiced. During the last summer (2010 March/April) almost 18% holding, in which planting was taken up in 2009, were irrigated. Life saving irrigation was not an usual practice in the traditional rubber growing regions until very recently. However, in recent times farmers started practicing life saving irrigation to save their young plants from adverse drought conditions. Chlorophyll bleaching and leaf scorching were observed in unirrigated plants whereas growth was much better in irrigated plants.

Experiments conducted with tilling the plant base in young plants resulted significant level of soil moisture retaining and the growth was significantly superior to that of untilled plants (Jessy *et al.* 2010). Both tillage and life saving irrigation were found effective overcoming the transient drought condition. Under short dry spell, application of potassium and silicon were found effective in reducing the adverse effect of water stress in young plants (Prasannakumari *et al.*, 2010). Thus to enhance the ability of plants to tide over drought stress in addition to irrigation proper nutritional management is required. Adopting both these management practices together may give adequate protection to plants to withstand drought stress.

In the non-traditional rubber growing region like the Konkan region in India, long dry spell and high temperature are the limiting factors for establishment of rubber plants. Providing irrigation, either basin or drip irrigation, at the rate of 0.5 ETc is found beneficial for the successful establishment of rubber. In a few trials life saving irrigation was provided for the first three years for establishing young plants. Adequate irrigation resulted in good growth and thus reduced the immature period to six years as compared to 9 years in the rainfed control in non-traditional Central India. Irrigation led to higher leaf area index resulting in greater solar radiation interception and these trees showed greater and uniform growth in North Konkan region. Tapping during the peak summer season is uneconomical and injurious to trees if they are not irrigated. Clonal variation existed in the degree of drought tolerance in non-traditional areas. RRIM 600 and RRII 208 are the potential clones that seem to have better growth and yield in North Konkan region than other clones like RRII 105.

Attempts were made to quantify the optimum irrigation requirement for immature and mature phase of two rubber clones for summer period. Irrigation during summer months significantly improved the growth of immature rubber leading to early tappability from 9 years to 6 yrs. Results indicated that irrigation at 50% of the crop evapotranspiration (0.5 ETc) was sufficient for improving the growth in immature phase. Significant increase in yield was observed with higher level of irrigation in comparison to lower level of irrigation in the first few years of tapping, thereafter yield was stabilized in all levels of irrigation. Results revealed that when water availability is limited, irrigation can be provided at 50% and 25% of saturated level for immature and mature phase of rubber plants, respectively without affecting, growth, tappability and yield. In Konkan region with limited water resource, deficit irrigation can be practiced as a strategy to manage water more efficiently while maintaining good productivity under the prevailing sub humid climatic condition.

Recent studies showed that there are indications of climate change in the NR growing regions in India and increasing temperature is the most prominent change indicated (Shammi Raj *et al.*, 2010). Under the changing climate, survival/establishing young plants during summer is a major problem to be addressed seriously.

Key words:

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