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Proceedings of 24[th] Kerala Science Congress, 29-31 January 2012, RRII, Kottayam, pp. 34-36

Stress management strategies in *Hevea brasiliensis* for ethylene stimulation

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INTRODUCTION

The growing demand for natural rubber and the shortage of labor in the rubber plantation industry necessitates increasing the productivity of the crop. Under the changing scenario of climate, rubber trees are more susceptible to environmental stress in the traditional rubber growing regions (Satheesh and Jacob, 2011). Labor shortage and environmental constrains are major factors that warrant rubber farmers for evolving suitable management strategies in their plantations. Low frequency tapping with stimulation is widely used in rubber plantations for enhancing latex yield. Frequent stimulation in rubber trees reported to induce metabolic disorders (Krishnakumar *et al.*, 2009). Therefore, minimum exposure of ethylene compounds is the safe method to keep the health and productivity of rubber trees. Application of the stimulant near the tapping cut (panel application) is the currently recommended method for stimulation. Considering the deleterious local effects of stimulants, a study has been carried out to assess the yield potential and stress responses while stimulating the trees away from the tapping panel.

MATERIALS AND METHODS

Stimulation experiments were carried out in mature *Hevea* trees (clone RRII 105) harvested under S/2d3 tapping system. Thirty trees of uniform girth and yield were selected and were stimulated with commercially available ethylene compound, Ethephon, in five different treatments *viz.* (A) 150 cm above the bud union, (B) near the bud union, (C) both near the bud union and 150 cm above the bud union, (D) just above the tapping panel (standard stimulation practice) and (E) unstimulated control. A concentration of 5% Ethephon was used in treatments A to C and 2.5% Ethephon was used in treatment D. The trees were observed for a period of one month before and two months after stimulation for latex yield and stress responses.

The rubber yield determined (g/t/t) was compared between treatments and controls. Stress response in the soft bark tissues were studied by analyzing components like hydrogen peroxide (H_2O_2), peroxidase, cyanide (CN), β-Cyanoalanine synthase (β-CAS) and malondialdehyde (MDA) using standard analytical protocols. Data obtained were analyzed statistically and compared with controls and between treatments.

RESULTS AND CONCLUSIONS

The present study indicated that rubber trees can be stimulated by applying Ethephon away from the tapping panel. It will reduce the direct toxic effect of ethylene on the tapping panel. Trees with modified stimulation treatments (B and C) showed more latex yield that continued for more than a period of 40 days after stimulation (Fig.1). Among B and C treatments, the maximum latex yield was noticed in group C. Stimulation reduced the dry rubber content in the latex. Compared to trees stimulated by panel application (D), the yield potential and carbohydrate content in the bark tissue were high in treatment C (Table 1). The high rubber yield and carbohydrate content in the laticiferous tissues could be significantly correlated. Biochemical components analyzed in the soft bark tissues of stimulated and control trees are summarized in Table. 1.

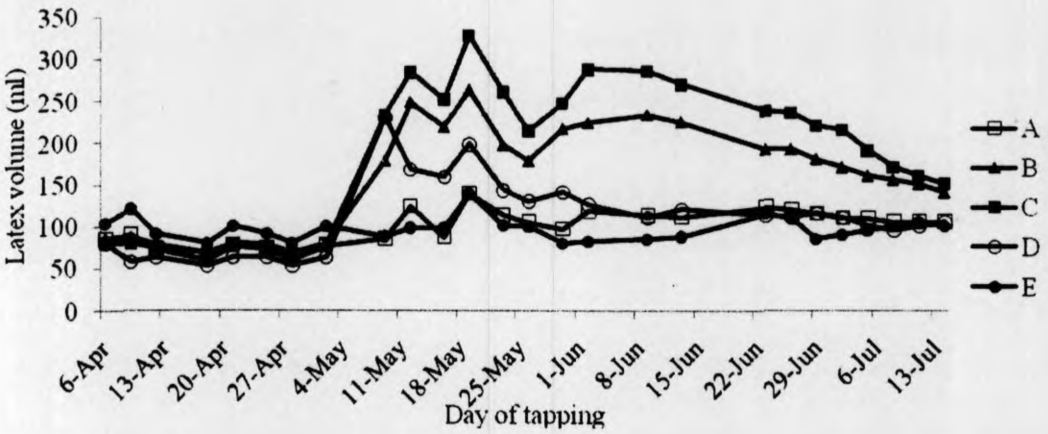

Fig. 1. Latex yield (ml) per tap during the pre and post-stimulation period (**A**-150 cm above bud union; **B**-just above the bud union; **C**- both A and B regions; **D**- panel application; **E**-unstimulated control) Arrow indicates the day of stimulation

Table 1. Latex yield and stress components during different stimulation treatments

No	Components analyzed	Treatments				
		Group A	Group B	Group C	Group D	Control (E)
1.	Dry Rubber Content (%)	44.84 ± 1.21	40.92 ± 1.45	38.71 ± 0.95	41.16±1.82	44.56 ±0.69
2.	Rubber yield (g/t/t)	40.13 ± 2.53	81.57±14.06	**88.74±10.48**	60.27±2.94	39.01 ±3.65
3.	Total soluble sugars (mg/g tissue)	5.49 ± 0.115	6.90 ± 0.183	**7.83 ± 0.227**	5.65±0.277	6.44 ±0.086
4.	Hydrogen peroxide (µ mol/mg tissue)	0.01±0.0005	0.012±0.0006	0.013±0.001	**0.014±0.001**	0.009±0.001
5.	Peroxidase (unit/min/mg protein)	4.198±0.134	4.14 ± 0.134	4.14 ± 0.093	**3.69±0.09**	5.17 ±0.102
6.	Cyanide (mg/g tissue)	5.12 ± 0.178	5.90 ± 0.29	6.17 ± 0.157	**6.71±0.141**	4.59 ±0.131
7.	β-Cyanoalanine synthase (nmol H_2S/min/mg protein)	0.69 ± 0.025	0.64 ± 0.018	0.65 ± 0.024	**0.57±0.013**	0.77 ±0.013
8.	Malondialdehyde (µ mol/g fractional wt.)	5.59 ± 0.303	5.61 ± 0.198	5.71± 0.421	**6.05±0.421**	4.03 ±0.333

Values indicated with ± standard error

Since the ethylene compounds are reported to cause oxidative stress reactions, the present study analyzed the extent of oxidative stress generated while applying the stimulant away from the tapping panel.

Hydrogen peroxide (H_2O_2), in the bark tissue increased in stimulated trees. However, the accumulation of H_2O_2 in tissue was comparatively low in trees stimulated away from the tapping panel (A to C). The level of H_2O_2 detoxifying enzyme peroxidase, was high in unstimulated trees. Trees stimulated near the tapping panel (D) showed the lowest levels of peroxidase which seems to be inadequate to scavenge the H_2O_2 produced in the tissue. There is a linear relation between H_2O_2 content and peroxidase activity in the stimulated trees. Malondialdehyde (MDA) content, was high in the soft bark tissues of stimulated trees. In *Hevea,* stimulation could induce MDA accumulation in tissues indicating the lipid peroxidation resulted by the oxidative damage. However, both H_2O_2 content and MDA levels noticed in trees stimulated away from the tapping panel were not as high as in trees stimulated near the tapping panel.

Analysis showed that stimulation could enhance the CN levels in the tissue. However, trees stimulated away from the tapping panel showed lesser CN content than trees stimulated by panel application method. The CN scavenging enzyme, β-Cyanoalanine synthase (β-CAS), was comparatively low in treatments A, B and C. Low levels of β-CAS activity were noticed in trees stimulated near the tapping panel.

Stimulating rubber trees using any safe methods would be highly relevant to harvest latex by keeping the tree health. This study showed that the stress responses were minimum in trees stimulated at both regions away from the tapping panel (C). In this treatment the yield response was comparatively better than any other stimulation method. Hence, stimulating rubber trees away from the tapping area can be a better option for managing the deleterious effects of yield stimulants in *Hevea*.

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