*J. Rubb. Res.*, **7(2)**, 127–137

# *Latex Diagnosis in Relation to Exploitation Systems in Clone RRII 105*

N. USHA NAIR*#, B. RAMESH NAIR*, MOLLY THOMAS* AND JAYASREE GOPALAKRISHNAN*

*Base values or critical limits were fixed for latex diagnosis (LD) parameters in clone RRII 105 under the recommended tapping system 1/2S d/3, which ensures an optimum yield in the* BO-1 *and* BO-2 *panels. The critical limits fixed were used for assessing the exploitation status of smallholdings and for optimising stimulation schedules in clone RRII 105.*

*Latex diagnosis studies conducted under different exploitation systems revealed that negative aspects of intensive tapping and over stimulation could be detected by changes in the levels of LD parameters from their threshold levels.*

*Based on the levels of latex diagnosis parameters and yield under 1/2S d/3 tapping system, the production metabolism of RRII 105 is characterised as active. The production potential of RRII 105 with its high metabolic activity and low sugar reserve limit its ability to respond to hormonal stimulation. In RRII 105 an increase in yield is not obtained beyond five stimulations a year under d/3 or d/4 tapping systems.*

**Key words**: latex diagnosis; exploitation; stimulation; yield; tapping system; RRII 105; parameters; smallholdings; metabolism

The rubber plantation industry in India has achieved tremendous progress due to the widespread cultivation of RRII 105 by smallholders. In the traditional tract, more than 75% of the cultivated area is occupied by this clone. However, the yield from the smallholding sector reaches less than half the possible limit mainly because of the intensive exploitation of trees leading to tapping panel dryness (TPD). Being a precocious yielder with a very active metabolism, RRII 105 is susceptible to TPD. In the smallholdings, up to 15%–20% of crop loss occurs due to TPD in the *BO-1* and *BO-2* panels. Although the Rubber Board's recommended tapping system is 1/2S d/3, farmers mainly resort to alternate daily or daily tapping and the smallholdings come under different levels of over exploitation. Only 10% of the smallholders adopt a less intensive system[1] than 1/2S d/2. RRII 105 being a clone with genetically high yield potential, it is necessary that the stress due to tapping should be minimal. The present tapping recommendation for RRII 105 is 1/2S d/3, which ensures a sustained optimum yield with minimum incidence of TPD throughout the productive phase of the tree.

*Rubber Research Institute of India, Kottayam 686 009, Kerala, India
#Corresponding author (e-mail: usha@rubberboard.org.in)

It has been shown by numerous researchers that latex diagnosis (LD) taking into account certain biochemical parameters in latex (sucrose, thiols, inorganic phosphorus and DRC) which are involved in flow and regeneration mechanisms, could be related to the production of a clone at a given time[2-4]. The levels of these quantifiable elements can be used for assessment of the production capacity of clones under any exploitation system, to optimise exploitation (stimulant application and tapping systems) to avoid over-exploitation and to achieve the maximum production of a clone under the given agro-climatic situations.

Application of latex diagnosis as a tool for optimising exploitation requires fixing threshold values of these parameters under an optimum tapping system[6]. 1/2S d/3 tapping system is considered as optimum for RRII 105 because under this system the yield potential of the clone can be fully achieved with minimum incidence of TPD [8]. LD measurements can reveal symptoms of over/under exploitation by comparing the values obtained with the threshold levels which are clone characteristic and it is possible to assess the productivity status of the plantation with respect to the exploitation system practised[7]. This paper reports LD studies conducted in clone RRII 105, for developing critical limits for LD parameters under optimum production and for optimising exploitation systems for the clone.

## MATERIALS AND METHODS

### Experiment 1: Fixing of Base Values for LD Parameters in Clone RRII 105

Field experiments were conducted at Malankara estate, Thodupuzha, Kerala (9° 50' N; 76° 48' E ) which represents the Central Zone of the traditional rubber growing area on clone RRII 105 under 1/2S d/3 frequency of tapping in the *BO-1* (third year of opening) and *BO-2* (first year of opening) panels. There were 3 blocks for each panel with 280 trees in each block. The trees were grouped into different yield classes. Forty trees were then randomly selected from each block. LD parameters were analysed monthly for three consecutive years (1996–1998) for each panel. Critical limits were evolved from the LD parameters estimated in the sampling season (August to November). The average yield per tree per tapping under 1/2S d/3 frequency were calculated from the block yield data of the estate during the period .

### Experiment 2: Testing of Base Values in Smallholdings

The base values were validated in 50 smallholdings under two Rubber Producer's Societies (RPS), Aimcompu and Chirakadavu, in the Central Zone of the traditional rubber growing tract in India during 2000. LD parameters were estimated from the small holdings during August to November. From each holding ten trees were sampled. All the smallholdings were under 1/2S d/2 frequency of tapping and in the *BO-1* or *BO-2* panels. Yield of individual holdings were derived from the RPS yield records.

### Experiment 3: Latex Diagnosis for Optimising Stimulation in Clone RRII 105

Experiments were laid out in completely randomised block design under 1/2S d/3 tapping system with five levels of stimulation (2.5% a.i. ethephon groove application) at the experimental farm unit (EFU) of the Rubber Research Institute of India (RRII) located at

Kottayam, Kerala. There were 20 replications per treatment. The treatments are given below:

T0–1/2S d/3 6d/7 (control)
T1–1/2S d/3 6d/7. ET 2.5%. Pa. 3/y
T2–1/2S d/3 6d/7. ET 2.5%. Pa. 4/y
T3–1/2S d/3 6d/7. ET 2.5%. Pa. 6/y
T4–1/2S d/3 6d/7. ET 2.5%. Pa. 8/y
T5–1/2Sd/3 6d/7. ET 2.5%. Pa. 16/y.

The experiments were done on *BO-1* (1st year of opening) and *BO-2* (3rd year of opening) panels in 1998 and 1999 during the period May to December (commencing from the start of pre-monsoon showers and covering the peak yielding season). Yield of individual treatments were recorded on all tapping days. LD parameters were estimated at monthly intervals.

### Experiment 4: Latex Diagnosis to Study Interactions between Stimulation and Tapping

LD parameters were estimated in a tapping experiment in clone RRII 105 (*BO-1*, 1st year) with three tapping frequencies (d/2, d/3, d/4) and different levels of stimulation. The experiment was laid out in randomised block design with five replications comprising 15 trees per replication at the EFU of RRII located at Kottayam. The treatments were as follows:

T0–1/2 Sd/2 6d/7 ( Control)
T1–1/2 Sd/3 6d/7. ET 2.5%. Pa. 3/y
T2–1/2 Sd/3 6d/7. ET 2.5%. Pa. 4/y
T3–1/2 Sd/3 6d/7. ET 2.5%. Pa. 5/y
T4–1/2 Sd/4 6d/7. ET 2.5%. Pa. 5/y
T5–1/2 Sd/4 6d/7. ET 2.5%. Pa. 7/y
T6–1/2 Sd/4 6d/7. ET 2.5%. Pa. 9/y.

From each replication, five samples were taken. The experiment was initiated during April 1997. LD parameters were estimated during two consecutive years 1998 and 1999.

### Estimation of Latex Diagnosis Parameters

A known amount (≈1g) of latex extracted with 2.5% trichloroacetic acid and aliquots were used for estimations of sucrose[10], Pi[11] and thiols[12]. DRC was determined by gravimetric method.

## RESULTS

### Experiment 1: Base Values of LD Parameters

The critical limits of LD parameters (*Table 1*) fixed for RRII 105 are relative to the average yield per tapping obtained in the *BO-1* and *BO-2* panels under 1/2S d/3 frequency of tapping in the Central Zone of the traditional rubber growing areas. The ranges for the base values have been fixed based on the least lower limit and greatest upper limit of the LD parameters obtained from both the panels which takes into account the yield differences in the *BO-1* and *BO-2* panels.

### Experiment 2: Testing of Base Values in Smallholdings

The base values were field tested in smallholders plots by comparing the values of LD parameters obtained from the holdings in each location with the critical limits (*Tables 2a* and *2b*). The productivity status (g/tree/tapping) of the smallholdings which resorted to relatively higher frequencies of tapping taking annual yields above 6 kg/tree/year was below the optimum fixed under 1/2S d/3 (67.50–76.51g/tree/tapping).

TABLE 1. STANDARD BASE VALUES FOR CLONE RRII 105 UNDER 1/2S D/3 FREQUENCY OF TAPPING

| Item | Value |
|---|---|
| Thiol (mM) | 0.30–0.45 |
| Pi (mM) | 20.70–30.50 |
| Sucrose (mM) | 5.22–10.37 |
| DRC % | 35.0–44.00 |
| Yield (g tree/tapping) | 67.50–76. 51 |
| Yield (kg tree/year) | 6.75–7.65 |
| TPD percentage: *BO-1* | 5.99 |
| *BO-2* | 7.62 |

Note: The levels of latex diagnosis parameters have been fixed under 95% confidence limits based on the least lower limit and greatest upper limits of the values during the period of observation (1996–1998).

TABLE 2A. PRODUCTIVITY STATUS AND LATEX DIAGNOSIS PARAMETERS OF SMALLHOLDINGS IN TWO RUBBER PRODUCERS' SOCIETY (2000)

| Name of RPS | Yield kg/tree/year | Thiol (mM) | Pi (mM) | Sucrose (mM) | DRC (%) |
|---|---|---|---|---|---|
| Aimcompu | <6 (Low) | 0.20 | 22.96 | 7.59 | 38.97 |
| | 6–7 (Optimum) | 0.23 | 24.75 | 8.48 | 39.14 |
| | >7 (High) | 0.22 | 23.91 | 8.50 | 40.03 |
| CD | | NS | NS | NS | NS |
| Chirakadavu | <6 (Low) | 0.27 | 15.24 | 8.89 | 39.30 |
| | 6–7 (Optimum) | 0.40 | 19.11 | 14.48 | 40.10 |
| | >7 (High) | 0.30 | 18.56 | 14.38 | 39.83 |
| CD | | 0.07 | NS | 4.38 | NS |

TABLE 2B. AVERAGE EXPLOITATION STATUS AND LATEX DIAGNOSIS PARAMETERS OF SMALLHOLDINGS IN TWO RUBBER PRODUCERS' SOCIETY (2000)

| Name of RPS | Tapping days | Yield (g/t/t) | Yield (kg/t/y) | Thiol (mM) | Pi (mM) | Sucrose (mM) | DRC (%) | TPD (%) |
|---|---|---|---|---|---|---|---|---|
| Aimcompu | 136 | 54.31 | 7.20 | 0.24 | 23.83 | 8.91 | 39.67 | 8.9 |
| Chirakadavu | 118 | 57.23 | 6.75 | 0.32 | 19.31 | 13.31 | 39.54 | 6.8 |
| CD | | | | 0.05 | 2.61 | 2.86 | NS | |

The levels of LD parameters (Thiols and Pi) in relation to yield extracted (low, optimum and high yield groups) varied in the two locations (Chirakadavu and Aimcompu).

It could be seen that in Aimcompu, in all the yield classes, the thiol levels were below optimum with high Pi levels indicating that the holdings in all the yield classes were over exploited. In Chirakadavu the thiol levels showed significant differences between yield groups, the levels in the optimum yield group (6 kg–7 kg/tree/year) being 0.40 and 0.30 in the higher yield group (>7 kg/tree/year). A fall in the level of thiols when higher yields are taken (*Table 2b*) indicate that thiol levels are insufficient to neutralise the oxidative stress from over exploitation which consequently appear to be the first factor of fall in productivity in smallholdings[13]. TPD incidence which are indicative of the level of exploitation and physiological stress of the trees was higher in Aimkombu (8.9%) where the thiol levels were below critical limits when compared to Chirakadavu (6.8%).

**Experiment 3: LD for Optimising stimulation**

*Table 3a* shows the yield per tree per tapping for *BO-1* panel (first year of opening) of stimulated treatments compared to the control. The stimulated treatments gave a higher yield per tree per tapping than the control. However, there was no significant difference in yield between the different levels of stimulation. There was a tendency to a slow decline in the levels of sucrose, thiols and DRC with higher levels of stimulation. Only treatment T5 (16 stimulations) showed a significant difference in thiols, and DRC over T0, and T1 which indicated that the metabolism of the trees were altered at the higher level of stimulation.

*Table 3b* gives the results for *BO-2* panel (third year) which depicts the fall in the levels of thiols and sucrose at higher levels of stimulation. Comparing the different treatments, for *BO-2* panel, T1 can be fixed as the optimum schedule since the yield of T1 was on par with T2, T3, and T5 while LD parameters (thiols, Pi, sucrose) did not show any significant difference with the control. The yield obtained under T1 in the *BO-1* and *BO-2* panels (d/3 with 3 stimulations) is the optimum limit of achievable yield maintaining the physiological balance of the trees. While the yield is quite the same for all the stimulated treatments, the levels of sucrose and thiols show decrease in the more intensive stimulation treatments. There was difference in the levels of LD parameters in the *BO-1* and *BO-2* panels. These variations in the levels of LD parameters in the *BO-1* and *BO-2* panels could be attributed to the fact that stimulation on *BO-1* panel of a virgin tree reflect the starting of the rubber latex factory and later are directly related to the different yields (g/tree tapping) obtained from the two panels. *Figures 1a* and *1c* clearly depict the negative impact of stimulation in the levels of thiols and sucrose even when higher yields are obtained. The Pi levels did not show an appreciable increase with increased levels of stimulation (*Figure 1b*).

**Experiment 4: Latex Diagnosis in stimulation and tapping**

The cumulative yield[14] of this experiment observed during 2 years of opening of *BO-1* panel showed that d/3 tapping frequency with five stimulations per year gave the highest yield. The yield of T1 and T2 (d/3 with 3 and 4 stimulations/year) were comparable with the control treatment T0 (1/2S d/2 frequency, *Table 4*). The yield under d/4 was lower than the control (d/2) and d/3 systems. A significant

TABLE 3A. LATEX DIAGNOSIS PARAMETERS IN CLONE RRII 105 (*BO-1*) PANEL UNDER 1/2S D/3 AND DIFFERENT LEVELS OF STIMULATION

| Treatment | No./frequency of stimulations (Days) | Thiol (mM) | Pi (mM) | Sucrose (mM) | DRC (%) | Yield[a] (g/t/t) | TPD (%) |
|---|---|---|---|---|---|---|---|
| T0 | | 0.301 | 17.81 | 4.13 | 38.40 | 74.83 | 5 |
| T1 | 3(90) | 0.266 | 18.80 | 3.04 | 39.58 | 87.45 | nil |
| T2 | 4(60) | 0.227 | 18.83 | 2.15 | 37.20 | 92.79 | 5 |
| T3 | 6(45) | 0.235 | 19.78 | 3.04 | 39.03 | 88.80 | nil |
| T4 | 8(30) | 0.239 | 21.82 | 2.85 | 37.34 | 97.92 | nil |
| T5 | 16(15) | 0.191 | 19.73 | 2.23 | 36.49 | 93.49 | 20 |
| CD | | 0.036** | 3.46 | 1.12[NS] | 2.2* | 8.85 | |

[a]Average yield during May to December 1999
*Significant at 5% level
**Significant at 1% level.

TABLE 3B. LATEX DIAGNOSIS PARAMETERS IN CLONE RRII 105 (*BO-2*) PANEL UNDER 1/2S D/3 AND DIFFERENT LEVELS OF STIMULATION

| Treatment | No./frequency of stimulations (Days) | Thiol (mM) | Pi (mM) | Sucrose (mM) | DRC (%) | Yield[a] (g/t/t) | TPD (%) |
|---|---|---|---|---|---|---|---|
| T0 | | 0.41 | 29.77 | 7.89 | 42.55 | 102.91 | Nil |
| T1 | 3(90) | 0.39 | 28.07 | 6.63 | 39.30 | 125.30 | Nil |
| T2 | 4(60) | 0.36 | 31.15 | 5.18 | 38.37 | 126.12 | Nil |
| T3 | 6(45) | 0.32 | 30.15 | 4.75 | 40.80 | 122.14 | 10 |
| T4 | 8(30) | 0.34 | 34.16 | 3.21 | 36.21 | 134.14 | 10 |
| T5 | 16(15) | 0.30 | 32.66 | 4.23 | 34.89 | 128.07 | 20 |
| CD | | 0.05** | 3.87[NS] | 2.13* | 2.67* | | |

[a]Average yield during May to December 1999

increase in DRC of latex over control was observed in the d/4 treatments.

*Table 4* shows the variation in the levels of LD parameters between the treatments under different tapping frequencies and stimulation in the 3[rd] year of the experiment in *BO-1* panel. The levels of LD parameters in T1,T2 and T3 were comparable with the control. The levels of thiols and sucrose showed a significant lowering in T5 and T6 treatments when compared to the control. High DRC, low thiols, and very low sugar, depict a physiological imbalance indicating a slowing down of the *in situ* latex

TABLE 4. LATEX DIAGNOSIS PARAMETERS FOR CLONE RRII 105 UNDER DIFFERENT TAPPING FREQUENCIES (PANEL *BO-1*)

| Treatments | Thiol (mM) | Pi (mM) | Sucrose (mM) | DRC[a] (%) | Cumulative yield (kg/400 trees)[b] | TPD (%) (3rd Year)[c] |
|---|---|---|---|---|---|---|
| T0–1/2Sd/2 6d/7 (Control) | 0.336 | 15.03 | 6.42 | 42.49 | 6785 | 25.1 |
| T1–1/2Sd/3 6d/7. ET2.5%. Pa. 3/y | 0.282 | 20.83 | 6.27 | 44.10 | 6566 | 11.6 |
| T2–1/2Sd/3 6d/7. ET2.5%. Pa. 4/y | 0.290 | 20.67 | 4.67 | 44.66 | 6723 | 7.4 |
| T3–1/2Sd/3 6d/7. ET2.5%. Pa. 5/y | 0.303 | 21.21 | 4.08 | 41.89 | 7162 | 15.3 |
| T4–1/2Sd/4 6d/7. ET2.5%. Pa. 5/y | 0.296 | 18.74 | 3.03 | 46.59 | 6182 | 14.0 |
| T5–1/2Sd/4 6d/7. ET2.5%. Pa. 7/y | 0.213 | 15.41 | 2.61 | 46.39 | 6011 | 13.1 |
| T6–1/2Sd/4 6d/7. ET2.5%. Pa. 9/y | 0.225 | 16.83 | 2.65 | 46.62 | 6382 | 16.2 |
| CD | 0.083 | 5.68 | 2.19 | 2.61 | | |

[a]Upto 4% over estimate
[b]April 1997–October 1999 (Status Report, January 2000)
[c]Karunaichamy *et al.*[16]

metabolism under low frequency tapping (d/4). *Figure 2* shows the changes in the levels of LD parameters during the two years of the experiment. The negative impact of stimulation as seen by a fall in the levels of sucrose and thiols was more apparent in the second year.

## DISCUSSION

The production mechanism of RRII 105 can be explained based on the studies conducted in RRII 105 and in clone PB 235[6,9]. RRII 105 and PB 235 are clones with a high DRC (sign of active rubber biosynthesis), low sugar and thiol (indicating a rapid utilisation of the substrates) and a high Pi (indicator of active metabolism), and therefore, characterised as metabolically active clones. The high yielding attributes of these clones are due to their easy flow and efficient regeneration mechanism. The need for stimulation (improving flow by breaking the flow restricting mechanisms and activating the metabolism) is not indicated for these clones. PB 235 has been already classified as a clone not suitable for stimulation[6]. The production potential of a clone can be explained based on the production of the clone without stimulation which determines the initial metabolic activity. The sucrose concentration in the latex without stimulation, characterises the carbohydrate theoretically and immediately available for isoprene synthesis and the ability of the clone to be activated by stimulation and hence to convert that sugar[17].

Based on the experiments conducted on RRII 105 in the *BO-1* and *BO-2* panels the average production of the clone is 67.5 g/t/t – 76.5 g/t/t under 1/2S d/3 frequency of tapping (*Table 1*). Production level of RRII 105 without stimulation is high. The latex sugar content prior to stimulation is low for RRII 105. *Experiments II* and *III* indicate a significant decline in sucrose and thiol levels at higher

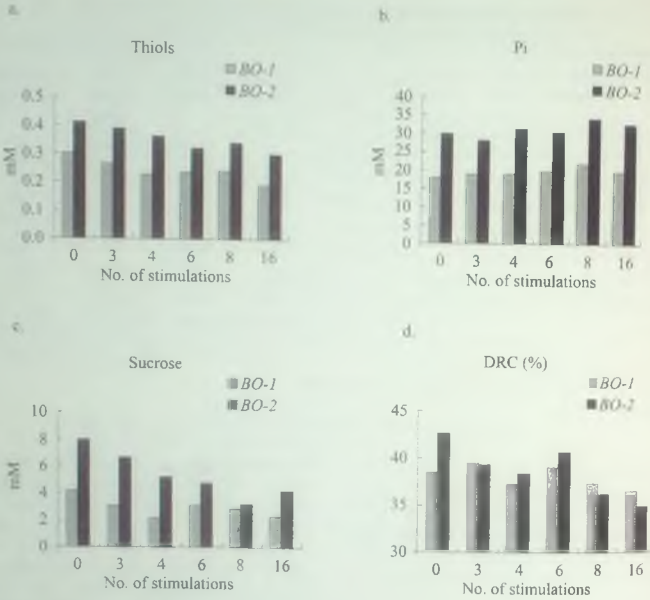


*Figure 1. Latex diagnosis parameters in clone RRII 105 (* BO-1 *and* BO-2 *panels) under different levels of stimulation.*
*a: Thiol levels under different frequencies of stimulation in RRII 105;*
*b: Pi levels under different frequencies of stimulation in RRII 105;*
*c: Sucrose levels under different frequencies of stimulation in RRII 105;*
*d: DRC under different frequencies of stimulation in RRII 105.*

levels of stimulation. Sucrose and thiols become the basic limiting factors at higher levels of stimulation. A high Pi level in RRII 105 latex indicates a metabolism sufficiently high. The Pi levels (*Figures 1b* and *2b*) did not show a significant increase with stimulation indicating that the activation of latex metabolism through stimulation is limited. Studies have shown that latex metabolism and rubber yield cannot be increased beyond three stimulations per year under d/3 and five under d/4 systems. The fall in production beyond five stimulations under d/4 tapping system indicates that the latex generating metabolism can not be increased further.

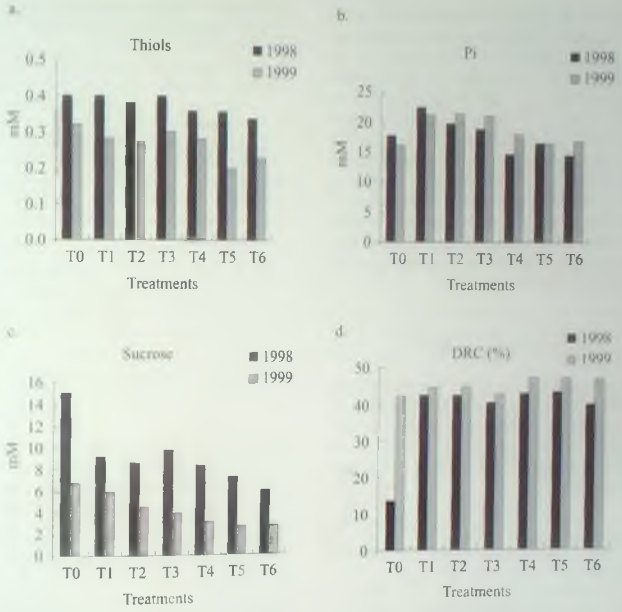


*Figure 2. Comparative variations of latex diagnosis parameters in clone RRII 105 (*BO-1 *panel) between the two years of experiment.*
*a: Thiol levels under different tapping frequencies in RII 105;*
*b: Pi levels under different tapping frequencies in RRII 105;*
*c: Sucrose levels under different tapping frequencies in RRII 105;*
*d: DRC levels under different tapping frequencies in RRII 105.*

Results of the present study also show that five stimulations a year under d/3 and d/4 system have given yield improvement. TPD incidence under 1/2S d/3 system with optimum stimulation is also lower when compared to 1/2S d/2 system as seen from the studies (*Tables 1, 2b, 3a, 3b* and *4*). The present study indicates that frequencies higher than five stimulations a year under d/3 and d/4 system of tapping may have to be recommended only with caution although improvement in yield has been reported[16] (in some particular situations).

The study revealed that threshold levels could detect physiological imbalances due to over stimulation by fall in the levels of sucrose and thiols enabling the plantations to avert adverse reactions leading to decreased production as reported earlier[17,18] where as in intensively tapped smallholdings expression of physiological imbalances varied with the situations. Clonal characteristics must be taken into account in rationalising long-term exploitation of *Hevea*[19]. Latex diagnosis system provides the plantation flexibility to crop exploitation systems and ensures higher productivity without causing physiological stress.

ACKNOWLEDGEMENT

The authors thank Dr. K. R.Vijayakumar. Joint Director (Exploitation Studies) RRII. for the help rendered in the above studies. We also thank the management of Malankara estate, for their co-operation in the conduct of the field experiments.

*Date of receipt: May 2003*
*Date of acceptance: April 2004*

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