*Proceedings of Placrosym XV (2002): 120-127*

# STUDIES ON WINTERING AND FLOWERING PATTERN OF DIFFERENT *HEVEA* CLONES IN COASTAL KARNATAKA

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## ABSTRACT

**The wintering and flowering patterns of *Hevea* clones in coastal Karnataka, one of the major non-traditional areas growing rubber, were studied. Forty clones were studied for wintering and twenty-three clones for flowering. The study was carried out at weekly intervals during the wintering and flowering seasons of 1998-99, 1999-2000 and 2000-01. In general, wintering pattern of the clones was not uniform over seasons. While three distinct clusters were obtained for 1998-99 and 2000-01 seasons, four clusters were obtained for 1999-2000. However, certain clones exhibited uniformity of wintering pattern in all the seasons. Further, results indicated that some of the clones were more influenced by the environment than others for wintering pattern. Individual clusters had close relatives grouped together irrespective of seasons, thus, indicating the genetic control on wintering behaviour. The observations on flowering indicated that commencement of flowering depends on wintering pattern. Wide variations were observed for the male to female flower ratios, pollen stainability and also initial fruit set. Owing to the adverse influence of environment, natural fruit recovery was seldom achieved. The results generated can be used for characterisation of clones and also to select them for appropriate breeding programmes apart from designing suitable breeding orchards.**

## INTRODUCTION

The para rubber, *Hevea brasiliensis* is a deciduous tree that displays annual leaf shedding called 'wintering'. Wintering is reported to occur from December to February in South India. Wintering may either be complete or partial depending upon the clone, age of the plants, seasonal factors, location, etc. (George *et al.*, 1967 and Priyadarshan *et al.*, 2001). Refoliation and flowering follow wintering. Flowering is dependent on wintering, clone and agroclimatic conditions (Meenattoor *et. al.*, 1989). The clonal specificity on wintering pattern and flowering behaviour in the traditional rubber growing areas (George *et. al.*, 1967 and Soman *et. al.*, 1995) and the non-traditional regions like Tripura has been well established (Meenattoor *et al.*, 1989; Vinod *et. al.*, 1996; Sowmyalatha *et. al.*, 1996). Though rubber cultivation has been in existence in the non-traditional region of coastal Karnataka for the last four decades, little information is available on the wintering and flowering characteristics of *Hevea* tree in this region. The present study was aimed at assessing the performance of different clones for wintering pattern and flowering behaviour in Coastal Karnataka.

## MATERIALS AND METHODS

### WINTERING

Forty clones planted under different clone evaluation trials at HBSS, Nettana (75°32′ E; 12°43′ N; 110 MSL) constituted the material for the study (Table 1). Twenty trees per clone were selected and observed individually for the entire leaf fall period at weekly intervals from December to February and their wintering pattern scored using the visual score scale (Vinod *et. al.*, 1996). Observations were initiated in 1998-99 season and concluded during 2000-2001. In general, the entire leaf shedding process extended for ten effective weeks every season. The average score for the ten weeks was computed for the clones individually for three seasons. Analysis of variance was performed using the average data. The average data was also used to compute the proximity values between the clones using the formula.

$$d_{ii'} = \Sigma (X_{ij} - X_{i'j})^2$$

where, $d_{ii'}$ is the distance between the clones $i$ and $i'$ ($i$ = 1 to m) and $x_i$ and $x_{i'}$ are the values of clones $i$ and $i'$ for the corresponding week, $j$ ($j$ = 1 to n). The proximity matrix was used to cluster the clones using Sneath and Skal's (1973) unweighted pair group method using arithmetic averages (UPGMA). Clusters were arrived at empirically by fixing the cut off distance at 30 units and the grouping was done individually for the seasons.

### FLOWERING

Since good flowering was not observed in all the forty clones selected for wintering studies, the study was limited to twenty three clones from among them which showed good flowering (Table 1). The study was conducted at weekly intervals during the flowering seasons of 1999 to 2001. Five trees per clone were subjected to the studies. For the sex ratio and fruit set studies, two branches per tree were selected and the count was made on five panicles randomly on each branch. Pollen stainability was assessed by counting stained pollen, using squash preparations of another lobes made with 1 per cent acetocarmine.

## RESULTS AND DISCUSSION

### WINTERING

The combined analysis of variance (Table 2) showed significant variation in the pattern of wintering contributed by the clones, weeks, seasons and also the interactions among the three factors. This indicated that the wintering pattern of clones in this region is at random and is highly influenced by the environment, other than the genetic factors.

The average weekly data were used to group the clones based on their wintering pattern individually for all the three seasons. The clusters constructed using UPGMA exhibited different grouping of clones in all the three seasons. While three clusters were distinct during 1998-99 & 2000-01, four clusters emerged during 1999-2000.

The cluster characteristics for the component clones of the individual seasons are given in Tables 3, 4 and 5. The classification was based on the commencement of wintering (early, normal and late), progress of wintering over weeks (slow and fast) and the nature of wintering (complete, partial or intermediate). The early

**Table 1. Details of the clones used in the study**

| Clone | Parentage | Country of origin | Clone | Parentage | Country of origin |
|---|---|---|---|---|---|
| RRII 105* | Tjir 1 x G11 | India | PB 252* | PB 86 x PB 32 | Malaysia |
| RRII 118* | Tjir 1 x PR 107 | India | PB 311* | RRIM 600 x PB 235 | Malaysia |
| HP 185 | Tjir 1 x Mil 3/2 | India | PB 86* | Primary clone | Malaysia |
| HP 187 | Tjir 1 x Mil 3/2 | India | PB 28/83 | Primary clone | Malaysia |
| HP 204 | Tjir 1 x Mil 3/2 | India | GL 1* | Primary clone | Malaysia |
| HP 223 | Tjir 1 x Hil 28 | India | Ch 26* | Primary clone | Malaysia |
| RRII 203* | Mil 3/2 x Hil 28 | India | PR 255* | Tjir 1 x PR 107 | Indonesia |
| HP 372 | Mil 3/2 x Hil 28 | India | PR 261* | Tjir 1 x PR 107 | Indonesia |
| RRII 300* | PB 86 x Mil 3/2 | India | Tjir 1 | Primary clone | Indonesia |
| RRII 308 | G11 x PB Mil 6/50 | India | GT 1* | Primary clone | Indonesia |
| AVT 73* | Primary clone | India | RRIC 36 | PB 86 x PR 107 | Sri Lanka |
| RRIM 600* | Tjir 1 x PB 86 | Malaysia | RRIC 45* | RRIC 8 x Tjir 1 | Sri Lanka |
| PB 5/51* | PB 56 x PB 24 | Malaysia | Hil 28 | Primary clone | Sri Lanka |
| PB 213* | PB 56 x PB 86 | Malaysia | Mil 3/2 | Primary clone | Sri Lanka |
| PB 215* | NK | Malaysia | KRS 128 | RRIM 501 x PB 5/63 | Thailand |
| PB 217* | PB 5/51 x PB 6/9 | Malaysia | KRS 163 | PB 5/63 x RRIM 501 | Thailand |
| PB 235* | PB 5/51 x PB 5/78 | Malaysia | KRS 25 | Primary clone | Thailand |
| PB 242 | PB 5/51 x PB 32/36 | Malaysia | SCATC 88/13 | RRIM 600 x Pil B 84 | China |
| PB 255 | PB 5/51 x PB 32/36 | Malaysia | Haiken 1* | Primary clone | China |
| PB 260* | PB 5/51 x PB 49 | Malaysia | IAN 45/873* | PB 86 x F 1717 | Brazil |

* clones selected for flowering and fruit set study

wintering clones started to show yellowing of leaves as early as December I week and late wintering clones as late as I week of January. The clones which wintered between December II to IV week were classified as normal. The clones that showed steady progress of wintering were described as slow and those which showed leaf shedding at a very faster rate within a short gap of 1-2 weeks were described as fast wintering clones. Those clones, which shed leaves completely before reflushing are described as complete wintering clones and those which did not shed leaves completely, are described to be partial wintering clones.

The tables reveal a wide variation for the cluster characteristics over seasons. During 1998-99 season, cluster I comprised of the majority of clones under study which started to shed leaves earlier and slowly progressed over weeks to show complete wintering. Prominent among the clones were RRII 105, PB 242, PB 252, Ch 26, PR 261, Haiken 1, PR 255 and KRS 128, which were found to be in the cluster I for subsequent seasons also. The cluster III comprised of RRII 203 and KRS 25 alongwith other clones which were also found to occupy the III cluster in the subsequent seasons. These clones were found to winter normal and exhibited a steady progress and were partial in nature. The clone PB 217, which was in the III cluster during 1998-99 and 2000-01 seasons, however, was found in a separate group during 1999-2000 season owing to its late wintering nature. Rest of the clusters were intermediate to these and the constituent clones shifted their positions between clusters I and III besides II in all the seasons. This clearly indicated that some clones were more influenced by the environment in the wintering behaviour than others.

**Table 2. Combined analysis of variance for the wintering pattern of forty clones for three seasons**

| Source | Degrees of freedom | Mean squares | Variance ratio |
|---|---|---|---|
| Clone | 39 | 22998.63 | 300.22* |
| Week | 9 | 284733.56 | 16106.06* |
| Season | 2 | 5585.34 | 1421.77* |
| Clone x Week | 351 | 11720.31 | 17.00* |
| Clone x Season | 78 | 8296.27 | 54.75* |
| Week x Season | 18 | 10990.11 | 310.84* |
| Clone x Week x Season | 702 | 7109.67 | 5.16* |
| Error | 22,781 | 44647.05 | |

* significant at 5% level

**Table 3. Cluster characteristics for wintering pattern of forty clones in 1998-99 season**

| Cluster | No. of clones | Clones | Wintering nature |
|---|---|---|---|
| I | 29 | RRII 105, HP 185, HP 187, Hp 204 HP 223, HP 372,AVT 73, RRIM 600, PB 5/51, PB 213, PB 215, PB 242, PB 255, PB 260, PB 252, PB 86, PB 28/83, G11, Ch 26, PR 255, PR 261, GT 1, RRIC 36, Hil 28, Mil 3/2, KRS 128, KRS 163, SCATC 88/13, Haiken 1 | Early, slow, complete |
| II | 2 | Tjir 1, IAN 45/873 | Early, fast, complete |
| III | 9 | RRII 118, RRII 300, RRIC 45, RRII 203, PB 235, PB 311, KRS 25, PB 217, RRII 308 | Normal, slow, partial |

**Table 4. Cluster characteristics for wintering pattern of forty clones in 1999-2000 season**

| Cluster | No. of clones | Clones | Wintering nature |
|---|---|---|---|
| I | 28 | RRII 105, RRII 118, HP 187, HP 223, HP 372, RRII 300, AVT 73, RRIM 600, PB 5/51, PB 215, PB 235, PB 242, PB 255,PB 260, PB 252, PB 86, G1 1, Ch 26, PR 261, RRIC 36, Hil 28, KRS 128, KRS 163, SCATC 88/13, Haiken 1, PR 255, Tjir 1, IAN 45/873 | Early, slow, complete |
| II | 4 | RRIC 45, GT 1, PB 213, PB 28/83 | Normal, slow, complete |
| III | 7 | RRII 203, PB 311, Mil 3/2, HP 204, KRS 25, RRII 308, HP 185 | Normal, slow, partial |
| IV | 1 | PB 217 | Late, fast, partial |

**Table 5. Cluster characteristics for wintering pattern of forty clones in 2000-2001 season**

| Cluster | No. of clones | Clones | Wintering nature |
|---|---|---|---|
| I | 10 | RRII 105, PB 242, PB 252, Ch 26, PR 261, Haiken 1, PR 255, Tjir 1, IAN 45/873, KRS 128 | Early, slow, complete |
| II | 24 | HP 185, HP 187, HP 204, HP 223, HP 372, RRII 300; RRII 308, AVT 73, RRIM 600, PB 5/51, PB 213, PB 215, PB 235, PB 255, PB 260, PB 311, PB 86, PB 28/83, G1 1, GT 1, RRIC 36, Hil 28, KRS 163, SCATC 88/13 | Normal, slow, complete |
| III | 6 | RRIC 45, RRII 118, Mil 3/2, PB 217, RRII 203, KRS 25 | Normal, slow, partial |

On a closer examination of the individual clusters, it was observed that in quite a number of cases close relatives were grouped together irrespective of the seasons. RRIM 600 and RRIC 36 derived from PB 86 share same cluster in all the seasons. HP 223 and HP 372 with Hil 28, PB 255 and PB 260 with PB 5/51 and SCATC 88/13 with RRIM 600 showed similar associations. However, there are few more cases showing similar grouping but not in all seasons, the details of which are presented in table 6. Also, it is very pertinent to note that the number of relatives grouped apart in different clusters is relatively small in the all three seasons. This strongly suggests the genetic influence on the wintering pattern of genotypes, part from the environmental modification as described by Vinod *et. al.*, (1996).

FLOWERING

In general, during all the seasons under study good flowering was not observed in any of the clones. Flowering was concentrated on the exposed areas and on the upper canopies of the trees.

The time of commencement of flowering for individual clones over seasons are presented in Table 7. It has been observed that RRII 105, IAN 45/873 and PB 311 were the early flowering clones irrespective of the seasons. RRII 105 and IAN 45/873 were early wintering clones and PB 311 started to winter normally. However, unlike the other two, in PB 311 panicles emerged alongwith new flushes. Similarly, the clones GT 1, PB 235 and PB 260 were late to commence flowering irrespective of the seasons. The rest of the clones exhibited variations, which are intermediate in nature. The peak flowering period for all the clones in this region was February to middle of March. However, most of the clones continued to flower during April and May. Remarkably, the cessation of flowering occurred by April in clones like RRII 105, RRIM 600, PB 311, PR 255, PR 261 and Haiken 1.

Other attributes related to floral biology of the clones are furnished in Table 8. The study revealed highly significant variation among clones for the traits. The male/female flower ratio was wide in PB 311 (32.70 : 1) followed by PB 235 (21.50 : 1). It was much narrower in IAN 45/873 (6.87 : 1) and PR 261 (7.95 : 1). Marked protandry was observed in all the clones studied. The anthesis of

**Table 6. Grouping of relatives under individual clusters for three seasons**

| Cluster | Parents | Seasons | | |
|---|---|---|---|---|
| | | 1998-1999 | 1999-2000 | 2000-2001 |
| RRII 105 | ♀ Tjir 1 | - | + | + |
| | ♂ G1 1 | + | + | - |
| RRII 118 | ♀ Tjir 1 | - | + | - |
| HP 185 | ♂ Mil 3/2 | + | + | - |
| HP 187 | ♀ Tjir 1 | - | + | - |
| | ♂ Mil 3/2 | + | - | - |
| HP 204 | ♂ Mil 3/2 | + | + | - |
| HP 223 | ♀ Tjir 1 | - | + | - |
| | ♂ Hil 28 | + | + | + |
| RRII 203 | ♀ Mil 3/2 | - | + | + |
| HP 372 | ♀ Mil 3/2 | + | - | - |
| | ♂ Hil 28 | + | + | + |
| RRII 300 | ♀ PB 86 | - | + | + |
| RRII 308 | ♀ G1 1 | - | - | + |
| RRIM 600 | ♀ Tjir 1 | - | + | - |
| | ♂ PB 86 | + | + | + |
| PB 213 | ♂ PB 86 | - | + | + |
| PB 235 | ♀ PB 5/51 | - | + | + |
| PB 242 | ♀ PB 5/51 | + | + | - |
| PB 255 | ♀ PB 5/51 | + | + | + |
| PB 260 | ♀ PB 5/51 | + | + | + |
| PB 252 | ♀ PB 86 | + | + | - |
| PB 311 | ♀ RRIM 600 | - | - | + |
| | ♂ PB 235 | + | - | + |
| PB 255 | ♀ Tjir 1 | - | + | + |
| PR 261 | ♀ Tjir 1 | - | + | + |
| RRIC 36 | ♀ PB 86 | + | + | + |
| SCATC 88/13 | ♀ RRIM 600 | + | + | + |
| IAN 45/473 | ♀ PB 86 | - | + | - |

+ Grouped - Not grouped

staminate flowers occurred between 11.00 A.M. to 12 noon during the first fortnight of March in all the clones. The pistillate flowers opened 10-15 days after the anthesis of male flowers. The data on pollen stainability showed higher percentage of stained pollens in RRIM 600 followed by PB 260, Ch 26 and PB 2335. However, it was much lower in Haiken 1, PB 252, PB 86 and PB 213. The clone GT1 was male sterile as there were no mature anthers realised in the male buds. Saraswathyamma *et. al.* (1986) have earlier reported the male sterile nature of GT 1. In spite of having good flowering in some of the clones under study, expected natural fruit set could not be realised in any of these clones. Generally, poor initial fruit set was observed in clones, with no fruit set in few clones during all the three seasons. This was primarily due to the desiccation of the female flowers even before the anthesis of male flowers. However, relatively better initial fruit set was seen in clones like PR 261 (16.67%), PB 217 (16.44%) and Ch 26 (15.93%). It was poor in PB 213, Haiken 1 and PBB 311. However, due to severe incidence of diseases like *Corynespora* lead fall, followed by fruit rot caused by *Phytophthora* none of the fruits survived to maturity under natural conditions. However, possibility of salvaging fruits by suitable control measures is being explored.

## CONCLUSION

In general, refoliation commenced before or at the completion of wintering process in majority of the clones. However, it was observed that the clones which shed leaves late reflushed late. Normally, the fast wintering clones escape from the incidence of leaf diseases, while the slow wintering clones have young leaves for a longer period enough for exposure to pathogens, rendering them vulnerable to various leaf diseases

**Table 7. Time of commencement of flowering in twenty three clones for three seasons**

| Clones | 1999 | 2000 | 2001 |
|---|---|---|---|
| PB 311 | Jan IV week | Jan III week | Jan IV week |
| IAN 45/873 | Jan IV week | Jan II week | Jan IV week |
| RRII 105 | Feb I week | Jan III week | Jan IV week |
| PR 261 | Feb I week | Jan IV week | Feb I week |
| PR 255 | Feb I week | Jan IV week | Feb II week |
| PB 5/51 | Feb II week | Jan IV week | Feb I week |
| RRIM 600 | Feb II week | Jan IV week | Feb II week |
| RRII 203 | Feb II week | Jan IV week | Feb I week |
| RRII 118 | Feb II week | Jan IV week | Feb 1 week |
| RRIC45 | Feb II week | Jan IV week | Feb 1 week |
| PB 86 | Feb II week | Jan IV week | Feb 1 week |
| PB 252 | Feb II week | Jan IV week | Feb I week |
| PB 217 | Feb II week | Jan IV week | Feb I week |
| PB 215 | Feb II week | Jan IV week | Feb I week |
| PB 213 | Feb II week | Feb I week | Feb I week |
| Haiken 1 | Feb II week | Jan II week | Jan III week |
| Gl 1 | Feb II week | Jan IV week | Feb 1 week |
| Ch 26 | Feb II week | Jan IV week | Feb I week |
| AVT 73 | Feb II week | Jan IV week | Feb I week |
| RRII 300 | Feb III week | Jan IV week | Feb I week |
| GT 1 | Feb III week | Feb I week | Feb II week |
| PB 235 | Feb IV week | Jan IV week | Feb I week |
| PB 260 | Feb IV week | Feb I week | Feb II week |

**Table 8. Average male : female flower ratio, pollen stainability and initial fruit set in twentythree clones over three seasons.**

| Clones | 1999 | 2000 | 2001 |
|---|---|---|---|
| PB 311 | 32.70 g | 68.60 de | 8.68 |
| IAN 45/873 | 6.87 a | 69.39 de | 10.37 |
| RRII 105 | 10.05 a-c | 84.91 i | 13.75 |
| PR 261 | 7.95 ab | 71.28 ef | 16.67 |
| PR 255 | 11.27 a-d | 66.77 d | 14.24 |
| PB 5/51 | 8.34 ab | 76.51 g | 12.77 |
| RRIM 600 | 12.73 b-d | 95.02 k | 15.27 |
| RRII 203 | 9.25 ab | 72.10 f | 9.49 |
| RRII 118 | 11.67 a-d | 75.98 g | - |
| RRIC 45 | 11.05 a-d | 78.72 gh | - |
| PB 86 | 14.35 c-e | 62.44 c | - |
| PB 252 | 11.80 b-d | 61.51 c | - |
| PB 217 | 9.30 ab | 80.93 hi | 16.44 |
| PB 215 | 9.65 a-c | 89.58 j | 15.49 |
| PB 213 | 10.25 a-c | 62.52 c | 7.70 |
| Haiken 1 | 10.00 a-c | 53.79 b | 7.95 |
| Gl 1 | 11.77 b-d | 67.06 de | 11.87 |
| Ch 26 | 17.43 ef | 91.69 jk | 15.93 |
| AVT 73 | 17.90 ef | 80.85 hi | 12.59 |
| RRII 300 | 15.33 de | 80.99 hi | 9.49 |
| GT 1 | 11.97 b-d | 0.00 a | - |
| PB 235 | 21.50 f | 90.65 j | 12.09 |
| PB 260 | 11.83 b-d | 92.71 jk | 14.51 |

Clone averages followed by same letters are not significantly different at 5% level based on Tukey's B test.

(Peries, 1979; Webster and Paardekooper, 1989). Slow wintering nature of clones like RRII 105, PR 255 and PR 261 could be one of the reasons for high incidence of *Corynespora* leaf fall in these clones. Grouping of the clones can be used as a tool for appropriately selecting them for different breeding programmes as flowering invariably follows wintering. Moreover, based on the wintering behaviour of the clones appropriate disease control measures can be adopted. The information can also be useful for characterisation of the clones in the region.

The results on the observed flowering attributes reveal greater degree of clonal specificity for the characters. However, the greater influence of the seasons particularly the climatic changes and disease outbreaks, often mask the true genetic expression for these traits. But the results can still be used to identify the synchrony in flowering between different clones, which in turn can be utilized to chalk out hydridisation programmes and also design appropriate multi clone breeding orchards. However, further insight into these attributes is required to fix the casual factors for the apparent variability.

## ACKNOWLEDGEMENT

The authors thank Dr. N.M. Mathew, Director of Research, Rubber Research Institute of India, Kottayam for constant encouragement during the study.

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