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WINTERING PATTERN AND FLORAL BIOLOGY OF *HEVEA* CLONES

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Wintering pattern and floral biology of 25 clones of *Hevea brasiliensis* were studied in two consecutive years. Most of the modern high yielding clones were found to exhibit partial wintering. The intra-clonal differences in the maturity of male and female flowers seem to play a major role in the prevalence of out crossing. So, while selecting parents for a polyclonal seed garden, care should also be taken to ensure that the peak periods of maturity of male and female flowers overlap as far as possible. Flowering in 1995 was accomplished two to six weeks in advance than during 1994. The continued drought and soil moisture stress experienced from December 1994 onwards might be the main factors which induced an early wintering and flowering in 1995. The early flowering during 1995 has triggered a second round of flowering during the same season, resulting in an extension of the flowering period.

Key words: *Hevea brasiliensis*, Floral biology, Anthesis, Agro-climatic stress, Pollen fertility.

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INTRODUCTION

In India, most of the polycross gardens and breeding orchards of *H. brasiliensis* are established in Kanyakumari District of Tamil Nadu, the area being selected in due consideration of the low incidence of diseases. By present standards, the component clones of the existing seed gardens are rather old. It is essential that newer clones be studied for inclusion in polyclonal seed gardens. Precise data on the floral biology and anthesis of different clones is an essential pre-requisite for breeding programmes.

Though much work has been done in this direction (Edgar 1958, George *et al.*, 1967, Meenattoor *et al.*, 1989, Sedgley and Attanayake, 1986), knowledge on the wintering pattern, floral biology and anthesis of most of the modern clones is rather meagre. Wintering and flowering in *Hevea* clones vary depending on the age of plants, location, agro-climatic conditions, etc. (George *et al.*, 1967, Meenattoor *et al.*, 1989). The present work forms part of a systematic study on the wintering pattern, floral biology and anthesis of a large number of *Hevea* clones under the agro-climatic conditions in Kanyakumari District of Tamil Nadu.

MATERIALS AND METHODS

A systematically laid out breeding orchard consisting of 25 clones planted in 1987 at the Hevea Breeding Sub-station, Kanyakumari was selected for the study. All the clones were planted in a compact area of 2.5 ha. The planting was at a wide spacing of 12 m x 12 m to ensure the maximum expression of characters of

individual clones and also to provide conditions for proper canopy development and flowering. Completely randomised design with 5 replications and single tree per plot was adopted.

Observations on wintering (at least 50% shedding of leaves) and refoliation were recorded from five trees in each clone at weekly intervals from the second week of December to the last week of April during 1993-94 and 1994-95. The flowering pattern was studied in four trees of comparable growth in each clone at weekly intervals during the period from the first week of January to the last week of May in 1994 and 1995. First flower opening is the date on which at least one flower has opened in any of the panicles under observation in a clone and 100 per cent flower opening correspond to the date on which all the panicles in a clone bear at least one opened flower.

Flower buds, destined to open the same day, were collected and fixed in modified Carnoy's fluid at 30 minutes interval from 06.00 to 12.00 hrs. As anther dehiscence was found to differ with changes in weather conditions, the samples were collected from different clones within the shortest possible period. Each time 50 buds were collected direct from the tree and instant killing of the buds were ensured by immersing in the above solution. After proper fixation, the flower buds were observed for the presence of dehisced anthers under a light microscope. Anthers were observed from four trees of each clone at the rate of 50 buds from each tree. Pollen fertility was observed under a light microscope by squashing the flower buds in a 1:1 solution containing 2 per cent aceto carmine and glycerine.

Observations on the time of opening of flower buds were recorded at 30 minutes intervals during the period from 11.00 hours to 18.00 hours from male flowers and female flowers(100 nos. each) from four trees in each clone. The opened buds were clipped off after each observation and the number of buds opened at every 30 minutes interval was recorded separately for the male and female flowers.

RESULTS AND DISCUSSION

Wintering and refoliation

Wintering during 1995 was 5 to 25 days earlier in different clones than during 1994 (Table 1). It was accomplished towards the last week of January in 1995 and second week of February in 1994. However, early wintering was noticed (middle of January in 1995 and last week of January in 1994) in RRII 203, RRIM 703, PB 310 and Gl 1. Wintering was found to be late in RRII 43 and RRII 208 in both the years and the process was found to be delayed up to the second week of March in RRII 5. In both the years, wintering was complete in clones RRII 5, RRII 33, RRII 43, RRII 203, RRII 208, RRIM 612, RRIM 701, PB 5/51, PB 86, PB 260, PB 310, PCK 1, PR 107, Gl 1 and Tjir 1 but was only partial in clones RRII 44, RRII 105, RRII 118, RRII 300, RRII 308, RRIM 600, RRII 703, PB 235, PB 311 and GT 1. Most of the popular high yielding clones belong to the partial wintering category.

New flushes of leaves, in general, start emerging before complete shedding of old leaves. However, bud break started after complete shedding of old leaves in RRII 33 and PR 107. An abrupt and complete shedding of old leaves and uniform emergence of new flushes were noticed in RRII 43, PB 86, PB 5/51 and PB 310. Refoliation in RRIM 701 was found to take place in two stages at two weeks interval. The clone PB 311 shed leaves from lower branches only, leaves of upper branches remain.

Table 1. **Earliness (no. of days) in wintering and flowering of *Hevea* clones during 1995(Mean ± S.D)**

Clone	Wintering	Sprouting of panicles	First flower opening	100% flower opening
RRII 5	5.2 ± 0.83	10.3 ± 1.25	4.75 ± 0.95	3..50 ± 1.29
RRII 33	22.2 ± 1.48	33.0 ± 2.58	23.25 ± 2.21	39.00 ± 2.16
RRII 43	11.4 ± 1.14	16.8 ± 1.5	19.75 ± 0.95	12.50 ± 4.20
RRII 44	14.2 ± 1.48	19.5 ± 1.29	23.25 ± 2.21	20.00 ± 1.63
RRII 105	23.6 ± 1.82	27.0 ± 1.41	28.00 ± 1.82	23.00 ± 1.41
RRII 118	15.6 ± 0.89	36.5 ± 1.91	36.50 ± 3.64	31.25 ± 3.77
RRII 203	12.2 ± 0.84	36.5 ± 1.73	50.00 ± 3.91	44.25 ± 4.03
RRII 208	15.8 ± 0.84	25.8 ± 1.50	20.75 ± 0.95	19.25 ± 1.25
RRII 300	17.6 ± 0.89	28.50±1.29	22.75 ± 2.21	22.25 ± 2.06
RRII 308	12.6 ± 1.14	12..25± 0.95	7.75 ± 0.95	7.75 ± 1.70
RRIM 600	7.0 ± 0.71	13.25± 0.95	9.75 ± 1.89	10.25 ± 1.70
RRIM 612	25.8 ± 0.84	33.25± 1.50	34.75 ± 2.98	27.50 ± 2.64
MIM 701	12.2 ± 1.10	12.00± 1.41	6.50 ± 2.08	5.25 ± 1.70
RRIM 703	13.0 ± 0.95	27.75± 1.50	27.25 ± 2.98	20.75 ± 2.21
PB 86	16.0 ± 1.41	13.00 ± 1.82	11.75 ± 1.25	11.25 ± 2.50
PB 235	17.3 ± 1.5	18.75 ± 0.95	20.25 ± 1.70	21.00 ± 2.16
PB 260	17.8 ± 0.95	25.75 ± 1.25	24.25 ± 2.36	25.00 ± 2.16
PB 310	14.5 ± 1.0	32.35 ± 1.25	39.75 ± 2.75	36.50 ± 3.87
PB 311	17.0 ± 1.63	19.25 ± 1.25	19.00 ± 1.82	19.75 ± 1.70
PB 5/51	18.8 ± 1.25	26.75 ± 1.70	23.75 ± 2.06	26.75 ± 2.50
PCK 1	15.0 ± 0.81	27.50 ± 2.38	21.75 ± 3.50	20.25 ± 1.25
Tjir 1	11.8 ± 1.25	19.25 ± 1,50	15.75 ± 0.95	21.25 ± 2.21
Gl 1	9.0 ± 0.70	40.00 ± 2,58	35.75 ± 2.62	35.00 ± 3.46
GT 1	4.2 ± 1.08	0.50 ± 0.57	—	—
PR 107	13.8 ± 1.08	33.75 ± 2.62	31.75 ± 1.25	32.50 ± 2.38

Flowering

The panicles were found to emerge along with new flushes of leaves in most of the clones studied. Panicles, in general, emerged towards the last week of January in 1995. The first male flower opened, in majority of clones, in the first week of March in 1994 and middle of February in 1995. The first female flower was found to open one to two weeks after the opening of the first male flower in all the clones examined except in PB 235 and PB 260 where the interval was more pronounced even up to three weeks. In fact, the intra clonal difference in maturity of male and female flowers seem to play the major role in the prevalence of outcrossing in *Hevea* clones. The aim behind establishing polyclonal seed gardens is to facilitate maximum cross pollination between parental clones. So, while selecting parents for a polyclonal seed garden, in addition to giving due consideration to important characters like yield, prepotency, genetic dive rgence etc., care should also be taken to ensure that the peak periods of maturity of male and female flowers overlap as far as possible.

The flowering characteristics of individual clones reported by Meenattoor *et al.* (1989) under the sub-tropical climate (Tripura) was quite different from that of the present study. For instance, Gl 1 has flowered late at Tripura, but it is one of the three clones (others being PB 260 and PB 310) which have flowered very early under the South Indian climate. Similarly, RRIM 600 which exhibited minimum flowering at Tripura flowered profusely under the South Indian climate. Differences, in varying degrees, were noticed in other aspects of flowering also such as initiation of flowering, peak period of flowering, duration of flowering period etc; between the tropical and sub-tropical climates.

Wide variations were observed in opening of flower buds in different clones (Table 2). Once the first flower is open, the process becomes complete within $2^1/_2$ to 4 hours. The male flowers open earlier than the female flowers in a panicle. The time lapse between the opening of the male and female flowers varies between 1.00 and 3.00 hrs. in different clones.

Anthers start dehiscing at different time and the time required for the completion of the process was also found to vary with clones. Fertility of pollen grains was found to be almost complete in clones RRIM 600, PB 235, PB 260, PB 310 and Gl 1 but a complete abortion of pollen was encountered at an early stage of its development in the male sterile clone GT 1. The other clones have exhibited varying percentages of pollen fertility (Table 2).

Table 2. **Anthesis, anther dehiscence and pollen fertility in *Hevea* clones during 1995**

Clones	Mean peak time of opening (hrs ± SD)		Period of anther dehiscence	Pollen fertility (%)	Atmospheric temperature,°C		Relative humidity (%)
	male flowers	female flowers			Min.	Max.	
RRII 5	12.00 ± 17	13.20 ± 16	07.00 – 10.30	96.7 ± 2.6	20.8	36.5	100
RRII 33	13.30 ± 12	14.15 ± 17	07.00 – 10.00	93.6 ± 1.8	22.0	37.8	98
RRII 43	12.30 ± 22	15.10 ± 14	06.30 - 10.30	91.0 ±2.0	22.0	37.8	98
RRII 44	13.00 ± 16	15.10 ± 17	08.00 – 10.00	93.6 ± 1.7	20.8	36.5	100
RRII 105	12.30 ± 9	14.45 ± 16	08.30 - 10.30	96.0 ± 1.9	23.1	34.5	89
RRII 118	12.15 ± 11	14.30 ± 19	07.30 – 10.30	87.8 ± 4.0	22.0	37.8	98
RRII 203	12.30 ± 16	15.10 ± 14	06.30 – 10.00	95.3 ± 1.5	23.1	34.5	89
RRII 208	15.15 ± 7	15.30 ± 12	06.30 – 10.30	95.0 ± 1.8	23.0	34.1	78
RRII 300	14.45 ± 12	16.20 ± 15	06.30 - 09.00	95.8 ± 1.2	23.1	34.5	89
RRII 308	14.30 ± 6	15.45 ± 16	06.30 - 09.30	94.8 ± 1.7	20.8	36.5	100
RRIM 600	13.00 ± 20	13.00 ± 12	06.30 - 09.00	98.3 ± 0.5	23.0	34.5	87
RRIM 612	13.30 ± 18	14.40 ± 15	06.00 - 09.30	95.6 ± 0.5	23.0	34.1	78
RRIM 701	13.40 ± 9	14.20 ± 17	06.00 - 09.00	95.0 ± 1.4	23.0	34.1	78
RRIM 703	15.00 ± 16	15.20 ± 16	06.00 - 08.30	89.9 ± 2.6	20.8	36.5	100
PB 86	13.45 ± 12	14.10 ± 11	06.30 - 09.00	92.2 ± 1.9	23.1	34.5	89
PB 235	14.30 ± 13	16.00 ± 14	07.30 – 09.30	98.3 ± 1.5	23.1	34.5	89
PB 260	13.45 ± 17	14.45 ± 11	07.00 – 10.00	99.1 ± 0.8	23.0	34.1	78
PB 310	13.20 ± 16	15.00 ± 14	07.00 - 10.00	99.4 ± 0.4	23.1	34.5	89
PB 311	15.00 ± 7	15.45 ± 13	07.00 – 10.00	97.0 ± 2.1	20.8	36.5	100
PB 5/51	15.10 ± 14	16.00 ± 14	06.00 – 09.00	96.4 ± 1.6	23.4	33.6	90
PCK 1	12.20 ± 17	13.40 ± 16	08.00 – 10.30	95.7 ± 1.5	23.4	33.6	90
Tjir 1	14.30 ± 14	15.45 ± 10	07.00 - 10.30	93.6 ± 3.2	23.1	34.5	89
Gl 1	13.30 ± 9	14.30 ± 17	07.00 - 10.00	98.1 ± 1.2	23.4	33.6	90
GT	M S	14.20 ± 12	M S	M S	23.4	33.6	90
PR 107	14.10 ± 12	15.10 ± 17	07.00 - 10.00	94.5 ± 1.0	20.8	36.5	100

M S = Male sterile

A comparative study of wintering and various flowering processes in different clones during 1994 and 1995 has revealed that the flowering during 1995 took place earlier than during 1994 (Table 1). This earliness in flowering could be attributed to differences in agro-climatic conditions during the two years. The North-East monsoon was more pronounced in 1993 and rain extended up to the last week of December (Table 3). In 1994, on the other hand, no appreciable rain was recorded after the second week of November and as a result, an extreme soil moisture stress was experienced from the middle of December. The continued drought and soil moisture stress experienced thereafter might be the main factor which induced an early wintering and flowering in 1995. Based on the differences (in number of days) of various flowering processes during 1994 and 1995, clones are

Table 3. Agroclimatic data recorded at Heavea Breeding Substation, Kanyakumari

Week		Rainfall (cm)		No. of rainy days		Atomospheric temperature (°C)				Relative himidity (%)	
From	To	1993	1994	1993	1994	1993		1994			
						Min.	Max.	Min.	Max.	1993	1994
29 November	5 December	1.8	1.0	2	1	22.0	30.5	22.8	31.7	93.5	89.9
6 December	12 December	2.4	0.0	2	0	20.1	32.0	22.4	32.9	93.5	86.4
13 December	19 December	3.1	0.0	2	0	21.3	31.2	23.6	33.2	89.4	83.8
20 December	26 December	5.5	0.0	3	0	23.7	32.0	24.8	33.6	81.1	78.6
27 December	2 January	1.9	0.0	2	0	21.0	31.8	23.4	33.6	90.4	72.9
From	To	1994	1995	1994	1995	1994		1995		1994	1995
3 January	2 January	2.3	1.0	2	1	22.4	33.1	23.1	33.8	88.5	89.8
10 January	16 January	3.2	4.8	4	2	21.9	32.5	22.8	32.7	96.8	89.9
17 January	23 January	1.2	0.0	1	0	22.6	31.4	23.0	34.1	89.1	78.4
24 January	30 January	2.0	0.0	2	0	20.9	32.7	23.8	35.1	87.1	74.8
31 January	6 February	0.8	0.0	1	0	25.2	34.1	23.6	35.8	72.8	72.6
7 February	13 February	0.0	0.0	0	0	21.1	34.6	24.4	36.7	92.1	72.8
14 February	20 February	2.7	0.0	2	0	22.1	34.3	24.2	36.2	81.7	70.4
21 February	27 February	0.8	0.0	1	0	21.0	36.0	24.6	36.1	94.7	69.8
28 February	6 March	0.0	0.0	0	0	20.4	36.1	24.8	36.8	94.2	71.9
7 March	13 March	1.3	5.2	1	1	22.6	36.0	24.1	36.1	93.4	76.6
14 March	20 March	4.6	0.0	2	0	20.7	36.3	24.0	36.6	88.8	74.3
21 March	27 March	1.2	0.5	1	1	23.2	36.2	24.0	36.1	90.85	78.4
28 March	3 April	0.4	0.0	1	0	23.9	36.3	24.4	36.4	94.2	72.8
4 April	10 April	2.9	3.6	2	3	23.8	35.6	23.8	36.0	94.5	90.4
11 April	17 April	0.8	4.5	1	7	22.9	33.7	21.9	34.5	98.1	94.9
	Total	38.9	20.6	32	16	--	--	--	--	--	--

Table 4. **Grouping of *Hevea* clones based on early flowering response to the agroclimatic stress durlng 1995 compared to 1994**

Early flowering (days)	Grouping of clones
Upto 15 days	RRII 5, RRII 308, RRIM 600, RRIM 701, PB 86, and GT 1
16 to 30 days	RRII 43, RRII 44, RRII 105, RRII 208, RRII 300, RRIM 703, PB 235, PB 260, PB 311, PB 5/51, PCKl, and Tjir 1.
31 to 45 days	RRII 33, RRII 118, RRII 203, RRIM 612, PB 310, Gl 1, PR 107.

classified into three groups as in table 4. The climatic differences during 1994 and 1995 were found to have the least effect on the male sterile clone GT 1. Only slight deviations were exhibited by RRII 5, RRIM 600, RRIM 701, PB 86, and RRII 308. This observation is in conformity with Meenattoor *et al.*, (1989) who have reported stable performance for RRIM 600, PB 86 and GT 1. The clones which have exhibited high earliness in wintering during 1995 are RRII 33, RRII 105 and RRIM 612. The maximum earliness with respect to flowering was exhibited by RRII 118, RRII 203, PB 310 and Gl 1.

The entire process of flowering was completed towards the middle of April in 1994 and no flower could be observed in any of the clones after the last week of April. On the other hand, the process of flowering took place one to six weeks in advance and complete withering of flowers were accomplished towards the last week of March, 1995. However, unlike in 1994, a second round of new flushes and panicles emerged towards the middle of April during 1995 in most of the clones except in RRII 33, RRII 43, RRIM 701, PR 107 and GT 1. An interesting feature noticed is that the clones have exhibited profuse flowering during the first round (February, 1995), produced only limited number of panicles during the second round (April 1995). Conversely, the clones which flowered sparsely during the first round exhibited profuse flowering during the second round. This additional round of flowering has resulted in almost a doubling of the duration of flowering and as such is advantageous in breeding programmes. Stress induced extension of flowering duration has been reported in other plants also (Martin, 1963). An extended duration of flowering induced by cold shock was reported in *Hevea* clones. (Meenattoor *et al.*, 1989).

The effect of the continued drought experienced during 1994-95 was expressed minimum on GT 1, RRII 5, RRII 308, RRIM 600, RRIM 701 and PB 86 which could be taken as an indication of their stable performance under different agro-climatic conditions.

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