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IMPROVING FRUIT SET IN *HEVEA* : SOME PRELIMINARY OBSERVATIONS

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Factors responsible for low fruit set in open pollination and hand pollination were studied under the agro-climate of Kanyakumari District of Tamil Nadu. *Oidium* was noticed to cause severe damage to flowers and young fruits, if not controlled properly. The harmful effects of solar radiations could be minimised by providing an overhead partial shade. Based on the stickiness of pollen and floral biology, it is assumed that pollination in *Hevea* could be brought about through an external agent only. The effectiveness of insect repellent coils to keep away the natural pollinating agents was analysed with a view to use them as an alternative for emasculation and post pollination plugging of flowers. Low pollination due to insufficient transfer of pollen was identified as the main factor responsible for the low fruit set in open pollination. The low fruit set, in spite of adequate pollen transfer, in controlled pollination is attributed to the damage caused to the panicles and flowers during the process of emasculation, pollination and post pollination plugging.

Key words : Fruit set, *Hevea*, Pollination, Solar radiation.

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INTRODUCTION

Low fruit set is a hindrance for successful hybridisation in *Hevea* clones. Measures to improve fruit set have been suggested by several workers (Attanayake and Dharmaratna, 1984; Yeang and Ghandimathi, 1984; Leconte *et al.*, 1984; Sedgley and Attanayake, 1986; Mydin *et al.*, 1989). In spite of following such measures, the maximum fruit set obtained in hand pollination was less than 5 per cent (Mydin *et al.*, 1989). The real cause for the low fruit set is yet to be established. In this paper some preliminary observations on the factors responsible for the low fruit set are presented. Results of some initial attempts made to enhance the rate of fruit set and to improve the turnover of hand pollination are also discussed.

MATERIALS AND METHODS

The experiments were conducted in a systematically laid out breeding orchard planted in 1987 at a wide spacing of 12.2 m x 12.2 m at the Hevea Breeding Sub Station, Kanyakumari. The atmospheric temperature, during flowering season, increased upto 37.8 °C and relative humidity went down to as low as 25 per cent. Bright sun light was available for 8.94 h (mean) per day and rainfall during the flowering season, was negligible. *Oidium* was controlled by dusting 70 per cent dust formulation of sulphur twice a week. Solar radiation was controlled by providing an overhead partial shade with coconut palm leaves. In case of rain and dull weather, shade was removed temporarily to facilitate exposure to light.

The effect of solar radiation was studied by comparing premature shedding of flowers in exposed panicles with those under partial shade.

In order to study the effect of injuring panicles, 600 panicles, at comparable stage, were labelled and emasculation was carried out in 300 panicles selected at random. The remaining 300 panicles were considered as control. Observations on withering of the panicles were recorded at weekly intervals. The sticky nature of pollen was demonstrated by estimating pollen content before anther dehiscence and at different stages after anthesis. Hundred male flowers each were collected at different intervals and all the pollen grains were disbursed in 100 ml distilled water by blending in a mixer. Only pulse rotation was given to avoid damage to pollen. Other floral parts were removed by passing through a sieve. The pollen grains were counted under a light microscope and expressed as pollen content per flower.

In the conventional method of hand pollination, panicles were emasculated by removing all the male flowers and immature and already opened female flowers, retaining only those female flowers which were to open on the day of pollination. The anther column was inserted within the perianth and plugged with cotton kept in place with a speck of latex. Pollination was also attempted using a concentrated solution of pollen. Pollen grains of mature male flowers were dispersed in distilled water, by smearing in between the bristles of two tooth brushes, sieved and allowed to settle down and the supernatent discarded. The concentrated pollen suspension was applied to the stigmatic surface using a dropper. The number of pollen deposited on the stigma was counted under a light microscope on the next day morning.

Insecticides and insect repellent coils were tried for prevention of insects pollinating flowers with rogue pollen. Water soluble BHC, at 0.5 per cent and 1 per cent concentrations, was sprayed on selected branches before opening of female flowers. Alternatively, insect repellent coils (Allethrin 3.5% w/w) were hung in lower branches and smoked throughout the night starting from just before the anthesis of female flowers. Ten insect coils were used per tree of 10 years age. Opened flowers were collected early the next morning and their stigma excised and observed for rogue pollen under a light microscope.

RESULTS AND DISCUSSION

The fruit set obtained in hand pollination at the Hevea Breeding Sub Station was not promising. Some of the factors identified to be responsible for the low fruit set are *Oidium* infection, injury caused to flowers during emasculation and pollination and the insufficient transfer of pollen.

Under climate favourable to *Oidium*, severe infection was observed to damage flowers and young fruits completely. Infected flowers either dried prematurely or remained with deformed perianth, till opening. None of the affected flowers were found to develop into fruits. The adverse impact of *Oidium* infection on fruit set has been reported by earlier workers (Wycherley, 1971; Yeang and Ghandimathi, 1984; Saraswathyamma and Panikkar, 1990). Sulphur dusting at biweekly intervals, with additional rounds in case showers occur during flowering period was found to provide reasonably good protection to flowers (Table 1).

High ambient day temperature, extended soil moisture stress, dry atmosphere make the summer season in Kanyakumari District different from that of other traditional rubber growing regions. Flowers are susceptible to the harmful effects of solar

Table 1. **Effect of sulphur dusting for control of *Oidium* infection on flowers**

Treatment	Flowers under observation		Flowers perished before opening		Flowers deformed		Total flowers affected		Flowers unaffected till opening	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Control	1420	732	434	160	270	277	704	437	716	295
			(30.46)	(21.85)	(19.01)	(37.84)	(49.57)	(59.69)	(50.42)	(40.31)
Sulphur dusting	1160	620	108**	47**	42**	64**	150**	111**	1010**	509**
			(9.31)	(8.64)	(3.62)	(10.32)	(12.93)	(17.90)	(87.07)	(82.09)

Values in parentheses indicate percentage. ** Chi-square value significant at 0.01 level.

radiations and various other stresses of summer season. Upto 28 per cent flower buds were noticed to dry prematurely in exposed panicles (Table 2). Female flowers are relatively more tolerant to dry atmosphere. High fruit set under low evaporation and low solar radiations have already been reported (Yeang and Ghandimathi, 1984). The overhead partial shade significantly reduced the premature shedding of flowers and improved the initial fruit set.

Emasculated panicles started drying during the first week itself. At the end of the second week 38.1 per cent panicles dried and another 45.57 per cent withered after six weeks. In the control, however, withering of panicles (with no fertilised flowers) started in the third week only and the survival of panicles upto the end of 4th week was significantly higher than that of emasculated panicles (Table 3). Most of the initial drying of panicles could be attributed to the damage caused by emasculation.

Pollen count immediately after anthesis of male flowers and 6 h later did not differ significantly from the count made before anther dehiscence and anthesis. However, the reduction in pollen content 24 h after flower opening was significant. Anther dehisces in the morning but anthesis of female flowers is completed in the evening only. This time gap between anther dehiscence and anthesis of female flowers lends support to the view that pollination in *Hevea* involves an external agent. This could be nocturnal flies. However, spraying insecticides did not prevent pollination as the spraying was done before anthesis and the insects could directly alight on the unsprayed parts which opened up subsequently. The insects could be repelled effectively by smoking with allethrin coils. Emasculation and post pollination plug-

Table 2. **Fruit set in exposed and partially shaded panicles under open pollination**

Treatment	Flowers observed	Survival upto opening	Initial fruit set (2 weeks)	Final fruit set
Exposed panicles	1807	1301 (72%)	874 (67.2%)	27 (2.07%)
Shaded panicles	2035	1722** (84.6%)	1314** (76.3%)	46^{NS} (2.67%)

Fruit set calculated based on opened flowers.
** Chi - square value significant at 0.01 level.
NS - Not significant.

Table 3. **Effect of emasculation on the survival of panicles**

Period	Not emasculated	Emasculated
Initial	382	294
After 2 weeks	382	182** (61.9)
After 4 weeks	308 (80.62)	66** (22.5)
After 6 weeks	107 (28.01)	48** (16.32)

Percentage values are given in parentheses
** Chi-square value significant at 0.01 level

Table 4. **Mean pollen content per flower at different stages of flower opening**

Morning (before anthesis and anther dehiscence)	Afternoon (immediately after anthesis)	Evening (6.00 h after anthesis)	Next morning (24.00 h after anthesis)
773.6±40.2	774.2±36.9	761.5±38.2	720.8±39.4

ging could be avoided by using such repellents.

Poor turnover from hand pollination and wide variations in fruit set among different cross combinations has been identified as impediments for a clear understanding of genetic characteristics of *Hevea* as well as in crop improvement (Leconte *et al.*, 1984; Yeang and Ghandimathi, 1984). Differences in the extent of damage caused to panicles and flowers during the process of emasculation, pollination and post pollination plugging could be one of the reasons for the differences in fruit set observed between crosses. The substitution of emasculation and post pollination plugging through the use of insect repellents would help us to achieve significant improvement in the turnover of hand pollination.

Young fruits even with a single unfertilised ovule are reported to abort during the course of its development (Yeang and Ghandimathi, 1984). In open pollination, 10.78 per cent flowers received at least one pollen but the flowers which have received more than five pollen were only 3.15 per cent (Table 5). Among the flowers pollinated with more than five pollen, 72.01 per cent developed into mature fruits, while the final fruit set in relation to the total successful pollination was 20.96 per cent only. Insufficient transfer of pollen could therefore be one of the main reasons for the low fruit set in *Hevea*.

Examination of stigma in hand pollinated flowers showed that 63.3 per cent flowers did not receive pollen (Table 5). The dehiscence of anther earlier to anthesis of female flowers and the sticky nature of pollen grains might adversely affect the quantity of pollen transfer in hand pollination. Yeang and Ghandimathi (1984) has pointed out insufficient transfer of pollen as one of the reasons for the low fruit set in conventional method of hand pollination. In the present study, pollen grains were

Table 5. **Pollen transfer and final fruit formation in open and hand pollination (%)**

	Natural open pollination			Hand pollination by conventional method
	Control	After sulphur dusting	After spraying with BHC (0.5% solution)	
Stigma with no pollen	89.22 ± 11.12	68.6 ± 9.96	91.26 ± 6.14	63.3 ± 8.21
Stigma with pollen in the range 1-5	7.63 ± 2.59	14.6** ± 4.40	3.74** ± 1.42	14.1** ± 5.80
Stigma with more than 5 pollen	3.15 ± 0.92	16.70** ± 4.50	5.0 ± 2.20^{NS}	22.6** ± 6.02
Total successful pollinations	10.78	31.30**	8.74^{NS}	36.70**
Percentage of fruit set inrelation to total successful pollintions	20.96	35.78^{NS}	-	9.31*
Percentage of fruit set in relation to the flowers pollinated with more than 5 pollen	72.01	67.9^{NS}	-	16.0**

* Chi-square value for comparison with control significant at 0.05 level
** Chi-square value for comparison with control significant at 0.01 level
NS - Not significant

Table 6. **Fruit set employing different techniques**

Method of hand pollination	No. of flowers observed	Initial fruit set*		Final fruit set	
		Number	Percentage	Number	Percentage
Conventional method	380	22	5.78	12	3.15
Conventional method without emasculation and post-pollination plugging	620	137**	22.09	78**	12.58
Application of pollen dispersed in distilled water	940	112**	11.91	4**	0.42

* 4 weeks after pollination

** Chi-square value for comparison with conventional method significant at 0.01 level

dispersed in distilled water and applied to stigmatic surface. Although pollen transfer was improved considerably (Table 6) fruit set obtained was very poor (0.42%). Pollen grains dispersed in distilled water absorbed water by endosmosis and cytoplasm was found protruded out through the pores. This could be the reason for the low fruit set. Fruit set in hand pollination is reported to be higher than that in natural open pollination (Morris, 1929; Ross, 1960; Rao, 1961; Wycherley, 1971).

This study, though preliminary, serves to highlight some of the major factors responsible for the low fruit set in open as well as hand pollination. Detailed investigations on different aspects mentioned here may help to standardise a much easier and rapid hand pollination technique for improved fruit set.

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