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HAND POLLINATION OF *HEVEA BRASILIENSIS* IN NIGERIA (1984—1990); COMPARISON WITH OPEN POLLINATED FIELD DATE

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ABSTRACT

Artificial hand polinations of *Hevea brasiliensis* were done at the Rubber Research Institute of Nigeria (RRIN) from 1984-1990: these involved 28,887 female flowers from which only 7.60% mean fruit set was obtained while only 5.13% of the flowers formed fruits that reached maturity. A correlation value of 0.65 was obtained between number of female flowers pollinated and fruits set.

Clonal variations were observed for flower production in the open pollinated field with very high correlation of +0.9 between male and female flowers. Clones PB 5/51 and RRIM 707 produced the highest number of both male and female flowers. The mean male to female flower ratio was 14.1. Male flowers had a higher correlation coefficient of $r = 0.32$ with fruit set than emale flowers with $r = 0.05$.

An estimate of 15% fruit set was obtained under natural open field pollinations in 1989 while only 8.8% of the flowers formed fruits that reached maturity. Only about 64% of the fruits set under both artificial and natural open pollinations reached maturity, while about 36% abortions of fruits took place. The implications of these results are discussed.

Key words, Male flowers, female flowers, pollination, fruit set, abortion.

INTRODUCTION

Low fruit set after artificial hand pollinations in *Hevea brasiliensis* has been reported in various parts of the world. In Malaysia, 3-8% fruit set was reported (Morris 1929, Ross 1960, Wycherley 1971) while in Nigeria 3-4% was reported (Onokpise 1976).

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Fruit set under natural open pollinated fields have similarly been very low, 0.3-1.6% and 0.26% were reported in Malaysian fields by Rao (1961) and Wycherley (1971) while in Puerto Rico, about 5% was reported by Warnke (1951).

Although the cause of low fruit set under natural and artificial hand pollinations has not been established, the abscission/ abortion of flowers and fruits has been observed at various stages of development from flowering to fruit maturity (Hossen *et al* 1981, Ross 1960, Onokpise 1976: Olapade *et al* 1985).

Though the artificial hand pollinations in the hybridisation programme of *Hevea brasiliensis* in Nigeria was initiated in 1965, quantitative estimates of fruit set under natural open-field pollination have not been obtained hitherto, whereas estimates are required to serve as a guide for improvement of the results of hand pollination. This paper therefore reports on the hand pollination exercise done at the Rubber Research Institute of Nigeria over seven years (1984 – 1990) and compares the result with the data obtained under natural open pollinated fields in 1989.

MATERIALS AND METHODS

Hand pollinations using different parents were done as described by Onokpise (1976) from 1984 to 1990 in the experimental rubber fields at the Rubber Research Institute of Nigeria (RRIN). In each year, 5 experienced pollinators were used. The total number of female flowers pollinated during the flowering seasons, usually between late February and early April were recorded. Data on fruit set were taken at about 3 weeks after pollination while that of physiologically matured fruits were taken in August prior to fruit dehiscence.

In 1989, Eight clones of *Hevea brasiliensis:* RRIM 628, RRIM 605, RRIM 623, GT 1, RRIM 707, RRIM 501, IAN 2960 and PB 5/51 were selected randomly and evaluated for flower and fruit production in the open pollinated fields at Rubber Research Institute of Nigeria. At the peak of flowering in March 1989, data were collected on the number of male and female flowers per inflorescences on two randomly selected branches per clone. Five inflorescences were sampled per branch as replicates. In April 1989, records of fruit set were taken following the same experimental design and in August 1989 physiologically matured fruits were counted before dehiscence.

RESULTS AND DISCUSSIONS

A Total of 28,887 female flowers were artificially hand pollinated from 1984 to 1990 while only 1,897 fruits were set representing about 7.60% from which only 1,167 matured pods were formed, that is about 5.13% (Table 1). There is significant flower abortion of about 93.46% between the phase of flowering and fruit set after artificial hand pollination. After fruit set also, an appreciable proportion of about 36% of the fruits were aborted at various stages of development before the physiological maturity of the fruits was attained, leaving only about 64% of fruits set to mature.

Although the number of female flowers pollinated varied annually from as low as 1,473 in 1986 to 4,540 in 1990 and to 7,226 in 1984: the fruit set which ranged from 3.59%- 11.67% is apparently unrelated to this number. It is noted that in 1984 and 1985, when over 7,000 female flowers were pollinated, each pollinator handled an average of about 1,400 flowers and the least fruit set success of 3.58%- 3.89% were recorded: while from 1986 to 1990 when the total number of female flowers pollinated annually ranged from 1,473 - 4,450 with each pollinator handling between 294 - 908 female flowers, the fruit set success rate improved and ranged from 6.02% - 11.67%. A correlation analysis between number of female flowers pollinated and % success of fruit set was found to be r=0.65 (Fig. 1), which suggests that better fruit set success is achieved when pollinators are asked to handle fewer female flowers. This may be due to better efficiency of manipulations i.e. the careful handling of the female flowers and effective transfer of adequate number of pollen grains from the male flowers to the female flowers. In addition a training programme was organised in 1988 to further improve the skill of the pollinators and the success rate improved accordingly. This is in agreement with the observations of Harihar & Yeang (1984) who found that inadequate number of pollen grains transferred to effect pollinations could cause abortion of fruit set in *Hevea brasiliensis.*

Studies on open pollinated fields revealed that there is clonal variation in flower production (Table 2). There is also a highly significant and positive correlation of 0.9 between number of male and female flowers (Table 3). This trend is particularly interesting as a natural design to ensure that female flowers receive enough pollen grains for effective pollination. The mean male to female flower ratio was 14;1 (Table 4). In monoclonal plots with high female flower production there was a high number of male flowers. PB 5/51 and RRIM 707 which were the most prolific in the production of mflme flowers were also among those that produced the highest number oaa eel flowers (Table 4).

The interaction between clone and branch in the production of male flowers and pods was significant (Table 2). This may be due to the effects of

high plant density when branches exposed to more sunlight produced more male flowers and pods: this agrees with the observations of Wycherley (1971) who reported the limiting effect of high plant density on seed production.

The correlation coefficient between male flowers and fruit set was r=0.32 which is six times the correlation coefficient between female flowers and fruits set r=0.05 (Table 3). Thus, while 10.24% of variation in fruits set can be accounted for by variation in male flowers only 0.25% of the variation in fruit set can be accounted for by variation in female flowers which suggest that the number of male flowers available for pollination of female flower has more influence on fruits set than the number of female flowers. This influence of male flowers on fruit set in this study is further in agreement with the findings of Harihar and Yeang (1984).

Average fruit set in the open pollinated field in this study was 15% while fruit formation at maturity was 8.88%. This is higher than that reported in Malaysia (Rao 1961) and Puerto Rico (Warnke 1951).

In comparison with fruit set under artificial hand pollinations from 1984 to 1990, it is clear that there is a better fruit set under natural field conditions. Although data was collected for 1989 alone in the case of open field pollination, the value of 15% is still higher than the 11.20% obtained for the same year with artificial hand pollinations.

Other workers in Malaysia have reported better fruit set through hand pollinations than in open pollinated fields (Rao 1961, Wycherley 1971, Morris 1929, Ross 1960) but the results obtained from this study are at variance with this view.

The problem of incompatibility encountered during artificial hand pollinations as experienced by Onokpise (1976) when he made 18 Crosses and one selfing using clones imported into Nigeria, coupled with clonal variations in fruit setting may be responsible for the lower success in fruit set in artificial pollinations when compared with open pollinated monoclonal plots.

The abortion of fruits between fruit set and pod maturity appears to be independent of the mode of fruit formation because 35.98% abortion was recorded under natural condtions (Table 4), while 35.31% was recorded under artificial pollinations (Table 1), leaving only about 64% of the fruits set in each case to reach maturity. It is suspected that the premature loss of pods is due to the high nutritional value of *Hevea* seeds which are rich in proteins and carbohydrates (22.30% and 22.39% respectively – USAID 1972). Under a dense humid canopy, such a nutrient reserve could provide a rich substrate for

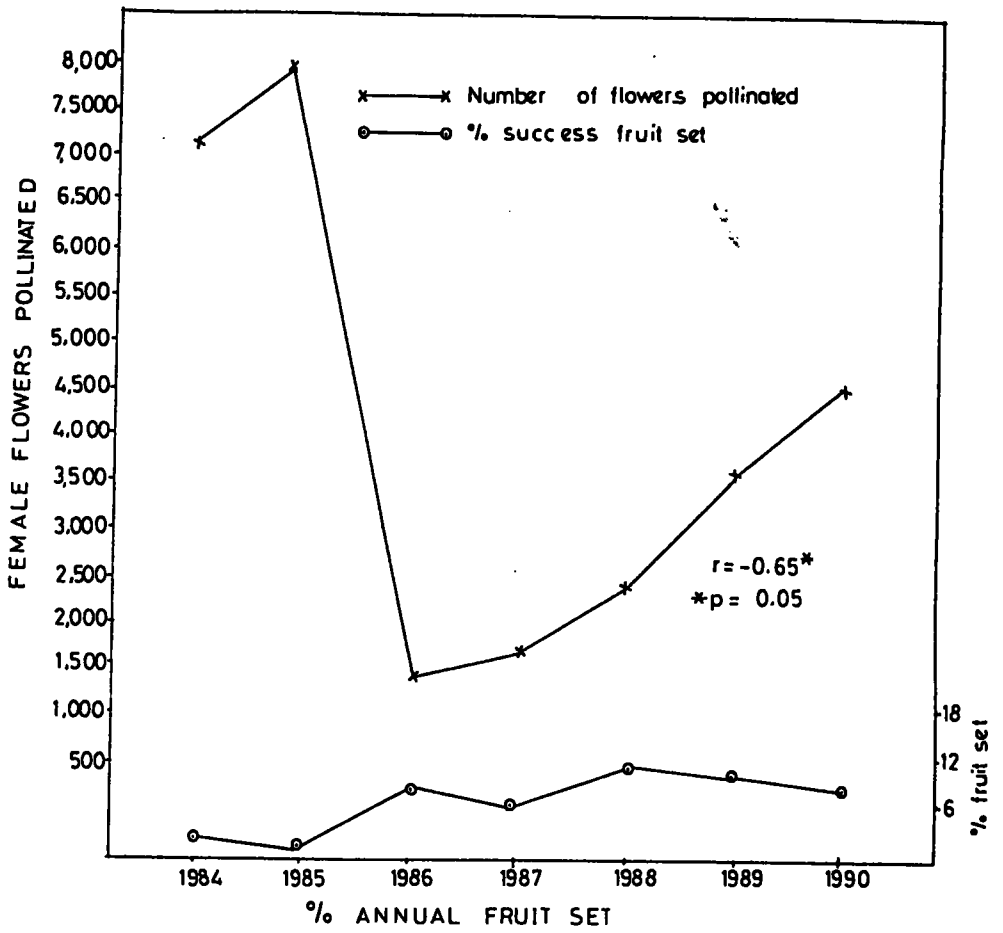

Fig.1: Relationship between number of female flowers pollinated and fruit set in Hevea brasiliensis

microbial activity that could lead to bio-deterioration of the pods. *Drechsclera Hevea* has been reported as a major pathogen of rubber pods (Okhuoya *et al* 1984) while *Phythophthora* sp have been associated with some pod rots (Anon 1989). However, clonal variation in pod retention at maturity suggests the presence of genetic variability that could be exploited.

Table 1:

Mean figures for flowers, fruit set and pods formed under artificial hand pollinations from 1984 – 1990 in Nigeria.

	Female flowers			Fruit set		Fruits aborted		Mature pods		
Year	No. Pollinated	No. Aborted	% Abortion	No.	%	No.	%	No.	% of fruit set	% of flower
1984	17226	6945	96.11	281	3.88	145	51.60	136	48.40	1.88
1985	7993	7707	96.42	286	3.58	141	49.30	145	50.70	1.81
1986	1473	1365	92.67	108	7.33	39	36.11	69	63.89	4.68
1987	1545	1452	93.98	93	6.02	13	13.98	80	86.02	5.18
1988	2494	2203	88.33	291	11.20	27	9.28	264	90.72	10.59
1989	3616	3211	88.80	405	11.20	162	40.00	243	60.00	6.72
1990	4540	4107	90.46	433	9.54	203	46.88	230	53.12	5.07
Total	28887	26990	646.77	1897	53.22	730	247.15	1167	452.85	35.93
X	4126.71	3855.71	92.40	271	7.60	104.29	35.31	166.71	64.69	5.13
S-	918.72	898.61	1.16	4.17	1.16	26.59	5.98	27.76	5.98	1.05

Table 2:

Mean squares for female and male flowers, fruit set and pods formed.

S.V.	Flowers Female	Male	+Fruit set	++Pods
Replicate	4.83	48.12	0.0124	0.0648
Clone	56.62**	39.72**	0.3545**	0.4140**
Branch	0.55	0.05	0.0417	0.1612
Clone x Branch	1.35	2.79*	0.0397	0.1444**
Error	3.87	190.34	0.0444	0.0483

** ; * Significant at p = 0.01 and p = 0.05 respectively (F-test).

+ $10g_{10}$ transformed data.

++ arcsin transformed data.

Table 3:

Correlation coefficients of flower and fruit characters.

	Male flowers	fruit set	Pods formed
Female flowers	0.90**	0.05	0.07
Male flowers		0.32	0.03
Fruit set			0.14

** Significant at p = 0.01 (t – test).

Table 4:

+ Mean figures for flowers, fruit set and pods formed per inflorescence in 8 clones of *Hevea brasiliensis* under natural open field pollination in 1989.

Clone	Flowers			Fruit set		Pods at Maturity		
	Male	Female	ratio	No	%	No	% (fruit set)	per % (flower)
PB 5/51	75.39ab	7.141a	11:1	0.20c	2.80	0.15c	75.00	2.10
RRIM 707	84.98a	6.91ab	12:1	1.85 a	25.50	0.51a	27.57	7.38
RRIM 623	40.54d	5.29abc	8:1	0.58b	10.85	0.42ab	72.41	7.94
RRIM 628	80.09ab	4.80cd	17:1	=	=	0.20c	=	4.17
GT 1	58.63c	3.18de	18:1	0.63ab	17.14	0.35b	55.56	11.01
RRIM 605	25.43e	1.73ef	15:1	0.26b	15.20	0.20c	71.43	11.63
IAN 2960	24.97e	1.66ef	15:1	0.26b	14.60	0.19c	73.08	11.45
RRIM 501	16.38e	1.24f	13:1	0.26b	18.92	0.19c	73.08	15.32
X	50.80	3.99	14;1	0.58	15%	0.28	64.02	8.88
S-x	9.09	0.79		0.19	2.30	0.04	6.08	1.43

+ Means followed by different letters in the same colum are significantly different at p = 0.05 (DNMRT).

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