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A SURVEY ON THE INCIDENCE AND PATTERN OF DISTRIBUTION OF THE BROWN BAST DISEASE OF *HEVEA*, IN SRI LANKA

By

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ABSTRACT

Estate records of brown bast incidence vary greatly from incidence recorded during the mapping of diseased trees in the field. A non-random, clustered distribution is most common, especially in clones RRIM 600, RRIM 623, PB 28/59 and RRIC 101. Brown bast in the clone PB 86 usually occurs with a random distribution. There may be more than one type of brown bast condition, related to clone and environment.

INTRODUCTION

The brown bast condition of *Hevea* is thought to be physiological in origin, as no pathogen has been detected in association with the disease (Liyanage *et al* 1982). During the early stages, the disease is characterised, in some clones, by late dripping and high flow rates of rubber latex from tapped trees. This is soon followed by the formation of dry patches along the tapping cut which, being brown in colour due to the deposition of a possibly starch based wound gum (Rhodes 1930), gives the disease its name.

Once a tree becomes diseased, it does not recover. Whilst the spread of the disease may be arrested by using isolation grooves, or slowed by discontinuing tapping, these are only temporary measures. Brown bast invariably spreads throughout the tree ultimately rendering it completely dry and unusable.

The disease is thought to be most prevalent in some high yielding clones, such as PB 28/59, GL 1 and RRIC 101, which are considered to be ' brown bast sensitive '. There is some controversy as to whether brown bast occurs at random or whether there is a definite pattern, which could be related to a particular environmental or physiological factor.

In this paper we report the findings of a survey carried out during the latter part of 1981 and early 1982 in which records of brown bast incidence from 53 estates, from the various rubber growing districts of Sri Lanka, were obtained and then selected areas from six of the more widely grown clones, mapped. These were then used to find out the pattern of distribution of brown bast trees.

MATERIALS AND METHODS

The survey

Letters and survey report forms were sent out to a sample of estates managed by the Janatha Estates Development Board (JEDB) or Sri Lanka State Plantations Corporation

(SLSPC) in all the major rubber growing districts of Sri Lanka. There were two survey report forms, No. 1 exclusively for clone RRIC 101 and No. 2 for other clones. Information requested included : date of planting, date of first tapping, initial and present tapping systems, duration, average yields, and brown bast incidence from annual records over 5 years.

The mapping

Once the influx of survey report forms had ceased, six common clones were chosen for further study. They were : PB 86, PB 28/59, RRIC 100, RRIC 101, RRIM 600 and RRIM 623. For each of these clones, six areas reported to have a relatively high incidence of the disease but which had been tapped for not more than 10 years, were chosen and maps drawn to approximately the same scale of 1 $cm^2 = 0{\cdot}025$ hectares.

Calculation of distribution

We used a $2{\cdot}1\ cm^2$ quadrat which enclosed approximately 50 trees on all of the 36 maps. Random sampling points were chosen by preparing a 1 cm^2 grid, on transparent tracing paper, on which each intersection had been allocated a serial number. The grid was then placed over the field map which could be clearly seen through the tracing paper.

Random numbers were obtained (Lindley & Miller, 1952) and the centre point of the quadrat placed directly on the grid intersect corresponding to the random number generated. Only recordings from quadrats which stayed entirely within the confines of the map, and therefore enclosed 50 trees, were taken.

The number of brown bast trees occurring at each sampling was used to make a frequency table from which $\bar{X}$ & S^2, estimates of the mean μ and variance σ^2 were calculated.

Frequency distributions were checked for goodness of fit against a poisson distribution using the cm-square (x^2) test and also the poisson assumption through the index of dispersion, with 100 degrees of freedom.

When $\mu = \sigma^2$, a random, poisson distribution occurs. However, when $u < \sigma^2$, the distribution is considered non-random, clustered, and when $\mu > \sigma^2$, non-random and uniform.

RESULTS

Brown bast : estate records

The clone PB 86, widely supposed to be resistant to brown bast, showed the highest mean incidence of disease, in trees which had been tapped for not more than 5 years (Table 1). The susceptible clones PB 28/59 and RRIC 101 showed relatively low mean incidence.

Table 1. *Incidence of brown bast in six clones covered by the survey, extracted from estate records*

Clone	Incidence* of brown bast in trees tapped for			
	1 - 5 years mean (%)	6 - 10 years mean (%)	11 - 15 years mean (%)	16 - 20 years mean (%)
PB 86	1·8	0·5	10·7	8·3
PB 28/59	1·0	2·6	13·7	—
RRIC 100	0·8	1·1	—	—
RRIC 101	0·7	1·8	0·4	—
RRIM 600	1·2	3·5	—	—
RRIM 623	1·5	2·6	7·7	—

* Based on diseased trees recorded in 1981

Where trees had been tapped for longer periods, clone RRIC 101 was consistently reported to have a low incidence of brown bast. Clone PB 28/59 showed gradually increasing mean incidence to have the highest incidence at 11 - 16 years of tapping. The clones RRIM 600 and RRIM 623 were reported to have relatively high mean disease incidence throughout the period reported whilst for clone RRIC 100 it was low.

Brown bast : selective survey

When compared with data collected during the drawing of maps, a somewhat different picture emerges where RRIM 623 shows highest mean incidence, followed by PB 28/59, RRIC 100, RRIC 101 and finally PB 86 (Table 2) for trees tapped up to 5 years.

Table 2. *Incidence of brown bast recorded in areas mapped for the study of distribution patterns*

Clone	Incidence of brown bast* (%) in areas tapped for 1 - 5 years	6 - 10 years
PB 86	3·6	8·3
PB 28/59	11·3	14·6
RRIC 100	6·0	10·1
RRIC 101	4·4	17·3
RRIM 600	—	11·3
RRIM 623	13·0	—

*Based on survey maps drawn in 1981 and 1982

In the case of trees tapped for 6 - 10 years, clone RRIC 101 shows highest incidence followed by PB 28/59, RRIM 600, RRIC 100 and PB 86.

Poisson distribution - x^2 test

In most of the areas tested for random (Poisson) distribution of brown bast trees, the distribution turned out to be clustered, non-random (Table 3). The exception to the rule was PB 86 where 2/3 of the areas showed a random distribution. RRIC 101 and RRIM 600 showed the largest proportion of non-random distributions (5/6).

Table 3. *Distribution of brown bast trees in 36 areas mapped in 1982, tested against poisson distribution*

Clone	Year of planting	Brown bast incidence mean	variance	X^2	Approximate distribution	D	Approximate distribution
PB 86	1965	2·59	5·12	43·16	C	195·71	C
	1970	0·70	1·47	4·30	R	207·90	C
	1971	5·22	5·38	10·19	R	102·03	C
	1972	0·44	0·37	2·50	R	83·25	R
	1972	2·56	1·99	11·31	R	76·96	R
	1973	0·44	0·67	11·81	C	150·75	C
PB 28/59	1966	13·25	14·21	35·78	C	106·17	C
	1970	2·78	3·80	17·21	C	133·32	C
	1971	6·60	3·76	16·99	R	56·40	R
	1972	7·74	16·56	48·32	C	211·81	C
	1973	2·19	2·53	24·07	C	114·37	C
	1973	2·06	1·42	9·34	R	68·24	R
RRIC 100	1971	4·59	5·15	38·55	C	111·08	C
	1971	8·04	7·56	12·93	R	93·09	U
	1972	1·89	1·59	13·58	U	83·29	R
	1973	1·62	2·16	12·32	R	131·99	C
	1973	4·01	16·81	502·07	C	415·00	C
	1974	2·48	3·50	19·00	C	139·72	C
RRIC 101	1970	3·28	4·71	61·84	C	142·16	C
	1971	17·35	21·62	52·07	C	123·36	C
	1972	4·63	8·70	38·84	C	186·03	C
	1973	3·77	8·29	179·31	C	217·69	C
	1974	0·84	0·50	12·77	U	58·93	R
	1974	1·26	1·51	6·75	R	118·64	C
RRIM 600	1969	4·70	6·06	31·32	C	127·44	C
	1969	5·24	8·53	20·19	R	161·16	C
	1970	5·53	7·40	26·38	C	132·48	C
	1970	6·75	14·21	91·70	C	208·41	C
	1971	7·54	19·71	148·07	C	258·71	C
	1971	4·79	6·81	43·24	C	140·75	C
RRIM 623	1967	4·00	3·28	8·44	R	81·18	R
	1967	10·61	17·59	92·50	C	164·13	C
	1968	5·26	7·69	28·71	C	144·74	C
	1968	8·20	19·10	103·10	C	230·60	C
	1969	5·01	8·30	7·97	R	164·01	C
	1971	4·49	11·08	50·12	C	241·84	C

D : **Index of dispersion**

R : **Random**
U : **Uniform**
C : **Clustered**
} **distribution**

Poisson assumption — Index of dispersion

This test gives much the same results as the x^2 test except that the results are shifted more toward a clustered distribution (Table 3). The areas in which the disease is randomly distributed is reduced, in the case of clone PB 86, to 1/3. Clone RRIM 600 shows an entirely clustered (non-random) distribution of the disease whilst clone RRIC 101 retains the 5/6 non-random (clustered) distribution.

Yield

High incidence of brown bast is often blamed on over exploitation, the extraction of high latex crops from rubber trees. A comparison between yield and brown bast incidence would therefore have been useful in determining any possible correlation between these factors. However, yield data from estate records could not be brought into a coherent form, for analysis, due to the great variation in the methods of reporting this data by estate administrations.

DISCUSSION AND CONCLUSIONS

Estate records and our own field observations (Tables 1 and 2) do not agree with each other. This may, at least partly, be explained by the different methods used in determining brown bast incidence. It is estate practice to rest a brown bast tree and recommence tapping of such trees at a later date, when they cease to be considered as having the disease. This results in a fairly large population of malignant brown bast trees which only come to light during the later years of tapping when such trees go completely dry. However, as this should apply equally to all clones, another explanation for this divergence may be that in clone PB 86, the disease is distributed randomly, but fairly densely, over the whole area while in others, such as PB 28/59 and RRIC 101, the disease occurs in clusters. Since we chose areas of about 5 acres, for our samples, from areas where brown bast incidence was relatively high, this gives credence to the latter explanation.

This suggests that there is more than one type of brown bast, borne out by the varied response to treatment with potassium (Compagnon, *et al* 1953).

The incidence of brown bast in clone RRIC 101 is kept low, probably due to the recommended practice of tapping once every 3 days (d/3). This increases during 6 - 10 years of tapping, when trees are tapped on panel BO - II (panel B) and is probably correlated to high yields and more frequent tapping.

This study suggests that environmental and clonal factors play an important role in the occurrence of this physiological disease, giving the clustered distribution common in clones observed. Several lines of investigation, including localised water stress and mineral deficiencies, deserve further consideration.

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