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SENSITIVITY RELATIONSHIP OF *HEVEA* CLONES TO THE BIOTIC STRESS OF POWDERY MILDEW (*OIDIUM HEVEAE* STEINM.)

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Field screening of 25 indigenous and exotic clones against powdery mildew (*Oidium heveae*) was carried out for four consecutive years relying on natural disease incidence. The phenotypic expression of symptom severity in terms of percent disease intensity (PDI) was used to compare the clones. The disease incidence of clones varied significantly in different years as evidenced by the significant clone x year interaction. Two methods *viz.*, mean and CV of genotypes and Huhn's rank sum were used to identify the comparatively stable genotypes. The clones RRII 208 and PB 310 were found to have less disease intensity with greater stability over the years based on mean and CV. As per Huhn's rank sum method, clones SCATC 93-114, RRIM 703, Hai Ken 1, RRII 208, RRII 5 and PB 310 were identified as stable sources of resistance.

Key words : Biotic stress, *Hevea*, Powdery mildew, Stability.

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INTRODUCTION

Breeding for disease resistance is becoming more important in crop improvement programmes for natural rubber (NR). Powdery mildew caused by *Oidium heveae* is one of the major leaf diseases of rubber. Genotypes selected either by direct or indirect screening methods must be tested across a range of environments for their tolerance to powdery mildew. Differences in comparative performance (genotype x environment interaction) may be reflected in genotype rankings differing among environments. Tree species typically express traits differently in different environments and genotypic rankings for any trait may change with the environment (Carson and Carson, 1989). The pathogen may also vary in virulence in different environments which in turn can cause the host genotypes to show a change in its ranking for resistance. In the present paper an attempt is made to identify clones, which exhibit stable response towards the incidence of *Oidium* over years through two different analyses.

MATERIALS AND METHODS

The 25 indigenous and exotic *Hevea* clones of diverse origin, which formed the material for the present study are listed in Table 1. These clones were laid out in two field experiments at the Rubber Research Institute of India (RRII), Kottayam, employing RBD with seven and five replications and seven plants per plot. Field screening for powdery mildew incidence was carried out at the peak season of incidence during four consecutive years. Leaf samples were collected from three trees per plot. In each tree, from the terminal whorls of two branches, five leaves per whorl were scored for disease intensity on a 0-4 scale and the mean score per plot was

Table 1. **The clones evaluated for disease intensity**

Origin	Clone	Parentage
India	RRII 5	Primary clone
	RRII 105	Tjir 1 x Gl 1
	RRII 118	Mil 3/2 x Hil 28
	RRII 208	Mil 3/2 x AVROS 255
	RRII 300	Tjir 1 x PR 107
	RRII 308	Gl 1 x PB 6/50
Indonesia	PR 255	Tjir 1 x PR 107
	PR 261	Tjir 1 x PR 107
China	SCATC 88-13	RRIM 600 x Pil B84
	SCATC 93-114	TR 31-45 x HK 3-11
	Hai Ken 1	Primary clone
Thailand	KRS 25	Primary clone
	KRS 128	PB 5/63 x KRS 13
	KRS 163	PB 6/63 x RRIM 501
Malaysia	RRIM 600	Tjir 1 x PB 86
	RRIM 703	RRIM 600 X RRIM 500
	PB 217	PB 5/51 x PB 6/9
	PB 235	PB 5/51 x PB S/78
	PB 255	PB 5/51 x PB 32/86
	PB 260	PB 5/51 x PB 49
	PB 280	PBIG Seedling
	PB 310	PB 5/51 x RRIM 600
	PB 311	RRIM 600 x PB 235
	PB 312	RRIM 600 x PB 235
	PB 314	RRIM 600 x PB 235

calculated and expressed as percent disease intensity (PDI) following Horsfall and Heuberger (1942). Data from the two trials were considered together for statistical

Table 2. **Percent disease intensity during different years (Trial 1)**

Clone	Percent disease intensity				
	1992	1993	1994	1995	Pooled mean
RRII 5	4.59	62.92	27.72	6.55	25.45
RRII 105	20.92	50.34	45.92	84.36	50.38
RRII 118	23.46	80.10	15.81	12.50	32.97
RRII 208	16.83	52.04	36.73	32.31	34.48
RRII 300	27.04	82.14	43.36	55.10	51.91
RRII 308	38.26	55.10	45.41	45.71	46.12
RRIM 600	17.34	27.55	55.10	63.52	40.88
RRIM 703	5.78	34.36	23.98	19.16	20.82
PR 255	11.73	64.54	29.08	50.44	38.95
PR 261	18.37	84.69	28.57	37.50	42.28
SCATC 88-13	37.24	68.26	38.77	66.12	52.60
SCATC 93-114	5.10	8.84	19.90	27.42	15.32
Hai Ken 1	2.55	29.76	40.82	43.44	29.14
CD (P=0.05)	17.78	22.73	NS	24.90	29.62
Genotype x Year interaction					5.2**

Source : Rajalakshmy *et al.*, (1997)

Table 3. **Percent disease intensity during different years (Trial 2)**

Clone	Percent disease intensity				
	1992	1993	1994	1995	Pooled mean
PB 217	42.14	72.29	77.43	46.43	61.32
PB 235	27.14	71.43	91.43	65.60	63.90
PB 255	59.29	36.43	64.29	43.14	50.78
PB 260	13.57	55.71	67.86	59.29	51.61
PB 280	28.57	57.14	82.26	50.00	54.49
PB 310	28.04	51.43	41.29	25.71	36.62
PB 311	20.00	43.57	79.29	60.24	50.77
PB 312	25.00	51.43	63.57	63.81	50.98
PB 314	18.57	67.14	71.19	63.14	54.76
KRS 25	32.14	57.14	61.67	50.36	50.33
KRS 128	32.56	57.42	58.51	48.57	49.26
KRS 163	27.00	52.14	65.00	60.71	51.21
RRII 105	22.86	45.03	86.43	80.36	58.66
CD (P=0.05)	17.27	NS	18.50	23.24	NS
Genotype x Year interaction					4.3**

Source : Rajalakshmy *et al.* (1997)

analysis to include the maximum number of clones. Non-parametric stability measures were used for selecting genotypes since they facilitate combining trials to have larger number of genotypes for performance testing in sets of environments with repeated measurements (Hanuman and Prabhakaran, 2000). For the purpose of computing and comparison, the years were treated as environment. Coefficient of variability (CV) as a stability parameter was computed as suggested by Francis and Kannenberg (1978). The CV and mean PDI of individual clones over the years tested were used for constructing a scatter diagram with mean and CV along the two axes. The mean, CV and general mean of PDI of all the clones were drawn on corresponding axes to form four quarters. Thus four groups of clones were identified.

Group 1 : Low mean, small CV
Group 2 : Low mean, large CV
Group 3 : High mean, small CV
Group 4 : High mean, large CV

Genotype x year interaction was determined using Huhn's rank sum method (Huhn, 1979). Ranks were assigned for variance and mean value of PDI with the

Table 4. **Stability parameters of disease intensity (Francis and Kannenberg's method)**

Clone	Mean PDI over years	CV (%)	Group
RRII 5	25.45	106.46	2
RRII 105	54.52	51.79	4
RRII 118	32.98	96.32	2
RRII 208	34.48	42.02	1
RRII 300	51.91	44.71	3
RRII 308	46.12	14.97	3
RRIM 600	40.88	53.71	2
RRIM 703	20.82	56.98	2
PR 255	38.95	59.76	2
PR261	42.28	69.37	2
SCATC 88-13	52.60	32.10	3
SCATC 93-114	15.32	66.78	2
Hai Ken 1	29.14	64.14	2
PB 217	61.32	32.23	3
PB 235	63.90	46.08	3
PB 255	50.79	25.90	3
PB 260	51.61	49.64	4
PB 280	54.49	40.62	3
PB 310	36.62	32.84	1
PB 311	50.78	49.59	4
PB 312	50.95	35.80	3
PB 314	54.76	44.57	3
KRS 25	50.33	25.80	3
KRS 128	49.27	24.34	3
KRS 163	51.21	33.20	3
General mean	44.46	47.82	
Range	15.32-63.90	14.97-106.46	

lowest values receiving the corresponding first ranks. The two ranks of each genotype were summed and the one with the lowest rank-sum was regarded as the most stable.

RESULTS AND DISCUSSION

The PDI for each clone in different years and their mean (Rajalakshmy *et al.*, 1997) are presented in Tables 2 and 3. Clones exhibited differential behaviour with respect to powdery mildew disease intensity over years. The inconsistency of the disease intensity over years was evident by the significant genotype x year interaction component. Stability parameters for disease intensity following Francis and Kannenberg (1978) are given in Table 4. The mean PDI ranged from 15.32 to 63.90 and CV ranged from14.97 to 106.46 per cent. The means for PDI and CV were 44.46 and 47.82 respectively.

The clones, which fell into different groups are shown in the scatter diagram (Fig. 1). When clones are selected for powdery mildew tolerance, those in group 1 and group 2 can be considered as promising candidates since both these groups have low mean PDI. RRII 208 and PB 310 can be considered more stable with less fluctuation with regard to intensity of powdery mildew over years. Eight clones *viz.*, RRIM 703, SCATC 93-114, Hai Ken 1, RRIM 600, RRII 118, RRII 5, PR 255 and PR 261 fell into group 2 with lower disease intensity but greater sensitivity to environmental changes and may be better adapted to specific environments. The inherent susceptibility of the 12 clones in group 3 was evident by the high mean PDI and low CV. A similar study on 20 clones of

Table 5. **Huhn's stability parameter**

Clone	Mean PDI	Variance	Rank of Mean PDI	Rank of Variance	Rank sum
RRII 5	25.45	7.15	3	9	12
RRII 105	54.52	14.87	22	20	42
RRII 118	32.98	19.86	5	23	28
RRII 208	34.48	0.49	6	3	9
RRII 300	51.91	9.38	19	15	34
RRII 308	46.12	8.91	11	12	23
RRIM 600	40.88	13.47	9	18	27
RRIM 703	20.82	0.04	2	1	3
PR 255	38.95	7.39	8	10	18
PR 261	42.28	17.31	10	22	32
SCATC 88-13	52.60	20.67	20	24	44
SCATC 93-114	15.32	0.38	1	2	3
Hai Ken 1	29.14	2.49	4	4	8
PB 217	61.32	16.76	24	21	45
PB 235	63.90	7.78	25	11	36
PB 255	50.79	21.17	15	25	40
PB 260	51.61	11.05	18	17	35
PB 280	54.49	9.06	21	13	34
PB 310	36.62	6.40	7	8	15
PB 311	50.78	14.70	14	19	33
PB 312	50.95	9.56	16	16	32
PB 314	54.76	9.06	23	13	36
KRS 25	50.33	2.80	13	5	18
KRS 128	49.27	4.17	12	6	18
KRS 163	51.21	4.40	17	7	24
Mean	44.46				25.96

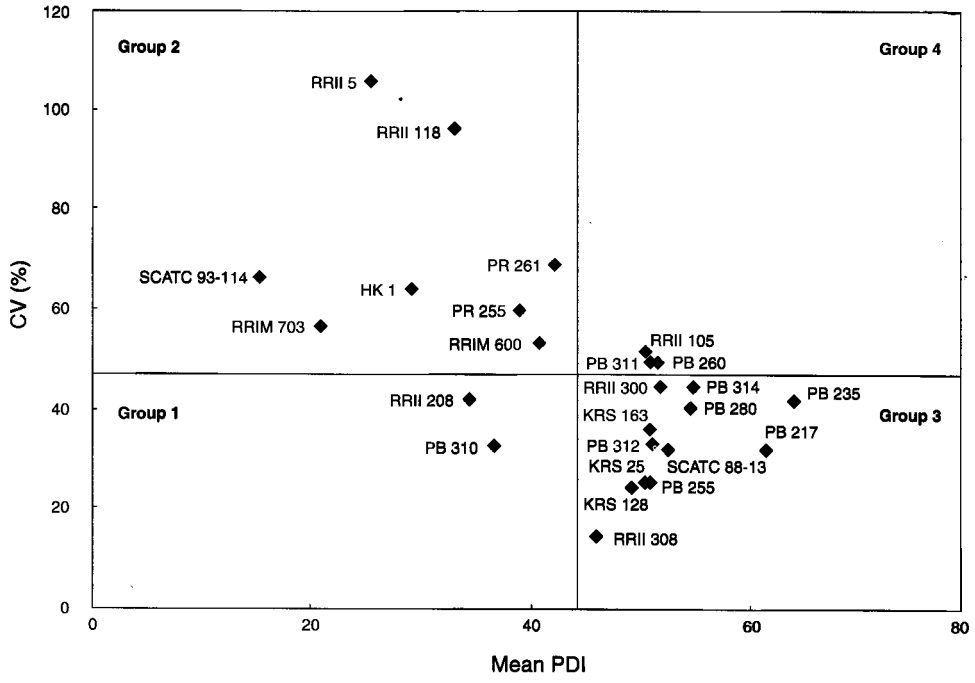

Fig 1. Scatter diagram showing different groups

Hevea plants grown in a nursery by John *et al.*, (2000) also revealed the same type of response for powdery mildew intensity. Selection in the presence of genotype x environment interaction helps in identifying genotypes with stable performance for disease resistance across environments (Finlay and Wilkinson, 1963; Kang, 1985; Matheson and Raymond, 1984). Rao (1997) suggested the use of CV as a stability measure in disease screening. The conventional coefficient of variability as suggested by Francis and Kannenberg (1978) is reported as a stability measure in *Hevea* by Tan (1995) also.

In the present investigation, when CV was taken as a stability criterion, both, the tolerant clone SCATC 93-114 and the moderately susceptible clone PR 261, were grouped into one category, which may lead to an erroneous conclusion. A shortcoming of this measure may be overcome by providing an unbiased basis for ranking with respect to stability of interaction effects, which could be provided by Huhn's rank sum method.

Huhn's stability parameter, based on ranks is furnished in Table 5. Clones SCATC 93-114 and RRIM 703 displayed the lowest rank sum followed by Hai Ken 1, RRII 208, RRII 5 and PB 310. Since this ranking involved both mean PDI and variance, this could be a more reliable measure. Huhn's ranking method thus gave a real picture of disease tolerance and provided the coincidence of observation and estimation. This corresponding or complementary association between actual and estimated values provided proof for the reliability of Huhn's ranking method for assessing sensitivity.

From the foregoing discussion it could be concluded that the clones SCATC 93-114,

RRIM 703, Hai Ken 1, RRII 208, RRII 5 and PB 310 exhibited comparatively stable tolerance towards powdery mildew. These clones may be exploited for imparting resistance to powdery mildew in *Hevea* breeding programmes.

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