Research Article *Journal of Plantation Crops, 2013, 41(3): 398-403*

Reaction of the polycross progenies to two major leaf diseases of rubber (*Hevea brasiliensis*)

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(Manuscript Received: 02-05-13, Revised: 08-07-13, Accepted: 05-08-13)

Abstract

A three-year study was undertaken to evaluate the polycross progeny of prepotent clones for their tolerance/susceptibility for abnormal leaf fall (ALF) disease caused by *Phytophthora* spp. and powdery mildew (PM) disease caused by *Oidium heveae* at the Central Experiment Station of Rubber Research Institute of India at Chethackal in Ranni. The clones were evaluated during 11th to 13th year after planting. The data obtained were analysed and computed progeny wise and clone wise. The pooled data of three years showed that for ALF disease, the clone P 128 (progeny of AVT 73) was superior over other clones with leaf retention of 76 per cent followed by the clones P 75 (progeny of PB 217) and P 69 (progeny of PB 252) showing leaf retention of 75 per cent. However, the evaluation of the progenies and clones within each progeny against PM disease were not encouraging as lot of variation was observed among the progenies and clones and the disease intensity in general, was very high. The pooled data of three years of assessment on PM disease revealed that the clone P60 evolved from the progeny of RRII 105 and the clones P 54 and P 104 evolved from the progeny of 5/76 showed less than 25 per cent of PDI and thus, were tolerant. The ALF disease tolerant clones P 132, P 69 and P 128 are also reported to be promising in terms of latex and timber yield.

Keywords: Abnormal leaf fall, *Oidium heveae*, *Phytophthora*, polycross, powdery mildew, prepotent

Introduction

Rubber (*Hevea brasiliensis*) is extensively cultivated in Kerala and in southern regions of Tamil Nadu and Karnataka. It is also a non-traditional crop of north-eastern regions of India. Small holdings account for 91 per cent of production and of 88 per cent of the area of this crop. Among the major leaf diseases of rubber, the abnormal leaf fall (ALF) disease caused by *Phytophthora* spp. and powdery mildew (PM) disease caused by *Oidium heveae* are of highly significance. Economic losses have been reported due to ALF and PM diseases. Yield loss to the tune of 38 to 56 per cent due to ALF was reported when the trees are left unsprayed for one disease season (Ramakrishnan, 1960). Jacob *et al*. (1989) reported 9 to16 per cent yield reduction due to ALF disease. Severe defoliation due to ALF results in sparse canopy and thereby to more weed growth. Yield loss of 8.1 per cent due to PM was reported in the clone PB 5/51 over a period of nine months in Malaysia (Wastie and Mainstone, 1968). In India, it was observed that in clone PB 86, 8 to 12 per cent more disease in unprotected plots compared to protected plots, resulted in 21 to 32 per cent crop loss (Jacob *et al*., 1992).

These two diseases are managed by fungicides. However, management of these diseases with the fungicides, at present, seems to be a difficult task owing to the scarcity of labour. Therefore, the use of tolerant/resistant clones, to some extent, is a permanent way of ensuring low disease incidence in the rubber plantations. In this direction, many studies have been undertaken to know the clonal reaction to these diseases. Clones likes PB 86, PB 235, PB 260, PB 28/59, RRIM 600 and RRIM 703 were found to be susceptible to ALF disease

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whereas, the clones RRII 105, PB 217 and GT 1 were observed to be tolerant (Edathil *et al*., 2000). In Sri Lanka, the clones RRIC 100 and RRIC 102 showed tolerance to ALF disease (Jayasinghe and Jayaratne, 1996). The clones susceptible to PM disease are PB 5/51, RRII 105, RRII 118, PB 217 and PB 235 whereas clones like PB 86, GT 1, RRIM 703, RRII 208 and PB 310 showed tolerance in India (Edathil *et al*., 2000). Presently, the crop improvement group of Rubber Research Institute of India (RRII) employs various techniques for evolving clones with high yield, disease tolerance/ resistance and timber yield. Polycross breeding is one of the major programmes initiated in this direction. The present study is based on a population of 150 clones (Table 1). These clones were evaluated for their tolerance/ susceptibility to ALF and PM diseases.

Materials and methods

The clonal evaluation was conducted in a compact family block design with three replications and 4-5 trees per plot at a spacing of 4.9 x 4.9 m. A total of 150 progeny clones were evaluated in two field trials, one trial (Trial-I) with 10 clones per progeny and the other (Trial-II), with five clones per progeny. The field trials were laid out at the Central Experiment Station of the RRII located at Chethackal in Ranni. The experimental plots received all recommended agro-management practices. The clones were evaluated for ALF and PM diseases in the 11th to 13th year after planting.

PM disease was assessed during February to March of each season. For this purpose, five leaves collected from each tree from the terminal whorls of four branches were observed for disease severity. The leaves were graded according to the intensity of infection on 0-5 scale where, 0 = no disease; 1= 1-10 per cent disease severity; 2 = 11-25 per cent disease severity; 3 = 26-50 per cent disease severity; 4 = 51-75 per cent disease severity and 5 = >75 per cent disease severity.

The per cent disease intensity was computed as per the formula:

$$PDI = \frac{\text{Sum of numerical ratings x 100}}{\text{No. of leaves examined x maximum severity grade}}$$

For ALF disease, the assessment on per cent leaf retention was carried out by counting the leaves and tagging four branches per tree at different canopy levels from four trees in each replication and recording the retention during October, at the end of disease season (Idicula *et al*., 1989).

The data obtained for three consecutive years were analysed according to the compact family block design analysis and computed progeny wise.

Table 1. Progenies of 10 clones evaluated for abnormal leaf fall and powdery mildew diseases

Progeny of									
AVT 73	**PB 217**	**PB 5/51**	**Ch 26**	**RRII 105**	**PB 215**	**PB 5/76**	**PB 252**	**PB 28/83**	**PB 242**
Trial-I									
P 12	P 25	P 38	P 48	P 1	P 44	P 50	P 17	P 33	P 7
P 16	P 26	P 41	P 49	P 3	P 45	P 51	P 18	P 35	P 118
P 65	P 27	P 42	P 95	P 4	P 47	P 53	P 20	P 36	P 120
P 67	P 28	P 43	P 97	P 56	P 88	P 54	P 22	P 37	P 126
P 122	P 30	P 84	P 156	P 59	P 90	P 99	P 70	P 78	P 62
P 123	P 31	P 85	P 157	P 106	P 148	P 100	P 71	P 79	P 63
P 127	P 73	P 86	P 158	P 107	P 150	P 102	P 130	P 80	P 116
P 128	P 74	P 87	P 159	P 109	P 151	P 103	P 134	P 138	P 121
P 173	P 75	P 144	P 160	P 111	P 152	P 104	P 135	P 139	P 171
P 177	P 76	P 147	P 162	P 113	P 153	P 166	P 179	P 141	P 172
Trial-II									
P 1	P 32	P 40	P 161	P 57	P 89	P 52	P 19	P 81	P 6
P 15	P 77	P 82	P 197	P 60	P 93	P 55	P 69	P 140	P 8
P 66	P 137	P 83	P 198	P 108	P 94	P 98	P 131	P 188	P 10
P 124	P 180	P 145	P 199	P 110	P 154	P 101	P 132	P 190	P 117
P 125	P 183	P 146	P 200	P 112	P 195	P 167	P 136	P 191	P 119

Results and discussion

Progeny wise reaction to abnormal leaf fall disease

The results on the pooled data on performance of progeny as a whole against ALF disease over a period of three years of assessment (Table 2) revealed that in Trial I, the progeny of PB 215 (65.63% leaf retention) was superior over other progenies followed by progenies of PB 217 (63.54% leaf retention) and RRII 105 (62.06% leaf retention) while in trial II, the progeny of PB 252 (68.33% leaf retention) was superior over other progenies. Over all, the result has indicated that the progenies of PB 215, PB 217 and RRII 105 and PB 252 exhibited tolerance to ALF disease.

Table 2. Evaluation of the progenies for abnormal leaf fall disease

Progeny of	Trial I		Trial II	
	Per cent leaf retention	Variance ratio (VR) within progeny	Per cent leaf retention	Variance ratio (VR) within progeny
AVT 73	54.67cd	33.12	59.20 b	26.86
PB 217	63.54ab	7.14	45.00 d	13.10
PB 5/51	48.90 d	6.17	46.02 d	71.45
Ch 26	50.23cd	7.32	49.19 d	30.52
RRII 105	62.06ab	4.10	57.70bc	4.94
PB 215	65.63 a	NS	55.16bc	NS
PB 5/76	51.73cd	17.74	46.29 d	10.10
PB 252	55.13cd	14.36	68.33 a	27.85
PB 28/83	55.07cd	6.83	54.91bc	11.96
PB 242	57.27bc	14.29	53.76 c	30.68
Variance ratio between progenies	7.14		22.40	

Reaction of clones within progenies to abnormal leaf fall disease

It is noteworthy that the most popular clone RRII 105 which is known to be tolerant to ALF disease performed better in the present studies and was consistent during all the three years of evaluation. The pooled data on leaf retention of RRII 105 over three years was 73 per cent in both the trials.

The data from Table 3 indicates the performance of the individual clones within a progeny against ALF disease pooled over two and three years. The pooled data with respect to the percentage of the total clones within individual family over two years revealed that the family of RRII 105 was promising with 53.33 per cent of its total clones showing tolerant nature with leaf retention ranging from 67 to 78 per cent while, the family of PB 215 with 26.67 per cent of its total clones were tolerant with leaf retention ranging from 68 to 74 per cent. The other progenies *viz.*, PB 217, PB 5/76 and PB 252 had 20 per cent of their clones showing tolerance to ALF disease. The pooled data on the performance of individual clones within the family for two years of evaluation revealed that the clone P 106 evolved from the progeny of RRII 105 was tolerant and superior with leaf retention of 78 per cent followed by the clones P 125 of the progeny of AVT 73, P 131 of the progeny of PB 252 and P 120 of the progeny of PB 242 with leaf retention of 75 per cent and thus were tolerant. The other clones had leaf retention ranging from 65 to 74 per cent.

With regard to the percentage of the total clones within individual family over three years, it was noticed that the progeny of PB 252 was superior over other progenies with 20 per cent of its clones tolerant to ALF disease for all the three years followed by the progenies of AVT 73 and PB 217 with 13.33 per cent of clones revealing tolerance to ALF disease. From the pooled data obtained from three years of assessment, it was observed that the clone P 128 of the progeny of AVT 73 was tolerant and superior over other clones with leaf retention of 76 per cent followed by the clones P 75 of the progeny of PB 217 and P 69 of the progeny of PB 252 showing leaf retention of 75 per cent and were tolerant. The clones P 132 of the progeny PB 252 and P 172 of the progeny of PB 242 showed leaf retention of 73 per cent over a period of three year assessment.

Progeny wise reaction to powdery mildew disease

The performance of progeny as a whole against PM disease was assessed over a period of three years (Table 4). The results on the reaction of different progenies to PM disease were not encouraging during all the three years of evaluation in both the trials. The disease was very high and found to be varying in both the trials.

Reaction of clones within progenies to powdery mildew disease

The data on tolerance nature of the individual clones in each progeny against PM disease for two

Table 3. Clones within each progeny showing tolerance to abnormal leaf fall disease

Progeny of	Clones within each progeny showing tolerance to abnormal leaf fall disease for 2 years			Progeny of	Clones within each progeny showing tolerance to abnormal leaf fall disease for 3 years		
	Progeny	Percentage of total clones in each family showing ALF tolerance over two years	Pooled data over 2 years (% leaf retention)		Progeny	Percentage of total clones in each family showing ALF tolerance over 3 years	Pooled data over 3 years (% leaf retention)
AVT 73	P 125	6.67	75	AVT 73	P 128	13.33	76
					P 65		71
PB 217	P 74	20.00	73	PB 217	P 75	13.33	75
	P 27		73		P 28		70
	P 180		69	PB 215	P 47	6.67	71
RRII 105	P 1	53.33	70	PB 5/76	P 51	6.67	69
	P 106		78	PB 252	P 179	20.00	72
	P 113		67		P 132		73
	P 111		70		P 69		75
	P 3		72	PB 242	P 172	6.67	73
	P 107		67	Control Trial-I	RRII 105		73
	P 56		70	Control Trial-I	RRII 105		73
	P 112		74				
PB 215	P 90	26.67	71				
	P 45		71				
	P 153		74				
	P 151		68				
PB 5/76	P 102	20.00	68				
	P 53		71				
	P 103		71				
PB 252	P 17	20.00	69				
	P 134		74				
	P 131		75				
PB 28/83	P 79	13.33	68				
	P 80		68				
PB 242	P 7	13.33	70				
	P 120		75				

Table 4. Evaluation of the progenies for powdery mildew disease

	Trial I		Trial II	
	Per cent disease intensity (PDI)	Variance ratio (VR) within progeny	Per cent disease intensity (PDI)	Variance ratio (VR) within progeny
AVT 73	53.78abc	12.19	48.06 a	NS
PB 217	60.72 c	NS	53.25ab	NS
PB 5/51	58.25 bc	6.54	64.89 c	NS
Ch 26	52.97abc	9.11	52.50ab	NS
RRII 105	47.03 a	3.23	50.03ab	24.55
PB 215	49.20 a	2.79	64.89 c	NS
PB 5/76	46.61 a	12.01	57.67bc	14.28
PB 252	50.19 ab	3.40	45.56 a	5.63
PB 28/83	53.11abc	5.32	55.56ab	NS
PB 242	45.20 a	2.19	54.83ab	NS
Variance ratio (VR) between progenies	3.80		5.61	NS

years and three years of evaluation are presented in Table 5. The pooled data with respect to the percentage of the total clones within individual family over two years and three years of evaluation were also not promising. Barring a very few clones, all other clones of different progenies were susceptible to PM disease, only one clone from the progenies of AVT 73 was found to be promising for a period of two years of evaluation amounting to only 6.67 per cent of the clones from the above said family. However, from the pooled data obtained from three years of assessment, it was observed that 13.33 per cent of clones of the progeny of PB 5/76 were tolerant to PM disease followed by 6.67 per cent of clones of the progeny of RRII 105.

From the resistance response of the individual clones of the progenies over the two year it was noticed only one clone *i.e*. P 127 of the family AVT 73 was tolerant to PM disease over a period of two years with less than 25 per cent of PDI. However, the pooled data over a period of three years of assessment revealed that the clone P 60 of the progeny of RRII 105 and the clones P 104 and P 54 evolved from the progeny of PB 5/76 showed less than 25 per cent of PDI and thus were tolerant and promising ones as far as PM disease is concerned.

The girth, timber and rubber yield of these clones have already been reported (Mydin, 2011).

Table 5. Clones within each progeny showing tolerance to powdery mildew disease

Progeny of	Clones within each progeny showing tolerance to powdery mildew (PM) disease for 2 years			Progeny of	Clones within each progeny showing tolerance to powdery mildew (PM) disease for 3 years		
	Progeny	Percentage of total clones in each family showing tolerance to PM over 2 years	Pooled data over 2 years (PDI)		Progeny	Percentage of total clones in each family showing tolerance to PM disease over 3 years	Pooled data over 3 years (PDI)
AVT 73	P 127	6.67	19	RRII 105	P 60	6.67	19
RRII 105	P 1	6.67	28	PB 5/76	P 54	13.33	22
					P 104		23
PB 5/76	P 51	6.67	27				

Among the clones found promising in terms of reaction to the ALF disease, clone P 132 evolved from the parent PB 252 is reported to be latex timber clone with >80 per cent improvement in yield over the high yielding clone RRII 105 coupled with high timber yield. Clone P 132 in this study was found to be promising against ALF disease and thus found to be a better clone for future. Clone P 69 also derived from PB 252 and was found tolerant to ALF disease, is reported to be a timber-latex clone with promising rubber yield and high timber yield. Clone P 128 evolved from the parent AVT 73 found to be tolerant to ALF disease in this study is reported to be timber clone with high timber yield though rubber yield is less.

The results of this studies indicated that the clones P 128 the progeny of AVT 73 followed by the clones P 75, the progeny of PB 217; P 69, the progeny of PB 252, P 132, the progeny PB 252 and P 172, the progeny of PB 242 were promising ones among all the clones evaluated for their tolerance reaction to ALF disease. The tolerance nature of the clone PB 217 to ALF disease has been reported in different studies (Edathil *et al*., 2000; Mushrif *et al*., 2004). However, in Malaysia, the clone PB 217 was rated as less tolerant to *Phytophthora* (RRIM, 1995). The parental clones planted along with the polycross progenies were also assessed for their reaction to ALF and PM diseases. In the present study, the parental clone RRII 105 was superior over other parental clones with leaf retention of 73 per cent followed by the parental clones PB 215 with leaf retention of 69 per cent and PB 217 with leaf retention of 65 per cent. The present experiment showed high variation in the behaviour of all the clones towards PM disease as also observed by Rajalakshmy *et al*. (1997). The clones P 104 and P 54 evolved from the progeny of PB 5/76 and the clone P 60 of the progeny of RRII 105 were tolerant and promising ones as far as PM disease is concerned.

Conclusion

The three year study on 150 clones evolved by polycross breeding was able to identify three clones *viz*., P 132, P 69 and P 128 being tolerant to ALF disease and seven other clones were moderately tolerant. However, only three clones showed tolerance to PM disease. The ALF tolerant clones P 132, P 69 and P 128 are also reported to be promising in terms of latex and timber yield.

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