STUDIES ON PADDY BLAST CAUSED BY PIRICULARIA ORYZAE

1. A METHOD OF TESTING VARIETAL RESISTANCE TO BLAST

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INTRODUCTION

BLAST caused by *Piricularia oryzae* Bri. & Cav. is the most serious disease of paddy in Ceylon. It is known to be aggravated by increased use of nitrogen-fertilizers (1), and as high yields are ultimately associated with the increased use of fertilizers, blast disease is one of the important limiting factors to the campaign of stepping up paddy production.

The usual control methods for blast fall into three main categories :

(i) Improved cultural practice.

(ii) Use of efficient fungicidal control measures.

(iii) Use of resistant varieties.

The development of disease resistant varieties, although a long-range project, constitutes the most practical solution to the problem of blast. By using such a variety the farmer will eliminate the labour and expense of fungicidal treatments.

The method described in this paper for testing the varietal resistance of paddy to *Piricularia oryzae* has proved to be very practicable, and the relative resistance is determined within a very short time. Briefly the method consists of predisposing the paddy plants to the disease by growing them in highland nursery beds, using sufficiently close spacing to raise the humidity in the immediate vicinity of the plants in order to favour the development of the fungus. At the same time, under these conditions the physiological status of the plant is rendered more favourable for infection. It has been found that under upland conditions silicification of the epidermal cells in the leaf is retarded and under conditions of silica deficiency the plants are also more susceptible to blast (2), possibly because assimilation of nitrogen is hampered and accumulation of soluble nitrogen occurs in the leaves, making them more susceptible to the fungus (3).

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MATERIALS AND METHODS

Since heterogeneity in the nursery could induce physiological variations in the plants thus altering the relative susceptibility to blast, great care has to be taken in the preparation of the nursery beds. The following procedure was followed :—

Rectangular nursery beds were ploughed to a depth of 6"-8", all large clods being broken up, the land raised slightly and levelled roughly. The surface soil was next sieved with a coarse sieve and the fertilizer mixture raked into it to a depth of 4". The beds were then given a final smoothing.

From preliminary experiments at Peradeniya and Karapincha, it was found that 4" between rows gave the optimum spacing for uniform induction of the disease. The fertilizers used and their rates of application were as follows :—

1. Compost	..	0·5 oz./sq. ft.
2. Ammonium Sulphate	..	0·10 oz./sq. ft.
3. Conc. Super Phosphate	..	0·10 oz./sq. ft.
4. Muriate of Potash	..	0·025 oz./sq. ft.

In the sandy soils at Karapincha, magnesium chloride was added at the rate of about 0.10 gm/sq. ft. A top dressing of ammonium sulphate at the rate of 0.10 oz./sq. ft. was added about 12 to 15 days after sowing in order to increase the susceptibility of the plants to blast. Parallel rows spaced 4" apart and about 4½ feet long running at right angles to the long axis of the nursery beds were made next, and surface-sterilized, ungerminated seed of the varieties being tested were dibbled in these rows at a rate of approximately 10 seeds per inch. Each variety was represented by one such row, and one variety was separated from the other by a single row of a standard susceptible variety (bombardment row) to provide a uniform inoculum. Careful checks had to be made to ensure that the rate of sowing was uniform throughout. Once sowing was complete the rows were covered thinly with soil and the beds were mulched with straw.

INOCULATION

As a rule, natural infection occurred readily, but to achieve uniformity in its occurrence, finely chopped, diseased paddy straw and leaves were sprinkled amongst the rows about seven days after sowing. The bombardment strips and susceptible varieties were usually infected first. In order to enable the disease to spread rapidly, the beds were watered thoroughly.

Lesions first appeared in the bombardment strips 9-12 days after sowing. The onset of the disease was always slow but its severity increased rapidly. The resistant variety showed little or no damage and stood out conspicuously between the flanking bombardment strips which, like the susceptible varieties, showed a stunted and " scorched " appearance. Four main types of lesions were noticed on the varieties being tested.

1. Minute, brown, dot-like lesions in the very resistant varieties.
2. Moderate sized, diamond-shaped or slightly elongated lesions which always showed a uniform brown colour with a yellow margin. These are associated with the moderately resistant varieties.
3. Large, watery green lesions irregular in shape found in all susceptible lines.
4. Large, white, irregular-shaped lesions which are found usually in the very susceptible types.

In some varieties the number of dot-like lesions assumed enormous proportions with the result that the leaves showed a bronzed appearance and the leaf-rolling mechanism was impaired.

DISEASE ASSESSMENT

Disease assessments were made using a standard assessment scale developed by H. Okamoto for the Ministry of Agriculture & Forestry, Japan (4), in which use was made of the approximate leaf area destroyed by the fungus expressed as a percentage of the total leaf area. The morphology of the lesions was also observed on the leaves so as to determine the resistance of the varieties. The letters D, S and L were used when over 20 per cent. of the lesions noticed were (*a*) dot-like, (*b*) small, uniformly brown, and (*c*) large acute or white respectively. The suffixes added to the letter D shows the degree of spotting noticed. The suffixes were graded from 0-10, where 0 is the least and 10 is the most affected. The varieties were graded into seven groups according to the leaf area destroyed. Their relationship is given below :—

Group	*Main Type of Lesion*	*% Leaf Area attacked*	*Degree of Resistance*
RR	D	0·2 or less	Very Highly Resistant
R	D	0·3 — 1·0	Highly Resistant
MR	D + S	1·1 — 5·0	Very Resistant
M	S	6·0 — 25·0	Moderately Resistant
MS	S + L	26·0 — 55·0	Moderately Susceptible
S	L	56·0 — 80·0	Fairly Susceptible
SS	L	80 and above	Very Susceptible

Illustrating " Studies on Paddy Blast caused by Piricularia oryzae "

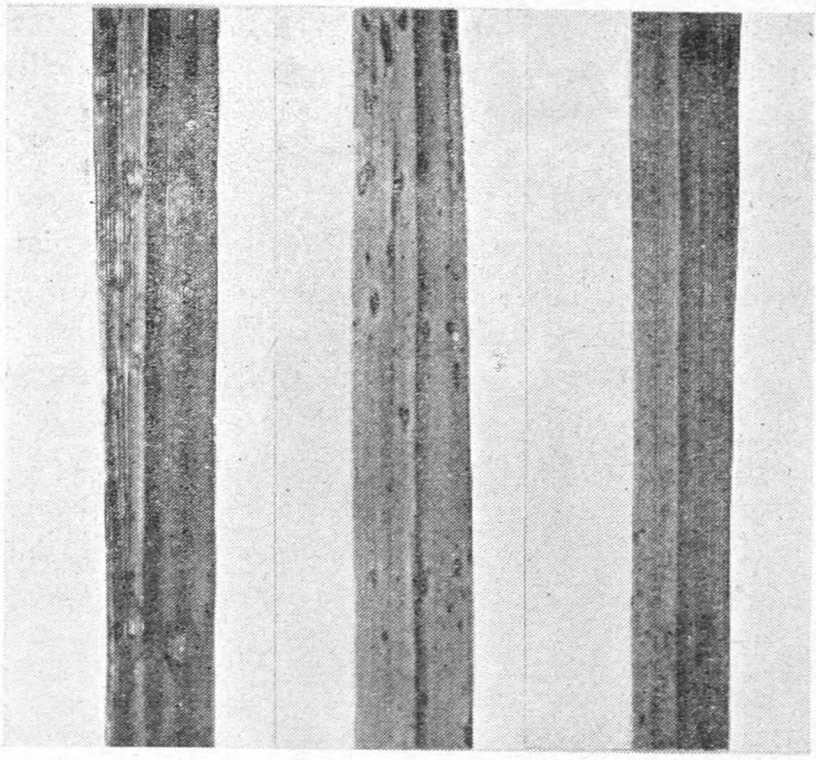

FIG. I : The three principle types of lesions (from left to right)—1. The large watery-green lesion (L), 2. The smaller uniformly brown lesion (S), 3. The dot-like lesion (D).

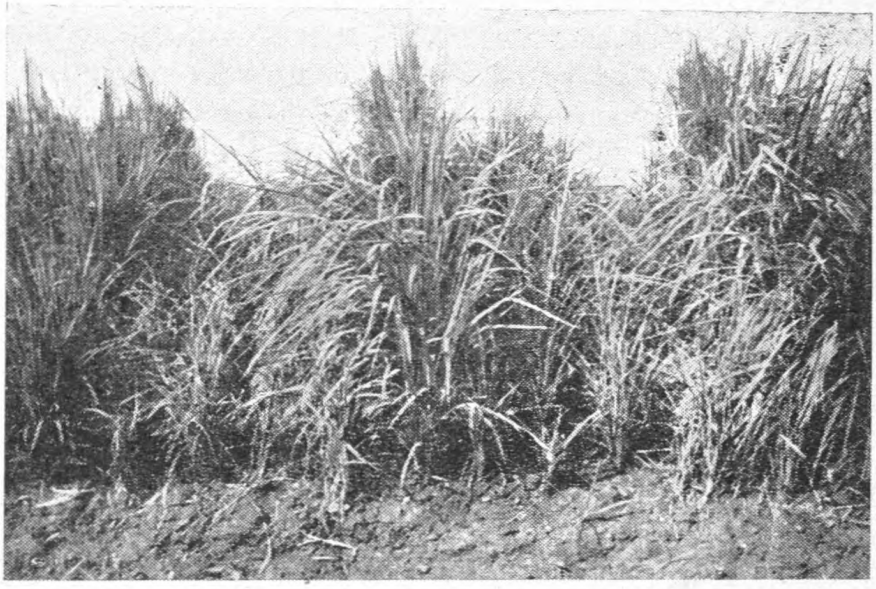

FIG. II : Close-up of an upland nursery showing a resistant variety in the middle of the illustration.

The results of the assessments are presented in Tables 1 and 2.

RESULTS

TABLE 1

Variety	Country of Origin	12.6.58 Percent Leaf Area Attacked	12.6.58 Lesion* Type	12.6.58 Grade of Resistance	14.6.58 Percent Leaf Area Attacked	14.6.58 Lesion* Type	14.6.58 Grade of Resistance
Adt 18	India	73	L	S	100	L	SS
Brondel Putih	India	41	L	MS	98	L	SS
Br 4	India	0·2	S	R	0·1	L	R
HMC 12	Burma	68	L	S	100	L	SS
MYAC 104	Burma	0	D 4	RR	0	D7	RR
CO 25	India	0·3	S	R	0·1	D + S	RR
Chuban	China	100	L	SS	100	L	SS
Ch. 18	China	28	L	MS	33	LS	MS
Ch. 1007	China	13	L	M	68	L	S
Ch. 1039	China	13	L	M	68	L	S
Gendah Beton	Indonesia	35	L	MS	98	L	SS
GEB 24	India	100	L	SS	100	L	SS
Heenati 310	Ceylon	25	L	MS	66	L	S
Hondarawala 502	Ceylon	38	L	MS	76	L	S
H 106	Ceylon	47	L	MS	100	L	SS
H 501	Ceylon	0	D3	RR	0	D 10+SL	R
H 105	Ceylon	0	D2	RR	0	D4	RR
H 103	Ceylon	38	L	MS	80	L	SS
H 5	Ceylon	0·1	D	RR	0	D 3	RR
H 4	Ceylon	0·5	S	R	0·1	D 3+S	RR
Murungakayan 302	Ceylon	0·1	D+S	RR	0·3	D 4+S	R
Murungakayan 301	Ceylon	30	L	MS	100	L	SS
Murungakayan 104	Ceylon	0·3	S	R	1·0	D + L	RR
Murungakayan 3	Ceylon	2·1	S	MR	0·1	D 3	RR
Murungakayan 101	Ceylon	0·1	D3	RR	0	D 4	RR
Murungakayan 304	Ceylon	0	D 3	RR	0	D 5	RR
Murungan Samba 3081	Ceylon	0·5	D + S	R	0·1	D 3	RR
Periavellai 538	Ceylon	0·4	D + S	R	0·5	S	R
Pebifun	Indonesia	15	L	M	62	L	S
Remadja	Indonesia	0	—	RR	0	—	RR
SR 26 B	India	0	—	RR	0	—	RR
Sinnanayan 398	Ceylon	5·5	S	M	24	S	M
Samo	Indonesia	25	L	MS	58	L	S
Satika	Indonesia	22	L	MR	50	L	MS
Tjahaja T 27	Indonesia	0	—	RR	0	—	RR
Vannan	Ceylon	53	L	MS	100	L	SS
V. I. 28061	Ceylon	0·3	S	R	0·1	D 1	RR
Waner	Indonesia	23	L	MR	60	L	S
2–2–98	Japan	100	L	SS	100	L	SS
Ptb 10	India	42	L	MS	86	L	SS
Ptb 16	India	1·0	D + L	MR	13	D + L	M

Note.—* Lesion Type : L—Large Lesions
S—Small Brown Lesions
D—Dot-like Lesions

TABLE 2

Variety	Country of Origin	Percent Leaf Area Attacked	Lesion Type*	Grade of Resistance
Balamawi	Ceylon	100	L	SS
Bengawan B 27	Indonesia	0	D 2	RR
Dahanala 2014	Ceylon	80	L	S
Devaredderi 26081	Ceylon	100	L	SS
H 2	Ceylon	95	L	SS
Heenati 309	Ceylon	78	L	S
Heenati 310	Ceylon	85	L	SS
HMC 12	Burma	100	L	SS
HMC 20	Burma	72	L	S

TABLE 2—*contd.*

Variety	*Country of Origin*	*Percent Leaf Area Attacked*	*Lesion Type**	*Grade of Resistance*
Hondarawala 568	Ceylon	81	L	SS
Kaluheenati 3254	Ceylon	100	L	SS
Kurulutuduwi B 13	Ceylon	100	L	SS
Madael 137	Ceylon	100	L	SS
Mas M 24	Indonesia	100	L	SS
Mawi B 11	Ceylon	73	L	SS
Molagusamba g18	Ceylon	60	S	SS
Murunga 137	Ceylon	100	L	SS
Murunga 307	Ceylon	100	L	SS
Murunga 308	Ceylon	100	L	SS
Murungakayan 302	Ceylon	0	D 5	RR
Murungakayan 303	Ceylon	8	S	M
Murungakayan 304	Ceylon	0	D 6	RR
MYAC 104	Burma	0	D 10	RR
Oddavalan 2449/20	Ceylon	94	L	SS
Pachchaiperumal 2462/11	Ceylon	100	L	SS
Periavellai 538	Ceylon	10	S	M
Perillanel 26014	Ceylon	73	L	S
Podiwi a-8	Ceylon	98	L	SS
Pokkali	Ceylon	27	S	MS
Ptb 16	India	47	LS	—
Rathkarayal 3753	Ceylon	74	L	S
Siam 29	Siam	93	L	SS
Sinnanayan 398	Ceylon	85	L	SS
Sinnanayan 2208	Ceylon	83	L	SS
SR 26B	Ceylon	0	D1	RR
Suduheenati HF 9	Ceylon	100	L	SS
Suduheenati ICPY 15	Ceylon	100	L	SS
Suduheenati ICPY 19	Ceylon	100	L	SS
Suduwi 305	Ceylon	100	L	SS
Suduwi 306	Ceylon	100	L	SS
Sulai 301	Ceylon	39	S	MS
Sulai 27614	Ceylon	96	L	SS
Tadukan	Philippines	0	D1	RR
Tetep	Formosa	0	D 1	RR
Uvarvellai	Ceylon	72	L	SS
Vellai Perunel 28724	Ceylon	100	L	SS
Wannidahanala	Ceylon	100	L	SS
Pi–1	Japan	32	S	MS
Pi–2	Japan	70	LS	S
Pi–3	Japan	0	D 1	RR
Pi–4	Japan	0	D 1	RR
Asahi	Japan	71	L	S
Norin 22	Japan	52	LS	MS

Note.—* Lesion Type : L—Large Lesions
S—Small Brown Lesions
D—Dot-like Lesions

The general principles used for induction of blast under upland nursery conditions consist of heavy nitrogen fertilization in the form of a top dressing of ammonium sulphate, inhibition of the uptake of silica by growing the paddy under upland conditions and increasing the relative humidity within the plots by close spacing.

A point which requires clarification is the extent of the physiological changes induced, by growing under upland conditions and their relationship to the physiological status of the paddy when grown under inundated conditions. As the type of resistance usually associated with Indica varieties is due to the hypersensitivity of the invaded cells to the fungus (5), it will be necessary to consider these physiological changes in the host cells with respect to the effect of silica and nitrogen nutrition which has been found by Baba and others to influence the sensitivity of the paddy plant to *Piricularia oryzae* (3). Thus it will be necessary to determine whether varieties found to be resistant under upland conditions continue to exhibit resistance when grown in flooded soil. Data that will be published shortly indicate that the resistant varieties in Ceylon as evaluated under upland conditions show no change in resistance when grown under inundated conditions irrespective of the fertilizers given, soil types used and elevations at which the varieties are grown.

The technique so far described is an evaluation of resistance to leaf blast phase caused by *Piricularia oryzae*. The most serious aspect of the disease, however, is neck rot which is generally the dominant phase of the disease at higher elevations (over 1,500 ft.). Experiments which will be published later have shown a positive correlation between leaf blast assessed by this technique and neck rot under inundated conditions. This method of assessment of resistance therefore holds true for both leaf blast and neck rot caused by the blast fungus.

These experiments on disease resistance were conducted at only two stations (Karapincha and Peradeniya). The source of inoculum at the latter station was a fairly virulent strain which was brought in the disease straw from Karapincha, so that in all probability the same strains of *Piricularia oryzae* were used in these experiments. It is, however, possible that there exists in other parts of the island different physiological races of *Piricularia oryzae*. If such races are discovered it could be necessary to re-evaluate the resistance of the purelines tested.

DISCUSSION

According to the data presented in Tables 1 and 2 the varieties *SR 26B, Murungakayan* 302, 304, *V.I.* 28061 were very resistant, while the lines *Bengawan* 27, *Tjahaja* 27, and *Sigadis* 3443 showed exceptionally high resistance. Of the 71 pure lines tested, 17 were highly resistant. These did not differ in the degree of resistance from the Formosan *Indicas, Tetep* and *Tadukan,* which were used extensively by the Japanese in their breeding work. Of the remainder, two were very resistant, four fairly resistant, two rather susceptible and forty-six very susceptible.

According to preliminary observations all varieties graded as RR, R, MR in Tables 1 and 2 may be grown under inundated conditions and remain blast-free at high dosages of nitrogen. The performance of varieties graded M and MS under inundated conditions requires further investigations, while varieties graded S and SS should be used with caution especially at high dosages of nitrogen.

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