BREEDING RICE VARIETIES RESISTANT TO BLAST DISEASE CAUSED BY *PIRICULARIA ORYZÆ* CAV.

I. Selection of Resistant Varieties from Genetic Stock

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INTRODUCTION

A PROGRAMME of selecting rice varieties resistant to blast disease (*Piricularia oryzæ* Cav.) was initiated at the Central Rice Research Institute in 1948. In carrying out the tests for resistance, methods were standardised for bringing about artificial infection, scoring infection and classifying the varieties into different susceptibility groups. The procedures adopted in these tests and the results obtained in the first phase of the programme completed in 1955, are presented below.

MATERIALS AND METHODS

Out of the collection of genetic stock maintained at this Institute, which consisted of over two thousand types in 1948, four hundred and seventy types were taken up for the tests. These were mostly improved varieties released for cultivation by various rice research stations in India and also a few foreign varietes.

The method of testing consisted of a series of screening tests in the seedling stage under artificial infection, followed by rigorous tests in the field under conditions favourable for blast development. In addition, all these types were also observed for their reaction to the natural infection of blast at seedling, post-transplanting and flowering stages in maintenance plots.

Artificial infection in the seedling stage.—A unit of twenty-five seedlings was raised for each variety in five small pots of 6 inches diameter, using normal field soil mixed with a small amount of well rotten farm-yard manure. When the seedlings were 25–30 days old, ammonium sulphate to give approximately 40 lb. of nitrogen per acre was applied to the pots. Within a week the seedlings begin growing vigorously with leaves turning dark-green when they are considered ready for artificial infection. In the first artificial infection test carried out in 1949, an isolate of the fungus obtained from Coimbatore was used. In the subsequent years, an isolate from the Institute

farm was used. No evidence for the existence of specialisation in pathogenecity was obtained in an infection experiment carried out in 1949 with isolates of the pathogen from different centres, Coimbatore, Wynad, Cuttack and Delhi (Padmanabhan, 1953 *a*).

The spore suspension was prepared from a culture of the fungus in oat meal agar containing thiamine (0·25 mg. in 1000 ml.) and biotin (0·015 mg. in 1000 ml.) and incubated at about 25° C. for 7–12 days. The suspension was prepared with sterile water or a solution of gelatine 0·25% *plus* sodium oleate 0·05% (Anderson and Henry, 1946). The seedling leaves were first wetted with water from a sprayer, and then sprayed with spore supension to run-off by using Devilibis atomiser.

For carrying out artificial infection, the pots were first arranged in compact blocks of 400 each, each block being covered all round with a wet cloth curtain suspended from a wooden frame about 6 feet high to provide the humid chamber conditions. The infection was carried out after sunset, and the seedlings were kept enclosed in the wet cloth chamber till about 8 A.M. the next morning. These precautions were taken to ensure contact of the leaves with water for as long a period as possible, as contact with water for a minimum period of 6–10 hours has been found to be necessary for establishment of infection by *Piricularia oryzæ* (Hemmi and Abe, 1931; Anderson *et al.*, 1947). During the period of incubation, the temperature ranged from 25–27° C. within the enclosure of the cloth curtain.

Index for the type of spots	Index for the number of spots	
A. Just reddish flecks		
B. Minute reddish spots showing no differentiation into distinct zones	I	1–3 spots per leaf
	II	4–15 spots per leaf
	III	Above 15 spots per leaf
C. Circular spots about 2–3 mm. in diameter with a central ashy zone and a dark purplish brown margin		
D. Broadly spindle-shaped spots only slightly longer than broad, 3–5 mm. in diameter		
E. Large distinct spindle-shaped spots with a central ashy zone and marginal zones 3–5 mm. broad and up to several centimetres in length		

The first sign of infection could be seen on the seedling leaves after 48 hours in some varieties, and within about a week the spots attained their maximum development. The leaf spots varied in size from small minute flecks to large spindle-shaped spots. The number of spots also showed some variation. Therefore, in scoring for infection, the extent of development of the individual spots as well as the number of spots which developed on a leaf were taken into consideration. Accordingly, a score card was devised as follows (Fig. 1).

With the help of the above score card the infection observed on the most heavily infected leaf in each seedling was scored as "II D" or "I C", etc. Then the observed infection score was converted to a numerical scale as follows:—

Numerical value for the type of spot		Numerical value for the number of spot	
A	1	I	2
B	2	II	5
C	4	III	10
D	8		
E	16		

The product of the two values for the type of spots and their number was taken as the numerical score. For example, if the infection score of a leaf was II C or III D, the corresponding numerical score was $5 \times 4 = 20$ or $10 \times 8 = 80$.

Further, in the case of very heavy infection seen on some susceptible types, an additional weightage was given for the leaf area totally destroyed, and a numerical value allotted to the percentage of leaf area destroyed, as below, was added to the numerical score of the leaf.

30% of leaf area destroyed	10
50% of leaf area destroyed	20
75% of leaf area destroyed	30
The whole leaf totally destroyed	40

The average infection score of the variety was arrived at by totalling the individual infection scores of the seedlings and dividing the total by the number of infected seedlings.

In the seedling infection tests, the varieties which received an infection score of 10 and above or which had any "D" or "E" type of spots were classed as belonging to the susceptible groups in the seedling stage.

Field tests.—The field tests were carried out for three successive years with the varieties carried forward from the screening tests, *i.e.*, varieties which had emerged as resistant both from the seedling tests and the type maintenance plots in the field. In each successive field tests, only the varieties which were resistant in the previous tests were included.

The seedbeds were sown in the first week of July. When the seedlings were three weeks old, ammonium sulphate was applied to the beds at the rate of 40 lb. N per acre. Observations on disease incidence in the beds were taken at the time of uprooting of the seedlings in the first week of August.

The seedlings were transplanted in a well prepared puddle. Green manure and farm-yard manure were applied as a basal dressing to give about 20 lb. N per acre. Three to four weeks after transplanting, ammonium sulphate was applied at the rate of 40 lb. N per acre.

In the first field test carried out in the year 1953–54, the test varieties were transplanted in two rows of 20 feet each, with a spacing of 6 inches between the rows and 6 inches between the plants in the row. In subsequent tests, each variety was transplanted in five rows of 20 feet each, with one foot of space between the rows and 6 inches between the plants in the row. The wide spacing between the rows was found useful for taking observations. A row of the highly susceptible variety Co. 13 was planted on either side of the test variety. Each variety was replicated twice. The total number of plants tested for each variety was 160 in the first test and 400 in subsequent tests.

Observations on the disease development in the field were taken twice in the season the first on the foliar infection at the rapid tillering phase and the second on neck and nodal infection at the time of the harvest of the variety. For leaf infection, the most heavily infected leaf in each plant was scored. At the time of harvest, the number of plants which had developed neck infection and nodal infection, and the number of healthy and infected tillers in each of the affected plants were noted. From the data the percentage of plants which had developed neck and nodal infection was calculated.

As blast appears under Cuttack conditions both in the seedbeds and in the transplanted crop in the tillering phase during the second crop season, also (January–April) the reaction of the test varieties to the disease in the second crop season also was studied more or less on the same lines as in the first season.

The criteria adopted for classification of the varieties were as follows:

Very resistant	..	Leaf-infection score less than 10, 'C', 'D', 'E' spots absent, neck-infection less than one per cent.
Resistant	..	Leaf-infection score less than 10, 'C' spots seen very rarely, 'D' and 'E' spots absent, neck-infection one to five per cent.
Moderately resistant	..	Leaf-infection score less than 10, 'C' spots common, 'D' and 'E' spots absent, neck-infection six to ten per cent.
Moderately susceptible		Leaf-infection score less than 20, 'E' spots absent neck-infection eleven to twenty per cent.
Susceptible	..	Leaf-infection score above 20, 'D' and 'E' spots common, neck-infection more than twenty per cent.

Results

On the basis of their reaction in the artificial infection tests in 1949, 1950 and 1951 and their field reaction in the type maintenance plots during 1948–53, three hundred and eighty-seven test varieties were eliminated as susceptible. In the field tests carried out during 1953–54, 1954–55 and 1955–56, five varieties were finally selected as resistant and sixteen as moderately resistant. The names of the selected varieties are given below.

Resistant	..	BJ. 1, CO. 4, S. 67, SM. 6 and SM. 9
Moderately resistant	..	ADT. 12, AKP. 8, AKP. 9, AS. 2, BAM. 4, CH. 55, CO. 25, CO. 26, CP. 6, CP. 9, H. 755, MTU. 5, Mugad-249, PTB. 10, S. 624, and SM. 8.

Out of the selected varieties, CO. 4, CO. 25 and CO. 26 have already been selected as resistant to blast by the Department of Agriculture, Madras, and Mugad-249 selected by the Department of Agriculture, Bombay. The reaction of the two varieties, PTB. 10 and S. 624 was found to be somewhat variable in some seasons being moderately susceptible or susceptible to leaf-infection or neck-infection.

The list of varieties tested and their classification into different relative susceptibility groups are presented in Table I.

TABLE I

Reaction of rice varieties to blast disease (tested at Central Rice Research Institute, Cuttack, during the years 1948–55)

Place of origin 1	Very resistant 2	Resistant 3	Moderately resistant 4	Moderately susceptible 5	Susceptible 6
India:					
1. Andhra ..			AKP. 8 (Maharajabhogam), AKP. 9 (Bangarutheega), MTU. 5 (Krishnakatukulu)	AKP. 6 (Mypali), BS. 1, HS. 21, MTU. 6 (Atragada)	AKP. 2 (Sunkisannam), AKP. 5 (Mypali), AKP. 7 (Palgarabayyahunda), AKP. 10 (Bangarutheega), AKP. 11 (Ramasagaram), HS. 8, HS. 12, HS. 19, HS. 22, HS. 35, HS. 38, HS. 39, HS. 47, MTU. 1 (Akkulu), MTU. 2 (Akkulu), MTU. 3 (Basangi), MTU. 4 (Basangi), MTU. 7 (Guttikusuma), MTU. 8 (Vankisannam), MTU. 9 (Garikasannavari), MTU. 10 (Krishnakatukulu), MTU. 11 (Konamani), MTU. 12 (Pedhaatragada), MTU. 13 (Delhibhogam), MTU. 14 (Atragada), MTU. 15, MTU. 16, MTU. 18, (Kodijillama), MTU. 19, SLO. 1 (Punasakonamani), SLO. 2 (Punasakonamani), SLO. 3

			(Konamani), SLO. 4 (Konamani), SLO. 5 (Palagummsari), SLO. 6 (Punasa-akkulu), SLO. 8 (Sannabasangi), SLO. 9 (Gortibasangi), SLO. 10 (Ratnachudi), SLO. 11 (Bikirisannam), SLO. 12, SLO. 14 (Punasaakkulu), SLO. 17, SLO. 18
2. Assam ..	AS. 2 (Kasalath)	S.55 (Badshabhog), S. 126 (Laundumra), S. 156 (Nagrasail), SB. 279 (Gamiribora)	AR. 1 (Salibadal), AR. 108-1 (Dholabadal), AR. 353-148, AS. 20-1 (Garen), AS. 35 (Farmah), HBJ. 1, HBJ. 2, HBJ. 3, HBJ. 4, M. 36-30 (Baurashmurali), M. 142 (Koimurali), M. 175-1 (Dholajali), S. 22 (Latisali), SC. 54-60 (Vijoysali), SC. 94-47 (Kerrsali), SC. 412-56 (Swarnasali), SJ. 226 (Bengalijoha), SL. 70 (Ahomsali), T. 2089 (Prasadbhog), T. 2090 (Andrewsali), T. 2091 Badshabhog, T. 2092 (Laundumra), T. 2094 (Jahari), T. 2095 (Latamaguri), T. 2096 (Gomiribora), T. 2097 (Karanganj), T. 2100 (Latisali), T. 2102 (Kerrsali), T. 2104 (Kasalath), D. 204-1 (Dumai), C. 203-3 (Chengri)
3. Bihar ..		BHR. 16 (Motisal), BHR. 141 (Juhlansar)	BHR. 36 (Kessore), BHR. 88 (Dahia). BHR. 115 (Dahia), BHR. 76-Bk

TABLE I—(*Contd.*)

Place of origin 1	Very resistant 2	Resistant 3	Moderately resistant 4	Moderately susceptible 5	Susceptible 6
4. Bombay ..			Mugad-249	Antersal-67, Antersal-200, Bhadas-79, Chimansal-94, Dodgya-622, Krishnasal-10, Patnai-6	Ambemohar-59, Ambemohar-157, Ambemohar-159, Antersal-90, Fine Waksal, Halga Red-244, Halga White-1690, Jaddu-1061, Kamod-86, Kolamba-184, Kolpi Early-70, Luchai, Maskaty-1315, Mugad-81, Mugad-141, Mugad-161, PR. 90, Warangal-57, Yalkirisal-4, Zinya-149, 280-51-36.
5. Kashmir ..					Bansal, Safed Zagir, Chatta Baber, Budgi, Mushka Budgi, Budgi Baber, Begam, Lolanzan, Ratibasmati
6. Kerala ..					Chuvannavellai, Kochuvittu, Karuvalan, Panamkomban, Samba, Valshivanandan, Veeravadantan, Kichilisamba, Arikirivashi
7. Madhya Pradesh			CP. 6 (Budhiabako), CP. 9 (Luchai)	CP. 2 (Nungi), CP. 8 (Benisar), CP. 12 (Banspati), CP. 13 (Kurbimohar), CP. 19	CP. 1, CP. 3 (Sultigurmatia), CP. 4 (Gurmatia), CP. 5 (Ludko), CP. 7 (Ajan), CP. 10 (Chattri), CP. 11 (Dubraj), CP. 14 (Badshabhog), CP. 15 (Chinoor), CP.16, CP. 17, CP. 18

8. Madras ..	CO. 4 (Anaikomba)	ADT. 12 (Chitrakali), CO. 25 (Hybrid), CO. 26 (Hybrid), PTB. 10 (Thekkan Cheera)	ADT. 6 (Red-Ottadan), ADT. 8 (Malagalukkulu White Sirumani), ADT. 9 (Poonkar), ADT.11 (Nellore Samba), ADT. 21 (Vadansamba), ASD. 6 (Anaikomban), PTB. 1 Aryan, PTB. 3 (Eravapandy), PTB. 5 (Veluthari-Kayama), PTB. 6 (Athikraya), PTB. 7 (Parambuvattan), PTB. 8 (Thavalakannan), PTB. 9 (Same as PTB. 8), PTB. 13 (Kayama), PTB.14 (Maseathi), PTB. 15 (Kavunginpoothala) PTB. 16, PTB. 18, (Erayapandy)	ADT. 1 (Red sirumani), ADT. 2 (White Sirumani,) ADT. 3 (Kuruvai), ADT. 4 (Kuruvai), ADT. 5 (Nellore Samba), ADT. 7 (Muthusamba), ADT. 10 (Korangusamba), ADT. 13 (Sannasamba), ADT. 14 (Vellaikar), ADT. 15 (Mutant from ADT. 4), ADT. 16 (Konakuruvai), ADT. 18 (Vellaikuruvai), ADT. 19 (Sarapalli), ADT. 20 (Hybrid ADT. 3 × ADT. 2), ADT. 22 (Vadansamba), ASD. 1 (Karsamba Red), ASD. 2 (Karsamba White), ASD. 3 (Veedivadangan), ASd . 4 (Kuruvaikalyan), ASD. 5 (Karthigasamba), ASD. 7 (Karsamba Red), CO. 1 (Natural cross from GEB. 24), CO. 2 (Poombalai), CO. 3 (Vellaisamba), CO. 5 (Chinnasamba), CO. 6 (Sadaisamba), CO. 7 (Sadaisamba), CO. 9 (Karsamba Red), CO. 10 (Gobikar), CO. 11 (Ayansamba), CO. 12 (Sendhinayagam), CO. 13 (Arupathankodai), CO. 14 (CO. 3 × Burma variety), CO. 15 (GEB .24 × ADT. 10), CO. 16 (same as CO. 15), CO. 17 (Vadansamba), CO. 18 (Vellaikar), CO. 19 (Sirumani), CO. 20

TABLE I—(*Contd.*)

Place of origin 1	Very resistant 2	Resistant 3	Moderately resistant 4	Moderately susceptible 5	Susceptible 6
					(Tella Sannavadlu), CO. 21 (Arupathanasmba), CO. 22 (Manavari), GEB. 24 (Mutant in Konamani), PLR. 2 (Chitrakali), PLR. 7. PTB. 2 (Ponarvan, PTB. 12 (Chitteni), PTB. 17) (Jeddu Halliga), PTB 19 (Sirumani), PTB. 20 (Chitteni)
9. Mysore . . .		S. 67	S. 624 (Maharajabhogam)		B. 16 (Thogarina), B. 194 (Musali), B. 281 (Belikannamhegge), B. 805, B. 888, B. 986, H. 324, H. 419, H. 535, S. 54, S. 139 (Mysore Kaddi), S. 199 (Alur Sanna), S. 246 (Nagpur Sanna), S. 317 (Halubbalu), S. 328, S. 476, S. 590, S. 661 (Coimbatore Sanna), S. 699 (Coimbatore Sanna), S. 701 (Coimbatore Sanna), S. 749 (Rathnachudi)
10. Orissa . .			BAM. 4 (Bayyahunda)	D.I. 3 (Orozosporas), T. 90 (Machakanta), T. 608 (Basabati), T. 1118,	BAM. 1 (Boroponko), BAM. 2 (Boroponko), BAM. 3 (Bayyahunda), BAM. 5 (Rathnachudi), BAM. 6 (Ratnachudi), BAM. 7

		T. 141 (Soru-chinnamali)	(Navakotisannam), BAM. 8 (Navakotisannam), BAM. 9 (Mypali), BAM. 10 (Mypali), BAM. 13 (Yana Kondnagi), B. 76, Benibhog, Balunganardhan, D.I. 4 (Orozosooras), FR. 13 A, FR. 43 B, ML. 1, ML. 3, N. 136, SR. 26 B (Kalambank), T. 56 (Kalakakkudia), T. 165 (Kajalchampa), T. 380 (Banko), T. 412 (Badshabhog), T. 442 (Kolakartika), T. 635, T. 812 (Rangolata), T. 885, T. 1145 (Ussa), T. 1242 (Magura)
11. Punjab ..		PB. 4 (Lal Nakanda 41), PB. 5 (Palmansuffid 246), PB. 10 (CM. 7-6), PB. 14 (Jhona 349)	NP. 97, NP. 130, NP. 137, PB. 1 (EC. 1-57-25), PB. 2 (Mushkan-41), PB. 6 (Phulputtas 72), PB. 7 (Sathra 278), PB. 12 (Mahlar 346), PB. 13 (Basmati 370)
12. United Provinces	H. 755	T. 9 (Duneapet)	Ch. 10 (UP) H. 33, H. 64, H. 108, N. 10 B (Basmati Pilibit), N. 12 (Suffaida), N. 22 (Rajbhog), N. 27 (Banki Pilibit), N. 32 (Baljati), T. 1 (Ramjiwain), T. 3 (Basmati), T. 17 (Bansi), T. 21 (Chawl), T. 22 *a* (Bansi), T. 23 (Kala Sukhdas), T. 36 (Jorhan), T. 43 (Sondhi) T. 56 (Jobda), T. 88 (Chakia), T. 100 (Benslot), T. 136 (T. 1×T. 100)

TABLE I—(*Contd.*)

Place of origin 1	Very resis-tant 2	Resistant 3	Moderately resis-tant 4	Moderately sus-ceptible 5	Susceptible 6
13. West Bengal		Bhogjira-1		Badkalamkati-65, Manikkalma, Nagra-68-6, Bhasamanik, Nagra-41-14, Badshabhog, Kaliboro-2, Bhogjira-2	Bhutmuri-36, Badkalamkati-7, Bolder, Dahijira, Kaladubraj, Ajan 246, Nonramsail, Sindur-mukhi, Raghusail, Randhuni-pagal, Patnai 23, Kalma-222, Rupsail, Seethasail, Kumergore Kaliboro-1, Kaliboro-3
China ..				CH. 4 (C.N.A.B. No. 4), CH. 5 (Szechuan Shui Pai Tiao), CH. 6 (Hunan Thirty culms), CH. 7 (Chekiang No. 3), CH. 13 (C.N.A.B.-Kweichow No. 2), CH. 25 (Szechuan Dan hung scented Rice), CH. 30 Ho-kiang Dry Field Glutinous, CH. 31 (Black Kernel Glutinous), CH. 36 (Yunan Shih Ping	CH. 1 (Canton Golden Early), CH. 2 (Nanje hao), CH. 3 (Hunan victory), CH. 8 (Chekiang No. 9), CH 9 (Rushy late 21-3), CH. 10 (C.N.A.B. 11-23-613), CH. 11 (Canton Fine leaf No. 31), CH. 12 (Canton kuan yiu hoien No. 16), CH. 14 (Kweiyaxy great white Hsleu), CH. 15 (A.H. 28-70 Faith × Fortuna), CH. 16 (A.H. 29-218 Blue Rose × Fortuna), CH. 17 (Pa-sian Red Leaf), CH. 18 (C N.A.B. Kweichow No. 8847), CH. 22 (Kunming Scented Rice), CH. 23 (Yunan we sen Serenli Perfume), CH. 26

	Purple Glutinous), CH. 40 (C.N.A.B. Land Rice), CH. 43 (974), CH. 46 (1007), CH. 49 (Linchou), CH. 53 (Wuke hualo), CH. 58 (Tainung No. 38), CH. 60 (Taoyri anyinwei), CH. 61 (Chikechin), CH. 68 (Chinshih-yih), CH. 70 (Cheanong No. 18) CH. 74 (Shentsuo No. 4), CH. 80	(Sung Pan Rice), CH. 32 (Honen Long Purple Glutinous), CH. 34 (Cheng tu Great White Fine Rice), CH. 35 (Ninger Small White Glutinous), CH. 38 (Hunan Tzu-Sin Upland Rice), CH. 39 (C.N.A.B. White Rice), CH. 42 (972), CH. 44 (988), CH. 45 (996), CH. 47 (1040), CH. 48 (Ahouchiac), CH. 50 (Paiweitsung), CH. 51 (Yinwei), CH. 52 (Chinggu), CH. 56 (Hungehiaochin), CH. 57 (Chingchiaschinggu), CH. 59 (Hsinchu No. 4, CH. 62 (Paimi-jih), CH. 63 (Tuanrzu), CH. 64 (Chinpaoyin), CH. 65 (Wuke), CH. 66 (Paimihin), CH. 67 (Tuangkuanghualo), CH. 72 (Tainong No. 45), CH. 73 (Tai-peh No. 7), CH. 77 (Kaoshiung No. 10)
Japan ..	JAP. 1 (Semichi No. 2), JAP. 3 (Kameji)	JAP. 2, (Omachi), JAP. 5(Ashahi)
New Guinea ..		New Guinea I
Pakistan ..	Atlai, Pashpai, Hashikalmi, Kagni	Indrasail, Kataktara, Dhepi, Dudsar, Charnock, Tilakka-chari, Daudkhani, Jessobalam, Panbira, Hatisail, Dharial, Jhingasail, Latisail, Pusur. Blue-stick, Daudin, Dular, Chitraj,

Place of origin 1	Very resistant 2	Resistant 3	Moderately resistant 4	Moderately susceptible 5	Susceptible 6
					Marichbati, Nigersail, Silver Jubilee, Bangalo
Russia ..				R. 4 (T. 1708), R. 5 (T. 2443), R. 9 (T. 2887), R.I.A.R.I.	R. 1 (T. 556), R. 2 (T. 1322), R. 3 (T. 1331), R. 6 (T. 2493), R. 7 (T. 2653), R. 8 (T. 2776), R. 10 (T. 3073), R. 11 (3078), R. 13 (T. 3304)
Siam ..		SM. 6 (Champa 133), SM. 9 (Pin Kaeo)	SM. 8 (Phuang Ngern)	SM. 1 (Khao Tod Long), SM. 3 (Chamba-Da), SM. 10 (Khao Bhudat)	SM. 2 (Mali Thong), SM. 4 (Nang Mol), SM. 5 (Leaung On), SM. 7 (Mali Ong), SM. 11 (Bang Phra), SM. 12 (Kod Phom), SM. 13 (Nang Tani)
U.S.A. ..				USA. 5 (Texas Patna C.I. 8321)	USA. 2 (Rexoro C.I. 1779), USA. 3 (Fortuna), USA. 4 (Nira C.I. 2072)

Discussion

In these tests artificial infection was used for rapid screening of the varieties at the seedling stage, but the final selection for resistance was based upon the reaction of the varieties in the field at the seedling, post-transplanting and neck emergence stages under conditions very favourable for the development of the disease. There were occasionally some varieties which were resistant at one stage and susceptible at another, but this differential reaction needs further careful study and confirmation. For practical purposes, it is clearly preferable to select varieties which are resistant at all stages when such varieties are available.

In the field tests, maximum advantage was taken of the prevailing climatic conditions at Cuttack to make the tests as rigorous as possible. Two factors, *viz.*, date of planting and age of the host have a definite relation to the degree of development of blast in the field (Padmanabhan and Ganguly, 1953, 1954). As regards the age of the host, maximum leaf-infection was seen on 45–50 days old plants, when they were in the vigorous tillering phase following transplanting. By delaying the planting up to the middle of August during the *Kharif* season and upto the end of January in the spring season, very heavy infection of blast could be obtained.

Since the level of nitrogenous fertilization also profoundly alters the reaction of rice varieties to blast (Krishnaswamy, 1952; Padmanabhan, 1953 *b*; Ganguly *et al.*, 1954), it was considered necessary to standardise the level of nitrogenous fertilization in these tests against blast. In the present study the level was fixed at 40–60 lb. N per acre as this level has been found to be the most economic N level for optimum yield response in rice throughout India. Besides at higher levels many a potentially good yielding variety which is not likely to develop the disease under conditions in which it will be cultivated in India will get eliminated.

Elimination of useful types is also likely to occur if the artificial infection tests are carried out under lower temperature conditions than those likely to be met with in the plains of India, since temperature influences the reaction of rice to blast through its effect on nutrient absorption and utilization (Hashioka, 1950). Conversely, varieties selected as resistant at temperature ranges common in the plains of India may not behave as resistant if they are grown under cooler temperatures. In fact, the performance of some of the varieties selected as resistant to blast in the present study in more than forty rice research centres in India during the years 1955–58 has confirmed that most of these varieties are not resistant to the disease in localities situated at higher elevations where cooler temperatures prevail.

How far the varieties selected as resistant and moderately resist ant to blast at Cuttack would be useful in different parts of India is being studied by the States in their rice research centres. The results will be published separately.

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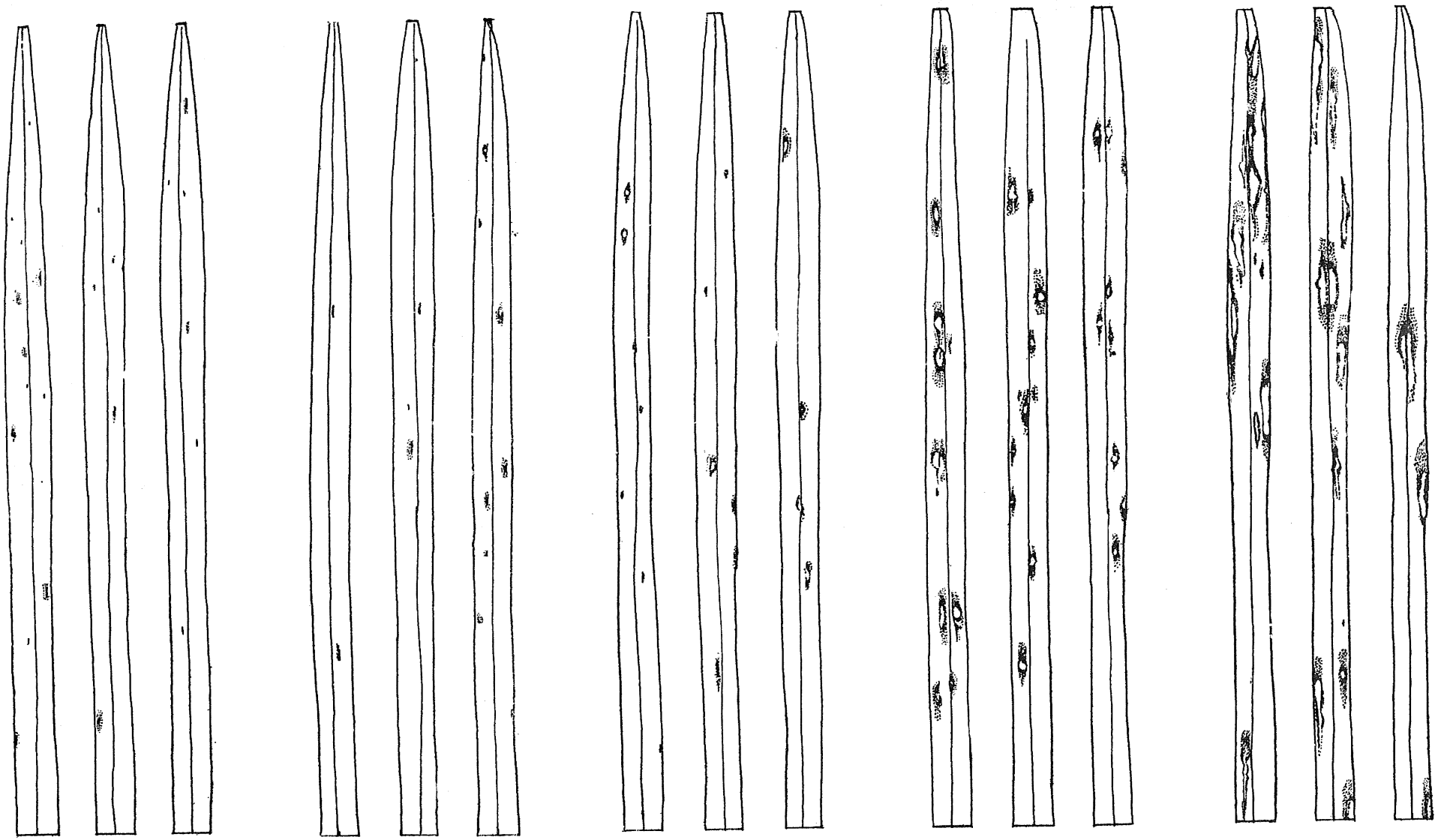

BLAST INFECTION GRADES