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

II. Selection of Resistant Varieties of Early Duration from the Genetic Stock*

BY S. Y. PADMANABHAN, D. GANGULY AND G. H. CHANDWANI

(*Central Rice Research Institute, Cuttack-6*)

Received January 22, 1964

(Communicated by Dr. R. Subrahmanyan, F.A.SC.)

INTRODUCTION

ONE of the principal lines of investigations undertaken at the Central Rice Research Institute, Cuttack, is breeding for blast resistance through isolation of resistant varieties from the Genetic Stocks. As there are nearly 4,000 rice varieties maintained in the Genetic Stocks at the Institute, for convenience of handling, the varieties are taken up in lots of about 500 varieties each and tested and classified into various groups of relative susceptibility. The varieties selected as resistant and moderately resistant in such tests are sent to the State Departments of Agriculture for trials of their performance under local conditions (Kulkarni, 1959; Venkatakrishnayya and Delvi, 1960; Mathur and Misra, 1961).

The results of the tests carried out during 1948 to 1954 with a first lot of 470 types from the Genetic Stock have been presented earlier (Padmanabhan and Ganguly, 1959). These varieties were departmentally released types from different Rice Research Stations in India and abroad. In the tests, five varieties, *viz.*, Bj-1, Co-4, S-67, SM-6 and SM-9 were classified as resistant and sixteen varieties, *viz.*, 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 were classified as moderately resistant to blast.

In the present contribution results are presented of such tests carried out from 1954 to 1961 with a group of early duration varieties in the Genetic Stocks, maturing within 120 days under Cuttack conditions (21° N.L).

MATERIAL AND METHODS

There are 490 varieties of early duration (maturing within 120 days) available in the Genetic Stocks, a representative collection of rice accessions from India and other parts of the world.

* Part I of the series appeared in *Proc. Ind. Acad. Sci.*, 1959, 50 B, 289-304.

The material was rapidly screened under artificial inoculation at the seedling stage during the first three years in both the main and the second crop season (*viz.*, in August and February, respectively). The techniques adopted for bringing about artificial infection, scoring the infection, and classifying the types into different susceptibility groups were the same as evolved and reported in the previous communication in 1959 (Padmanabhan and Ganguly, *loc. cit.*).

Besides artificial inoculation tests, all the types were observed for their reaction to natural infection of blast at seedling, post-planting, and flowering stages in the maintenance plots, and the susceptible types were progressively eliminated accordingly. The varieties which emerged as resistant in the screening tests in seedling stage were carried forward to the field tests.

Field Tests

The field tests were carried out for three successive years with the varieties carried forward from the screening tests.

In the seed-beds, the test varieties were again exposed to artificial infection; a week before transplanting, all the beds were covered with wet coarse cloth curtains on sturdy wooden framework to form $5' \times 8' \times 6'$ high humid chambers. Spore suspension, prepared from a culture of the fungus (Cuttack isolate) in oat-meal agar containing thiamine (0·25 mg. in 1,000 ml.) and biotin (0·015 mg. in 1,000 ml.) and incubated at about 25° C. for 7–12 days, was used for the artificial infection of seedling in the beds. Artificial infection was carried out for three successive days, late in the evening. The reaction of the varieties was noted after one week.

As has been stated earlier, heavy blast incidence could be induced in the field by late planting (after the middle of August) under adequate fertilization—60 to 80 lb. N/acre. In addition, the test varieties were flanked on either side with Co-13, a highly susceptible variety. The blast infection which developed severely on Co-13 constituted a heavy source of inoculum for the varieties under test.

RESULTS

Out of 490 varieties of early duration under tests, 149 varieties had been already tested and found susceptible in the first phase of this programme, *viz.*, in the years 1948–1953. The remaining 341 types are classified as shown in Table I.

TABLE I

Number of varieties tested and their classification in regard to their susceptibility to blast

Kind of tests	Number of types moderately susceptible to susceptible	Number of types moderately resistant	Number of types resistant	Number of types unclassified
1. In artificial inoculation test (1954 to 1958) seedling stage	214	..	..	..
2. Under field tests (1959 to 1961) (both foliar and neck-infection) ..	23	8	4	92
	237	8	4	92*

* These 92 varieties out of 341 types could not be classified, for the same were not tested sufficiently and, therefore, require to be tested in the next such series. The final reaction of these 92 types will be given in a subsequent communication.

The varieties finally selected as resistant and moderately resistant to blast are mentioned in Table II.

The list of varieties, classified into different susceptibility groups, is presented in Table III.

DISCUSSION

Due to the rigorous criteria adopted, and the elaborate procedure followed in carrying out the tests, only nine varieties, four in the present tests and five in the earlier series, could finally be selected as resistant to blast disease of rice out of more than one thousand varieties studied. As has been discussed in detail in the first communication, the reaction of a variety to both leaf and neck-infection has been taken into consideration in selecting for resistance. Amongst the varieties which emerged as resistant in the seedling stage tests, some continued as resistant to leaf-infection in the field, but showed various degrees of susceptibility to neck-infection. The opposite phenomenon, *viz.*, susceptibility to leaf-infection but resistance to neck-infection has also been met with by the senior author in other studies conducted with varieties drawn from all parts of the world.

TABLE II

List of varieties selected finally as resistant or moderately resistant to blast disease of rice

Sl. No.	AC No.	Type No.	Name of variety	Place of origin	Reaction
1	27	CH-27	Chang Ming Yunan	China	MR
2	28	CH-28	Si-Kong-Ya an (Red husk)	China	R
3	71	CH-71	Kaoshiung No. 18	China	MR
4	533	Jap-7	Aichi Asahi	Japan	R
5	1613	T-1446	Surli Black	S. Canara (India)	R
6	1771	T-1715	..	Belgian Congo	MR
7	1966	T-2009	..	U.P. (India)	MR
8	2082	..	Seluz 44	Australia	R
9	2250	T-6522	..	Coimbatore (India)	MR
10	2489	..	Nep-vai	Indo-China	MR
11	2565	T-1026	..	Coimbatore (India)	MR
12	2597	T-1160	..	Coimbatore (India)	MR

R—Resistant; MR—Moderately resistant; AC—Accession number.

Templeton *et al.* (1961), finding that there was a close correlation between seedling reaction and neck-rot in twelve varieties which they studied, have been led to the conclusion that testing for resistance could be based upon seedling reaction alone. Since such a correlation is more common than variability, the latter phenomenon may not occur when the reactions of a limited number of varieties only are taken into consideration.

Further work, done in Japan (R. Ito, 1963, Internatinoal Symposium on Blast Disease of Rice, the Philippines) and in Formosa (Taiwan) by Hashioka (1950), also shows that rice varieties do not react always in the same manner to leaf and to neck-infection. Therefore, it is very necessary to test

TABLE III

Reaction of rice varieties of early duration (120 days) of Genetic Stock to blast disease at C.R.R.I., Cuttack, during 1954–1961.

Place of origin	Resistant	Moderately Resistant	Moderately Susceptible	Susceptible
1. Andhra Pradesh	..	..	T. 1150 (Nellore), Nalla (Thakavadlu), Thatta-kottavadlu	SLO 16 (Kasipichodi), H.R. 67, H.R. 21, T. 894, Mottakar
2. Assam	..	..	T. 2058 (Assam 21), T. 2063 (Bengal 5), T. 2072, T. 2085	T. 623 (Tepi Dumai D. 138/2), T. 626, T. 639 (Lundumra), T. 2056 (Assam 19), T. 2057/1 (Assam 20/1), T, T, B, Cross 313–11, C. 203-3
3. Bengal	..	..	T. 657 (Patnai—Gosaba T. 230)	
4. Bihar	..	..		..
5. Bombay	..	..	Patnai-6, Waner-1	BR 17 T. 619 (Kolaba strain), T. 922, T. 924 (Jana paddy), Koda 68–1, Khare Bhat
6. Kashmir	..	..	It. 8	Aust. 370, Japani 1138
7. Kerala	..	..	T. 239 (Chamban), T. 240 (Salem Chamban), T. 247 (Kasturi Kazhma), T. 1357, T. 1457 (Mundaga Champan), T. 1452	T. 10 (Kochuvithu), T. 246 (Arupatham), T. 249 (Potta Modan), T. 251 (Navaranethi), T. 253 (Potta chornal), T. 1344 (Chuvannvathan, T. 1351, PTB, 28 (Kattamodan), T. 1829, T. 2012, T. 2015

TABLE III (*Contd.*)

	Place of origin	Resistant	Moderately Resistant	Moderately Susceptible	Susceptible
8.	Madhya Pradesh	..	..	Safeda (Kotah)	T. 23 (Safeda), T. 1687 (Surmatia), T. 1690 (Ajan), Safed Dhan, R_2 (Nungi No. 17), No. 13, Central Farm, Ujjain
9.	Madras	..	AC. 2565 (T. 1026), AC. 2597 (T. 1160), AC. 2250 (T. 6522)	T. 499, T. 522 (Vellai kuruvai), T. 1198, T. 1213 (Pavitram samba) T. 1704, T. 2107, T. 2108, Rascadam, Uvar kondan, T. 991	T. 115 (Extracted at Coimbatore), T. 418 (Arupathum Kuruvai) T. 480 (Vari samba), T. 482 (Panamara samba), T. 181 (Arupatham vellai), T. 182 (Sornavari) T. 186 (Thathan samba), T. 127 (Early Kuruvai), T. 257 (Avasara samba), T. 385 (Gorkondaro), T. 399 (Sarapalli samba), T. 407 (Malayalatham samba), T. 487 (Chitrakali), T. 504 (Mapilai samba), T. 508 (Jhooyare), T. 525 (Veral samba), T. 921 (Arubatham samba), T. 1200 (Kuthalai), T. 1155 (Vaddan samba) T. 1274, T. 1483 (Salem No. 3). T. 1488 (Anaikomban), T. 1494, T. 1498 (Kattai samba), T. 1507 (Sanna vathan), T. 1738 (Swarna-

					vari), T. 1770, T.K.M. 3 (Sornavari), T. 960 (Extracted), T. 1230, Thellathokka vadlu, ASD 8, ASD 9
10.	Mysore	AC. 1613 (T. 1446-Surli Black)	..	..	T. 18 (Kaptasannbatha), T. 25 (Gangasalabatha), T. 292 (Sirang), T. 690 (Kemburja), T. 1151
11.	Orissa, C.R.R.I.	..	..	T. 1278, T. 1516, T. 1525, T. 1519, T. 1727/1, N×60 (Beali) Natural cross	T. 1518, T. 1520 (Bawupur), T. 1521 (Asini chitta), T. 1524, T. 1284 T. 73–8, B. 76–116, N. 136
12.	Punjab	..	..	T. 647 (Jhona), T. 882, T. 883	
13.	Uttar Pradesh	..	AC. 1966 (T. 2009)	H. 287/1 (Nagina), N. Ch. 2, N. Ch 11, No. Ch 1	T. 2018, T. 2019, T. 2024, T. 2029, Surkarcha, Rambhog II, H. 162/1, H 42/4, Dudhahsn, H. 262/1 S. 78 (Gajgaur), S. 112 (Mutri), S. 114 (Bhanli red), S. 120 (Bhanli), H. 64
14.	Australlia	AC. 2082 (Seluz 44)	..	..	..
15.	Belgian Congo	..	A. 1771 (T. 1715)	T. 1718	..
16.	Brazil	..	..	T. 1654 (Cotetas)	..
17.	Burma	..	..		T. 282 (Mo Myawtol), T. 337, T. 2992
18.	Ceylon				E.K. 70 (Raja Mundri)
19.	China	..	AC. 27 (Ch. 27) (Chang Ming Yunan)	Ch. 69 (Tainong No. 38), Ch. 75 (Taichung No. 65) T. 954, T. 972, T. 973, T. 982, T. 985 (Kwing Yang Tsaw), T. 989,	Ch. 79 (Taiwan variety), T. 956, T. 957, T. 968, T. 969, T. 971, T. 974, T. 976, T. 978/1 (Igangmia)
			AC. 28 (Ch. 28)	T. 990, T. 1002, T. 1003,	T. T. 979, T. 980, T. 987, T. 988, T. 993, T. 999, T. 1000,

TABLE I (*Contd.*)

	Place of origin	Resistant	Moderately Resistant	Moderately Susceptible	Susceptible
			(Sikong Ya-an Red husk), AC. 71 (Ch. 71) (Kaoshiung No. 18)	T. 1009, T. 1010, T. 1020, T. 1023, T. 1030, T. 2112, T. 2114, T. 2115, T. 2116 (Ning-Sai Sia Tao), T. 2120 (Shengrdi-Seiro), T. 2121 (Kwei-chow 28), T. 2125	T. 1004, T. 1006, T. 1007 (Siao-Pa-Kuo), T. 1011, T. 1018, T. 1021, T. 1027, T. 1028, T. 1031, T. 1032, T. 1033, T. 1038, T. 1042, T. 2111, T. 2118, T. 2122 (Tsan Hus 4)
20.	French West Africa (Niger Segon)	..	..	T. 697 (Sikaso)	
21.	Indo-China	..	..	AC. 2489 (Nep-vai)	
22.	Iraq (Consul)	..	..	T. 1815	T. 1820 (Naima)
23.	Italy	..	..	T. 730 Early wright	T. 1665, T. 1680, T. 1682
24.	Japan	..	AC. 533 Jap 7 (Aichi-Asahi)	Jap 4 (Aikoku), Jap 8, (Norin 1), T. 1985 (Japan 11)	T. 1979 (Japan 3), T. 1980 (Japan 4), T. 1986 (Jap 12), T. 1993 (Jap 19)
25.	Nigeria	..	..	..	Farin Iri
26.	Portugal	..	..	E.A.N. No. 6	Precoce-6, Chines, Ardizzone, E.A.N. No. 4
27.	Russia	..	..	T. 911/1	T. 899
28.	South Africa	..	..	..	D.S. I
29.	U.SA.	..	..	T. 1158, Canilla (Commino)	U.S.A. I (C.I. 1645), T. 727 Magnolia

for both leaf- and neck-resistance to blast before a variety can be turned as "resistant" and released for cultivation.

Summary

1. Screening tests were carried out with 490 early duration varieties to isolate varieties resistant to blast disease of rice.

2. On the basis of the reaction of the varieties in the seedlings, post-transplanting and neck-infection stage, four varieties have been selected finally as resistant and eight as moderately resistant to blast disease of rice.

Acknowledgements

The authors are grateful to the field staff of Mycology Section for their help in carrying out the field tests and to the Director, Dr. R. H. Richharia, for his critical suggestions in the preparation of the manuscript.

References

1. Hashioka, Y. .. "Studies on the mechanisation of prevalence of the rice blast disease in the tropices," *Tech. Bull. No.* 8. *Taiwan Agric. Res. Inst.* Taipeh, China, 1950.

2. Kulkarni, N. B. .. "Blast disease of rice in Bombay State," *Poona Agric. Coll. Mag.*, 1959, **50** (1), 8–29.

3. Mathur, R. S. and Misra, M. P. "Resistance of paddy varieties to blast in Uttar Pradesh," *Curr. Sci.*, 1961, **30** (7), 272–73.

4. Padmanabhan, S. Y. and Ganguly, D. "Breeding rice varieties resistant to blast disease caused by *Piricularia oryzae* Cav. I. Selection of resistant varieties from Genetic Stock," *Proc. Ind. Acad. Sci.*, 1959, **50 B**, 289–304.

5. Templeton, G. E., Johnston, T. H. and Henry, S. E. "Rice Blast," *Rice Journ.*, 1961, **64** (4), 16.

6. Venkatakrishnayya, N. S. and Delvi, M. H. .. "Blast on rice in Mysore. Varietal behaviour of rice towards *Piricularia oryzae* Cav.," *Rice News Teller*, 1960, **8**, 1–15.