16. BREEDING OF RICE FOR RESISTANCE TO MAJOR DISEASES IN EAST PAKISTAN

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Introduction

When I received an invitation from Dr. Iwata, Convenor of Symposium on rice diseases and their control to be held in Tokyo, in September 1967, I accepted, not because I had much to contribute in this field, to acquire a good deal of first hand information on this important aspect of rice culture and to present our problems so that the developed countries could assist us with their experiences as we are just beginning to work in this field. Although rice is the major crop and grown throughout the year on various land situations and under irrigated and non-irrigated conditions, little attention was given to its improvement in the past and practically no importance was given to diesease problems. This lack of attention for adequate research was due, perhaps, to the country being self sufficient and more attention was given to export crops. The problem of rice disease was never thought to be acute as the innumerable small farmers were growing large number of indigenous varieties suited for their lands of low productivity. With the introduction of improved varieties, irrigation, fertilizer, insecticides and multi-cropping, the problem of disease is becoming more serious.

The major diseases of the past are becoming minor ones and the past minor ones are becoming the major ones. All diseases so far found which affect rice plants are described in this paper. In view of the Socio-economic the use of resistant varieties can hardly be over emphasised. The control of diseases by chemicals is neither easy nor so effective and as such the only acceptable remedy for disease control is to develop resistant varieties. The problem of breeding a resistant variety is not, however, a easy one. Lately the Govt. has realised that rice improvement needs to be undertaken more seriously and with this intensification, the prospect of obtaining disease resistant varieties is of much better. The experience gained in advanced countries and especially in Japan and IRRI will be liberally utilised in this country. The growing conditions of rice and the various rice crops which are grown are described before the problems of diseases are discussed in order to present the general picture of rice culture in Pakistan. The recommended measures for control of diseases will be described.

Geographical Position

East Pakistan is situated between 20.5°N and 26.5°N latitude and 88.5°E and 92.5°E longitude. It is a flat deltaic plain built up by the deposits of fertile silts of three mighty rivers, the Ganges, Meghna and Brabmaputra which originate in the Himalayas. The southern part of the prpvince near the sea is swampy and covered with mangrove forests. Sea water enters 100 miles inland which results in salinity problems.

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Climate of East Pakistan

The average annual rainfall ranges from "80-140" in different districts. The rainy season extends from April to October and very little rainfall occurs during November-December, January and February. The main crops rice, jute, sugarcane are grown during the monsoon period. Rice cultivation is expanding rapidly in the dry season with the introduction of artificial irrigation. The level of the water in the rivers begine to rise in May and reaches the peak in August; about 20 feet deep flooding more than 2/3rd of the country and from October onward, the water recedes. The flood waters are due to melting snow in the Himalayas and aboundant rainfall in the plains during the summer months.

The temperature in East Pakistan varies from a minimum of 40°F to a maximum 100°F, with an average of 75°F. The high temperature is favourable for luxuriant vegetative growth of plants and especially in rice. The temperature in December and January which is below 50°F is too low for fertilizatron of grains and good growth of seedlings.

Rice Crops of East Pakistan

Four distinct sizeable rice crops are grown in a year. They are Aus. Aman. Boro and Floating paddy. The approximate area under these classes of paddies are as below:

Aus	5.5 million acres.
T. Aman	9.5 million acres.
Floating rice	5.5 million acres.
Boro rice	1.5 million acres.

The 4 rice crops are classified according to their distinctly different characteristics. The characteristics of each of these crops are summarised as follows:

1. Aus

These are fixed-period, photo insensitive varieties which mature in 80-100 days. Although they can be grown the year round, best yields are obtained when sown in the period from March to May. In otherwords, they are thermo-sensitive and perform best under summer conditions. They are sensitive to cold climate. The colour of the kernel in general is red with few exceptions. They are also awnless.

2. Transplanted Aman:

A large number of varieties are used in this group and most of them are fine and white. They are photosensensitive and flower only when the day length is less than 12 hours in the month of October. They however, react to photo induction and flower in the Boro season in Aprill if planted in October-November. They are not highly sensitive to thermo-periodicity.

3. Floating Rice

These are long stemed awned varieties of rice with red kernels, are grown in areas where the land floods from 5-12 ft. deep during the summer. The stem grows, extends as the water rises to the extent of 1 foot a day for a short period during the rapid rise of water. They can cope with rapidly rising water due to their floating charateristic, provided the plants are of at least 6 weeks age. They are sensitive to photoperiodism and flower during short days. They also react to photo inducting the Boro season (November-April) similar to Transplanted Aman.

4. Boro

In some ways these varieties are similar to Transplanted Aman. Both red and white kerneled rice belong to this class of rice. They are mostly awnless but there are awned and awn tipped varieties. They can be grown as T. Aman but perform best in the season they are grown. They are adapted to cold climate.

5. Indigenous Rice

Indigenous varieties as described above, are very variable as they are grown in four defferent seasons and in various situations of land and under different climatic condition. They all belong to the indica race of rice.

6. Introduced Varieties

In recent years, japonica varieties have been intoroduced from Japan, Taiwan and elsewhere. Some of these varieties are now being grown successfully in the Boro season (Nov.-April). Norin 1, Riku-u 147, Foku-Bozu, Yabani M-47, Taipei 177, Taiwan 3 and Chianung 242 are some of the varieties that grow well in this season. They can also be grown with moderate success in Aus season.

IRRI selections have also been introduced in large numbers and are being tested for their suitability in different seasons. The selections IR8-288-3 and IR9-60 are being grown on large scale. Some IRRI strains appear to have desirable plant types for high yield and other characters. So far, these two selections have been found to perform best in Aus and Boro season and moderately well in Aman season. Other selections from the IR5 group appear to be suitable for Aman season are being rapidly multiplied for further observation and possible commercial production.

7. Indica × Japonica Hybrid

Under the auspices of the Inteinational Rice Commission of F.A.O., indica-japonica hybridization programe was undertaken in the early fiftys by almost all South-East Asian rice growing countries. Pakistan participated in this programme and T. Aman and Aus varieties were hybridised with Japonica paddies. In early years the hybrid lines showed good promise but later on failed to maintain their superiority.

History of Rice Breeding

Rice breeding in Pakistan was begun in 1911 by a botanist and 2 assistants. They worked on the improvement of two major rice crops, Aus and Transplanted Aman rice. The objectives were primarily for high yield in both these groups of rice. However, there were specific objectives which are ennumerated as below:

Aus:
(1) High yield.
(2) Earliness in maturity.
(3) Drought resistance.
(4) Lodging resistance.
(5) Flood resistance.

T. Aman:
(1) Hight yield
(2) Good grain quality.
(3) Lodging resistance.
(4) Earliness.
(5) Resistance to pests and diseases.
(6) Resistance to salinity.

Improvement on floating rice and boro rice was begun in 1934. A Research Assistant and a sub-station was provided for this purpose. The objectives for breeding are as follows:

Floating rice:
(1) Tolerance to flooded conditions.
(2) Yield.

Boro:
(1) Yield, (2) Earliness,
(3) Low temperature tolerance.

Breeding for Response to Heavy Manuring

Although Japan has carried out breeding under heavy manuring for the past 60 years

or more and has been able to increase rice yield per unit area, this has been ateempted in Pakistan for the last 10 years only. This resulted in the introduction of japonica varieties from Japan, Taiwan and elsewhere for the Boro season. They did not spread widely due to the rapid loss of viability. Japonica seed loses viability within 2 months under humid tropic condition. The characteristics of the cooked rice make them not readily acceptable to the people. They are also difficult to thresh. Indica × Japonica hybrids were made to overcome these defects, but this project did not achieve a high degree of success. Breeding for varieties that will give increased production under heavy manuring has been carried on since 1966 with the introduction of IRRI material. This project is showing good results to-date. The objective of good plant type and fertilizer response which were being looked for in the indica × japonica hybrids have now been materialised in the IRRI lines.

Rice Diseases

Hot, humid climatic conditions are favourable for development of various plant pathogenic organisms of Fungi, Bacteria and nematodes. The rice crop is attacked and damaged by many diseases. It is estimated that the annual loss from diseases alone may vary from probably more than 5-10% a year. Rice diseases which have been reported to occur are listed in the table below:

Name of diseases	Causal organism	Parts affected
1. Blast	*Piricularia oryzae* Cav.	Leaf, Neck, Ear & Grain
2. *Helminthosporium* leaf spot, Brown spot or *Helminthosporiose.*	*Cochlioholus miyabeanus* (Ito et kuribayashi) Drechsler ex Dastur=*Helminthosporium Oryzae*	Leaf, leaf sheath and Grain.
3. Ufra	*Ditylenchus angustus* (Butler) Filipjev.	The sheath enclosing the emerging ear and grain.
4. Stem rot	*Sclerotium oryzae* Catt.	Leaf sheath and Stem.
5. Sheath blight(Oriental sheath and leaf spot).	*Pellicularia sasakii* (Shirai) S. Ito=*Coricium sasaki* (shirai) Matsumoto	Leaf sheath & leaf.
6. Foot rot or Bakanae.	*Gibberella fujlkuroi* (Saw) Woll=*Fusarium monili forme* Sheld.	Stem base and Grain.
7. Bacterial leaf Blight.	*Xanthomonas oryzae* (Uyeda et Ishiyama) Dowson.	Leaf.
8. Pan=sukh	Physiological	Leaf & Roots.
9. False smut	*Ustilaginoidea virens* Tak.	Grain
10. Stackburn	*Trichoconis padwickii* Ganguli.	Leaf & leaf sheath.
11. Narrow brown leaf spot.	*Cercospora oryzae* Miyake=*Sphaerulina oryzae* Hara.	Leaf.
12. Leaf smut	*Entryloma oryzae* H & P Sydow	Leaf.
13. Leaf and Grain spot.	*Curvularia lunata* (Wak) Bold.	Leaf & Grain.
14. Tungro	Virus	Leaf.
15. Yellow dwarf	– do –	– do –
16. Grassy stunt	– do –	– do –
17. Bunt	*Neovosia horrida* (Tak) Padwick & Azmat.	Grain.
18. Bacterial leaf streak.	*Xanthomonas translucence* f. sp. *oryzae* Pordesimo.	Leaf.
19. Minute leaf & Grain spot.	*Nigropsora oryzae* (B & Br.) Petch.	Leaf & Grain
20. Grain spot	*Phoma glumarum*	Grain.

1. Diseases caused by Fungi.

(1) Blast disease

This disease, which was negligible in the past, is becoming more prevelent in recent years with the use of commercial fertilizers. It is found in Aus, T. Aman and Boro rice but more in T. Aman perhaps because of favourable climalic condition for pathogens. There is a possible correlation between the doses of application of N and the incidence of this disease. Experimental evidence shows that with 30, 60, 90 & 120 Ibs. N the yield decreased from 18 to 60 per cent due to the increase in disease.

(i) Varietal resistance.

Fine, small grained, scented varieties have been found to be highly susceptible to neck blast and comparatively resistant to leaf blast. International uniform blast nursery tests have been conducted several times in different seasons and centres and over 800 varieties have been screened so far. Local Aus variety Kataktara have been found to possess a wide range of resistance to the existing races of blast.

Aus varieties Hashikalmi, Marichbeti and Panbara have also been found to be moderately resistant to the existing races.

Although some of the local varieties were seriously affected at the seedling stage, IR8 had moderate infection only. Similarly when a number of scented and other local varieties suffered from neck rots to the extent of 20—30%, IR8 escaped infection.

(ii) Control measures suggested.

Resistant varieties.

(a) Pre-sowing treatment of seeds with Granosan 'M' or Agrosan 5W @ 1 oz. per 80 1b. of seeds.
(b) Balanced fertilization.
(c) Clean cultivation.
(d) Burning stubles of the affected field in situ.

(2) Brown spot or *Helminthosporium* diseases.

This is the most common and one of major diseases in East Pakistan. It occurs in all classes of rice every year. In living memory it only occured in severe epiphytic form once in 1942—43 causing considerable crop failure resulting into severe famine in 1943. Common belief prevailed to the mass that Japanese army stationed in Burma spread this disease although there is no truth in this.

(i) Varietal resistance.

All local T. Aman varieties and collections have been found to be susceptible to this disease. 28 purelines out of about 418 Aus lines showed different degrees of resistance to the disease either in leaf or grain infection or in both. A list of these varieties is shown in the table below. There is arelation between the degree of leaf infection and grain infection.

(ii) Control measures suggested.

Seed treatment with Granosan M or Agrosan 5W, 1 oz. per 80 1b. of seeds.

(a) Resistant varieties (most practical)
(b) Adequate fertilization.
(c) Good management i.e. weeding, irrigation, etc.

(3) Stem rot.

This disease has been found in severe forms only in Transplanted Aman and floating rice. Aus rice grown in stagnant water have also been found to be infected by this disease.

(i) Varietal resistance.

Several varieties have been reported to be resistant to this disease. However, no detailed screening test has so far been made.

Comparative leaf and grain infection of different varieties of Aus paddy due to Brown spot disease.

Collection No.	Name of variety	Percentage of Leaf infection (average age of 3 yrs.)	Percentage of Grain infection (Average of 3 years).
534	Hanumanjata	37.9	19.5
774	Surjamani	52.8	32.3
916	Fara-paranji	53.4	22.4
783	Parangi	65.9	43.8
727	Gangajali	56.2	58.0
745	Roachita	68.6	54.0
880	Gaira	64.5	20.2
538	Palgar	74.0	45.4
691	Nagra 11	73.3	43.9
817	Sukiraj	68.7	32.2
744	Kurachina	69.9	46.5
809	Maishurah	69.8	27.8
919	Tara Aus	67.7	33.3
520	Jamira	71.9	22.8
773	Saita	76.6	35.6
460	Kahaniamaja	73.7	17.7
787	Krishnasaita	76.6	23.2
470	Parang Dhan	80.0	32.6
681	Kathidumra	84.3	29.2
605	Begunbichi	75.9	56.3
658	Chandra-chapa	84.0	37.0
882	Matichak	81.2	26.3
621	Chengamagura	81.9	39.7
668	Manikmadhu	82.1	29.2
637	Dharia II	89.0	22.1
795	Jali	92.6	21.2
457	Mahishlama	83.0	61.3
662	Shibjota	100.0	44.1

(ii) Control measures suggested.

(a) Resistant varieties (most practical).

(b) Drainage.

(c) Stuble burning.

(d) Balanced fertilization.

(e) Crop rotation.

(4) Sheath blight.

This disease caused by Fungus *Pellicularia filamintaceae* appears to be influenced by nitrogenous fertilizers. It has been in severe form in IRRI collections and some of the local transplanted Aman varieties. No systematic screening has yet been undertaken.

(i) Control measures suggested.

Resistant varieties (most practical)

(a) Drainage

(b) Stuble burning
(c) Balanced fertilization
(d) Crop rotation

(5) Foot rot or Bakanaeae disease

This disease has been found so far to occur in Transplanted Aman rice only and in localised areas. No work has been done to isolate resistant varieties. Seed treatment is being recommended.

2. Diseases caused by Nematodes.

This disease affects deep water paddy of few districts where the water is stagnant.

(i) Variatal resistance

Screening of variety resistant to this disease has been started. Wild paddy-*Oryza sativa* var fatua and about 10 varieties have been found to escape this disease to a certain extent.

(ii) Control measures suggested

Resistant varieties
(a) Stuble burning
(b) Clean cultivation
(c) Drainage
(d) Rotation

3. Diseases caused by Bacteria.

(1) Bacterial leaf blight caused by *Xanthomonas oryae.*

This disease has been observed for the first time in East Pakistan in IRRI rice collections and some of the local improved varieties. The nature of the disease shows that it may be a serious one in course of time. Nizersail Taipai 177 and few selections of IRRI crosses, namely BPI-76 × KH68 and CP231 × Kh68, showed resistance.

(2) Bacterial leaf streak.

This disease has also been identified to be present in East Pakistan for the first time in 1966. At the moment it is not so serious.

4. Disease caused by viruses.

The following virus diseases have been observed in East Pakistan and some of them appear to be quite new although others have been observed in the past.

(1) Tungro
(2) Yellow dwarf
(3) Grassy stunt

Local varieties appear to be resistant to these disease to a great extent.

5. Physiotogical disease

(1) Pansuk disease

This has been found in T. Aman in stagnant water. No varietal resistance work has been studied on this disease.

6. Disease complex

In recent years continuous cropping of rice on the same land day after day throughout the year and year after year under wet condition are being practised in certain area of the province especially where irrigation facilties have been introduced. Three rice crops are grown and fields do not dry properly at any time of the year. Under these conditions, rice plants suffer from a disease complex leading from partial loss to complete failure of crop. The diseased plants are characterised by drying of leaves from tip, tip burning, supression of tillering, death of tillers, yellowing of leaves, lesions, on leaves, nonemergence of ear heads and sterility of grains.

The remedy is to grow two rice crops and to have rotation with crops other than rice and to dry the field from time to time.

Study on IRRI Varieties Reaction to Blast and Blight

Varietal resistance to disease has been well established in many countiies. Resistant varieties have been identified and are being utilised to increase rice production. Varieties showing a high degree of resistance do not necessarily give high yield and so hybridization programmes are undertaken to obtain high yielding resistant strains. Systematic studies on screening for Blast resistance in IRRI materials and local varieties have been carried out at the seedling stage at two stations. The results are summarised in tables below. Similar studies have also been made on blast and blight infection at the flowering stage at three stations. These studies are rather exploratory in nature, made at the suggestion by IRRI. They however, reflect the behaviors of varieties towards infection at various stages. These studies are helpful in identifying the reaction of the diseases to different varieties.

Table 1.
Blast reaction at seedling stage at Barisal Farm.
1. Scales of infection.

Use of Varieties	1	2	3	4	5	6	7	Total
	27	70	50	37	12	10	6	212

2. Blast infection Rating at seedling.

Scale Unit	Type of Resistance.	No. of varieties in 3 sets of materials.			
		1st.	2nd.	3rd.	Total
1.	HR	1	3	0	4
2.	R	88	166	24	278
3.	MR	88	67	15	170
4.	MS	41	26	7	74
5.	S	19	22	11	52
6.	VS	8	13	3	24
7.	VS	1	1	0	2

Ratings: 1. HR— High resistant.
2. R — Resistant.
3. MR— Medium resistant.
4. MS— Medium susceptible.
5. S — Susceptible.
6. & 7. VS–Very susceptible.

Table 2.
Reaction to blast and blight at flowering stage and later on at 3 farms.

Name of the farm	Blast				Blight			
	R.	M.S.	S.	H.S.	R.	M.S.	S.	H.S.
Savar Farm	300	26	9	Nil	250	77	23	19
Comilla Govt. Farm	384	Nil	Ni 1	Nil	53	76	62	194
Abhoy Ashram Farm (comilla)	188	Nil	1	Nil	13	26	57	92

Note: R= 0—20% Plant infected.
M.S=20—40% 〃 〃
S=40—60% 〃 〃
H.S.=60—100% 〃 〃

Conclusion

An account of the culture of rice crops and steps taken for improvement have been stated. The diseases, so far, observed to occur, have been described. Limited work, so far done, on varietal resistance has been described. It has been of very preliminary nature and mostly for screening the reaction of the diseases to the varieties. A couple of decade ago there were 3 diseases of rice, recognized namely *Helminthosporium* disease, Nematode disease, and stem rot disease which occured in sizeable amount. In recent years however, a no. of other dieseases have been observed in great magnitude. They are namely blast, bacterial leaf blight, physiological diseases and viruses. It is high time that steps are taken to breed resistant varieties in order to stabilise the yield.

The accout of work on disease problems and varietal resistance will reveal that work has just been started in this respect and it will be intensified in the near future. Assistance from developed countries will be gratefully accepted to solve the disease problems in the country and get workers trained in the field.

Discussion

K. Fujii, Japan: At present, what are the major problems in breeding resisitant varieties for major diseases in your country?

Answer: Problems are (1) Lack of trained personals and facility for carrying out inoculation artificially and to study the reaction of different races of various organisms which cause diseases.

H. Oka, Japan: Certain modern varieties, such as IR8 and Ponlai's have a wide adaptability and can generally be grown in the wet (Aman) and the dry (Boro-Aus) seasons. Under the condition of your country, do you think that the same varieties can be grown in different crop-seasons?

Answer: IR8 can be grown as Boro and Aus successfully and Ponlai as Boro only when grown in other season yield goes very low.

H. Ito, Japan: You insist upon the difference in the loss of germination ability between japonica and indica. But I think it is dependent upon difference in the moisture content of seed and temperature at the harvesting time.

Answer: The loss as of viability by the japonica varieties have been observed by us year after year, although they were equally dried like the indicas. One of the reason we ascribe is the thin seed coat of japonica paddies. Moisture content is certainly not the reason for loss of viability of japonica rice.

Comment by B.H. Siwi, Indonesia: On page 203 Alim mentioned that fine, small grained scented varieties are suseptible to neck blast and comparatively resistant to leaf blast. I wonder if any of the participants has detected correlations between resistance or susceptibility to certain morphological characteristics.