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THE CONTROL OF THE CHIEF DISEASES OF RICE AS A MEANS OF INCREASING PRODUCTION

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Introduction: Though no organised survey of the diseases of the rice crop has been made on an All-India basis, and an estimate of the losses caused in the country computed with any degree of accuracy, it may be safely asserted from the experience gained in the Madras province during the last two decades, that India loses annually nearly a tenth of her potential produce from the ravages of fungus diseases. The number of diseases recorded in India are many. Some occur in a chronic form causing what would appear to be negligible losses from the individual cultivator's point of view, but which considered in the aggregate are responsible for the loss of several thousand tons of rice per year. Remedial measures for such diseases are either unknown or uneconomic. Other diseases not so negligible from the individual cultivator's point of view fall in a different category. These break out periodically in an epiphytotic form. The epidemic spreads with great rapidity from field to field over extensive areas involving several thousands of acres often causing losses ranging upto 80 per cent of the crop. It is the control of this category of diseases that holds out promise of a substantial increase in the production of rice withiu the country. An attempt is made in this paper to recount the salient features of the study of two major diseases of the rice crop and to outline proposals for preventing such extensive losses as are incurred by individual cultivators.

THE MAJOR RICE DISEASES IN SOUTH INDIA.

I. 'BLAST' OF RICE

By far the most important disease in South India is the 'blast' disease caused by the fungus, *Piricularia oryzae*. This disease is of world-wide occurance and is reported to be of great economic importance in Japan, Italy, Bulgaria, the Philippines and Louisiana. It is not known, what losses it causes in other rice-growing countries like Burmah, Siam, China and Indo-China. In India, the disease has been recorded in Madras, Bengal, Bihar, Orissa, the Central Provinces, Mysore and Coorg.

In South India, the first record was from the Tanjore District in 1918. McRae (1918) computed the loss in an infected locality in the Tanjore District at 69 per cent of the crop. The disease has since been found to have spread throughout the rice-growing areas of the province. The intensity of the disease, however, varies from place to place and from season to season depending on various factors which influence the multiplication and spread of the inoculum. The chief factors are (1) the susceptibility of the variety of rice grown (2) the weather conditions at the heading period of the crop and (3) the nitrogen-status of the soil. In certain tracts where the varieties grown are very susceptible to infection, the disease periodically breaks out in an epidemic form during the cold weather months—December to February during which the mild sun and dewy nights are favourable for the development and spread of the disease. Such is the case in Nellore, Tanjore and Chittoor districts where the disease is a serious limiting factor in rice-production. In tracts where the favourite varieties happen to be less susceptible or more tolerant to the disease, the loss on account of 'blast' varies from almost nothing to about 25 per cent depending on the weather conditions experienced at the heading stage.

Results of Investigations: McRae isolated *Piricularia* from some cereals and wild grasses besides rice and made studies on their morphology and pathogenicity. He found that the isolate from rice, ragi *(E. coracana)* and the grass *Panicum repens* would not infect one another though all these isolates are infective on wheat, barley and oats. The ragi isolate was infective on Italian millet and *vice versa*. More precise work subsequently done has however, shown that the fungus on *Panicum repens* does go to rice. Two other grass hosts *Digitaria marginata* and *Dinebra retroflexa* have since been found infected with the rice strain of *Piricularia*. Of these three hosts, *Panicum repens* is found as an ubiquitous grass on the field bunds in all rice growing areas and whose growth the cultivators encourage for its soil-binding qualities.

Nature of the Disease: The disease attacks the rice plant in all stages of growth from the nursery to the earhead stage. In the nursery, affected seedlings wither and die. This is the one stage in the life cycle of the crop in which direct control measures like the application of fungicides are feasible. Experiments in Madras have shown that spraying of nurseries with Brodeaux mixture and the dipping of the aerial portion of the seedlings in Bordeaux mixture at the time of transplanting

are effective. But the major problem of blast control occurs in the transplanted field. The fungus first attacks the leaves where the inoculum is multiplied and eventually attacks the culm, branches of the panicle and individual glumes, depending on the tolerance of the variety to the disease. On the culm the disease manifests itself in the nodes and the 'neck' or base of the panicle arresting the flow of nutrition to the earhead. Infected nodes and neck turn black and necrotic. The glumes fail to get filled and become chaffy.

Control Measures: Mention has already been made of the feasibility of fungicidal application in the nursery stage of the disease. But this represents only a fringe of the problem. Such measures are impossible in a transplanted crop which runs to over 8 million acres in Madras province alone. Realising the futility of direct control measures, Thomas (1930) initiated the study of varietal resistance. Since then over 250 cultures of rice, 33 of which were obtained from parts of India, outside Madras, were tested for their relative resistance to 'blast'.

The following table is typical of the wide range of susceptibility to the disease. It also shows that only one variety is completely resistant to 'blast'.

TABLE I:— *Relative resistance of 30 strains of rice (Average of 4 seasons.)*

S. No.	Name of variety.	Percentage of incidence.	S. No.	Name of variety.	Percentage of incidence.
1	Co. 1	18·4	16	Adt. 8	13·4
2	„ 2	26·0	17	„ 10	48·3*
3	„ 3	19·1	18	„ 11	21·5
4	„ 4	....	19	„ 13	11·7
5	„ 8	13·7	20	„ 18	24·2
6	„ 11	10·3	21	„ 19	34·7
7	„ 13	30·9	22	„ 21	11·6
8	„ 15	8·7	23	„ 22	11·9
9	„ 16	9·4	24	Ptb. 4	12·9
10	„ 19	17·2	25	„ 16	7·5
11	Geb. 24	16·6	26	Mtu. 15	10·2
12	Adt. 2	18·5	27	„ 9	15·7
13	„ 3	45·3	28	Ban. 6	16·9
14	„ 4	21·8	29	„ 9	11·2
15	„ 6	8·9	30	„ 12	10·0

* Control variety.

TABLE II:— *Showing the list of cultures that remained highly resistant to 'blast' Pirirularia oryzae neck infection consistently during the four years of trials, in Coimbatore under experimental conditions.*

S. No	Variety.	Duration in days.	No. of years tested.
1	2	3	4
1	Co. 4	180 Long	4
2	Co. 16	180 Long	4
3	Ptb. 16	155 Medium	4
4	1979	187 Long	4
5	2364	190 Long	4
6	2380	186 Long	4
7	2496	186 Long	4
8	2501	186 Long	4
9	2507	173 Long	4
10	2552	190 Long	4
11	2554	190 Long	4
12	2555	190 Long	4
13	2713	181 Long	4
14	2744	189 Long	4
15	3185	185 Long	4
16	3273	190 Long	4
17	3381	183 Long	4
18	3458	189 Long	4
19	3635	190 Long	4
20	3820	180 Long	4
21	3839	180 Long	4
22	3840	175 Long	4
23	3883	172 Long	4
24	3892	175 Long	4
25	3941	173 Long	4
26	4067	169 Long	4
27	4070	169 Long	4
28	8036	183 Long	4
29	8037	180 Long	4
30	8348	183 Long	4

In the earlier years two cultures viz., Co. 4 and G. E. B. 24 both strains evolved by the Paddy Specialist, Madras, were found to be highly resistant. Subsequent work has, however, shown that while Co. 4 has proved to be consistently immune to blast under all conditions of cultivation, the apparent resistance of G. E. B. 24 was not a reliable factor. It breaks down under certain conditions such as the excessive application of nitrogenous manures. Both these strains were utilised by the Paddy Specialist, Madras, for hybridisation with susceptible varieties of rice and several 'blast' resistant cultures have been evolved.

The replacement of a susceptible strain with a resistant one is no easy problem in rice. The widely divergent conditions of soil, climate, seasons, cultivation practices, duration of varieties and availability of water supply, render it necessary to have a very large number of varieties which are suited to each tract. Cosmopolitan varieties which would thrive under a variety of conditions are almost unknown. Added to this, prejudices die hard. The grower, accustomed during several years to one or two varieties in his tract, would not give them up for another which shows even slight difference in grain size, colour, milling and cooking qualities. In extreme cases he insists even on the particular colour of the glume (husk) which has little or nothing to do with the market value of his produce. So the problem confronting the breeder is not merely the substitution of a resistant strain for a highly susceptible one, but the most complicated and prolonged process of producing strains which had all the agronomic and morphological characters of the old favourities with 'blast' resistance superimposed on them. With the paucity of suitable varieties to be used as resistant parents, the need for evolving resistant varieties to suit various tracts, and the fastidious demands of growers, the task of the breeder was colossal. Nevertheless, it must be said to the credit of successive Paddy Specialists in Madras that they set their heart to this difficult problem and with the colloboration of the Mycologist who subjected all promising material to the most rigorous tests, have succeeded in evolving several disease-resistant strains during the space of about 20 years of intensive work. These strains which are highly resistant to 'blast' disease even under the most adverse conditions and which are otherwise good yielders are ready for release. But the distribution of these over long areas in the normal course would take several years as long as the grower is given the utmost freedom to take them or reject them. It is therefore suggested that in order that the remarkable achievement of the Madras Agricultural Department may bear quick results, a system should be evolved by virtue of which 'blast' resistant strains of paddy are grown exclusively in all those tracts where the disease is known to occur in an epiphytotic form. If this policy is adopted, the freedom vested with the grower to choose his own variety will be restricted to the range of about half a dozen resistant cultures which are now available for multiplication.

Multiplication of Resistant Strains: The immediate need is to multiply these resistant strains. If a start is made with 20 acres

of 'seed farm' it is estimated that at the end of three years enough seed could be produced for planting 60,000 acres as the following statement shows:—

Area of seed farm at start	....	20 acres.
Seed rate per acre	....	30 lbs.
Average yield per acre	....	2,000 lbs.
Seed available at the end of the first year	....	$20 \times 2,000 = 40,000$ lbs.
Area of seed farm during the second year	....	$\frac{40,000}{30} = 1,330$ acres.
Seed available at the end of the second year	....	$1,330 \times 2,000 = 26,60,000$ lbs.
Area that could be sown by cultivators in the third year	....	$\frac{26,60,000}{30} = 88,667$ acres.
Seed produced by the cultivators at the end of three years *(one per cent of total produce.)*	....	$88,667 \times 2,000 = 1{\cdot}77$ million lbs.

In the meanwhile, fresh resistant strains which are in advance stage of evolution would become available for multiplication and these would naturally offer a wider range of resistant varieties for the growers to choose from.

It is therefore suggested that the past and present efforts of the Madras Agricultural Department to evolve 'blast' resistant strains of rice should receive the filip it deserves and that a scheme for multiplying the seed of 'blast' resistant strains should be taken up as expeditiously as possible.

The disease in relation to manuring: In this connection there is need for a note of warning. Experiments carried out at Coimbatore have definitely shown that excessive application of nitrogenous manures induce increased susceptibility to disease especially in the susceptible varieties. Another feature is that tolerant varieties which yield well in normal years show a break-down in their tolerance when nitrogenous manures are supplied in excess. Under the conditions of the experiment 20 to 25 pounds of nitrogen per acre appear to be about the optimum dosage, but no claim is made that it is true of all conditions.

II. 'FOOT ROT' OF RICE.

The disease next in importance in South India is the 'foot rot' disease caused by the fungus *Fusarium moniliforme* var *majus*. This disease is closely allied to the famous 'Bakane' disease of Japan and the 'man rice' disease of British Guiana. It was recorded by Thomas (1930) in the Godavari District of Madras province but has since been recorded in Coimbatore, Chingleput and Malabar District in Madras and in some provinces like Assam. Though discontinuously distributed at present, by virtue of its seed-borne nature it is a potential danger to rice production in India.

Nature of the Disease: The disease affects the crop in all stages but is mostly destructive in the seedling stages, when the plants are a fort-night to six weeks old. The most conspicuous symptom of the disease in the nursery is the appearance of pale abnormally enlongated slender plants which subsequently die in large numbers decimating the nursery. Seedlings may also wither and die without manifesting the over-growth phenomenon. In the transplanted crop the characterestic symptom is the appearance of stray tall lanky tillers which come to shot blade earlier than the rest of the crop but bearing pale green flags which shoot up conspicuously above the general level of the crop.

Investigation of the disease in Coimbatore was taken up in 1930 and has been pursued since then. The disease has been found to be seed-borne, and the dressing of the seed with organomercury compounds such as Ceresan and Agrosan G at the rate of 1 gram per pound of seed has been found to be effective in obtaining complete control of the disease. Considerable variation in their susceptibility to the disease exists among the varieties grown in the Province and among the resistant varieties may be mentioned G. E. B. 24, a cosmopolitan variety of medium duration which is also a good yielder.

Control Measures: The control of this disease is not difficult and the remedial measures are within the means of the cultivator and can be carried out by him without much effort. The high cost of organo-mercury compounds notwithstanding, the cost of treatment amounts to less than four annas an acre. The fungicides are not difficult to obtain in normal times. It is gratifying to record that one or two laboratory products made by Professor Seshadri of Andhra University have in

the experiments carried out at Coimbatore given results which compare favourably with those obtained from treatment with the imported products. Large scale manufacture of organo mercury compounds may be difficult at present owing to the non-availability of mercury but the starting of this industry when conditions return to normal will be highly useful. In 1946 a large-scale demonstration of the efficacy of seed treatment in the control of the disease was carried out at Government expense in Gobichettipalayam—an important rice growing taluk in the Coimbatore District—where the disease had become increasingly severe year after year. Forty-thousand pounds of cultivator's seed enough to cover an area of 1,000 acres were dressed with Ceresan and Agrosan G. The effect of this demonstration was so convincing to the growers that a demand has arisen for the wholesale treatment of the seed in the entire tract and arrangements are under way to comply with the request. Mention is made of this experience only to show the possibilities of controlling losses at least in the primary infection of seed-borne diseases like helminthosporiose of rice in provinces like Sind and Bengal where considerable damage is done in the nursery stage.