THE PRESENT POSITION AND CONTROL OF RICE DISEASES IN INDIA

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ABSTRACT

The diseases of rice are estimated to cause annually about 10 per cent. loss in rice production. The more important diseases are "blast," "helminthosporiose," "stem rot" and "foot rot". Of these "foot rot" can be checked successfully by treating the seeds with organo-mercurial fungicides and this method is now widely adopted whenever foot rot is prevalent in the country. "Blast" is the most destructive of the diseases and is of widespread occurrence. Research on the control of the diseases is directed towards evolution of highly resistant varieties, development of economic spraying and dusting schedules and the study of the factors favourable for disease development. There is need to intensify the programme of breeding resistant varieties in the country, as the cultivation of resistant varieties is the most economical method of control of the diseases. But since many resistant varieties are not presently available, plant protection by fungicidal spraying and dusting has to be resorted to, to save the crop against the damage caused by diseases. Economic spraying and dusting schedules have already been worked out for blast disease and they have to be popularised. For successful and large-scale adoption of plant protection measures, it is necessary to link the same with an efficient forecasting service. This has still to be organised in India.

INTRODUCTION

OF the various diseases reported on rice in India, the more destructive are "blast" caused by *Piricularia oryzæ* Cav., "helminthosporiose" or "brown eye-spot" caused by *Cochliobolus miyabeanus* (ITO *et* KURIB) Drechsler ex. Dastur (= *Helminthosporium oryzæ* B. de Haan), and "stem-rot" caused by *Leptosphæria salvinii* Catt. (*Helminthosporium sigmoideum* Cav. = *Sclerotium oryzæ* Catt.) and "foot-rot" caused by the fungus which has recently emerged into lime-light, *Gibberella fujikuroi* Saw. Recent reports go to show that the "udbatta" disease caused by *Ephelis oryzæ*, Syd. (*Balansia oryzæ* Nar. and Thirum.) is becoming destructive in parts of Bombay and in Jeypore tract of Orissa. Throughout Bengal, Bihar and in parts of Uttar

Pradesh and Madhya Pradesh a physiological root-rot complex is noticed in some seasons which tends to reduce the yield of crop.

Experienced plant pathologists like Thomas and Krishnaswamy (1948) have estimated that the diseases of rice might account for about 10% loss in rice production annually, or approximately 2·5 million tons. Epidemics of blast occurring in localised regions might cause up to 60–70% loss or even 100% in the case of individual fields. Even if the average loss caused by rice disease in a year were to be only 5% of the total rice production in the country, it would amount to a great deal, and prevention of such a loss should constitute one of the important methods of augmenting our meagre food resources.

The loss caused by the major diseases of rice, blast, helminthosporiose, and stem-rot, their mode of prevalence and control are discussed below:—

I. Blast Disease of Rice

(*a*) *Nature and extent of loss.*—Blast causes seedling blight in seedbeds. Severe leaf infection of blast occurring in the post-transplanting stage leads to total destruction of the foliage. At the neck-infection phase, blast is seen as a blackening extending a few centimeters on either side of the principal node in the rachis just below the ears. As a result of the infection, half-filled or totally chaffy earheads are formed and the earhead also tends to break, and fall off.

Serious losses in yield due to epiphytotics of blast disease have been recorded in different regions in India, such as Tanjore delta, Nellore, Hyderabad, Bombay, parts of Orissa, Kashmir and Kerala. In the first recorded outbreak of blast in India in 1918, in Tanjore, MacRae estimated the loss as 69% (Thomas and Krishnaswamy, 1948). In 1952, a seventy-five acre crop was completely wiped out in Deras Farm in Orissa. In 1955–56 season the early rices were totally destroyed in Kashmir, and about 70% of the remaining crop was severely damaged by blast. Under experimental conditions favourable for development of the disease, a loss of 43% in grain yield has been recorded in the Central Rice Research Institute Farm in a susceptible variety (Padmanabhan *et al.*, 1956).

Only large-scale plant disease surveys can give an objective estimate of the loss in yield caused by the disease in the country. The work of estimating crop losses is greatly facilitated if data are available to show the loss in yield the crop is likely to suffer under a given severity of infection. Studies made in this connection on blast disease have shown that the relation between loss in yield and the neck-infection phase of blast outbreak could be expressed by the equation

$$Y = 1967{\cdot}95 - 18{\cdot}72\,X,$$

where Y = expected yield in lb. per acre and X = the estimate of the percentage of neck infection.

Based on this, it was estimated that for every one per cent. increase in neck infection in a susceptible variety there was a loss of 0·95% in yield. This relationship was worked out with a highly susceptible variety and it was anticipated that the relationship might be different with a less susceptible variety (Padmanabhan and Ganguly, 1955; Padmanabhan, Ganguly and Jha, 1958). Recently Rangaswamy and Subramanyan (1957) have confirmed that the loss in grain yield due to neck infection in susceptible and moderately resistant varieties was much higher than the loss in a resistant variety. Further studies are in progress to understand the relation between leaf infection and loss in yield with and without neck infection.

(*b*) *Epidemiology*.—The disease is reported to be seed-borne elsewhere but in India, though the spores of the pathogen have been seen to occur in the blackened kernels of the infected ears, no direct evidence is so far available to show that the disease is seed-borne. But alternative sources of infection might occur in nature. For instance, cross-inoculation studies carried out in Madras have shown that the isolates of the fungus occurring on *Panicum repens* and *Digitaria marginata* can infect rice (Ramakrishnan, 1948; Thomas and Krishnaswamy, 1948). Recently Pawar and Kulkarni (1954) observed that *Setaria intermedia* had leaf-spots resembling those of blast on rice and the causal organism was morphologically similar to *P. oryzæ*. *Dinebra retroflexa* has also been recorded as another collateral host in Andhra (Thirumal Rao, 1956). More disturbing was the recent report from Costa Rica (De Gutierrez, 1954) that the cultivated sugarcane was also a collateral host. How far these hosts help in the perennation of the fungus or serve as potential reservoirs of inoculum remains to be studied. The survival of the fungus in such grasses or in rice stubbles, perhaps in another phase of its life-cycle, is also a possibility.

Regarding the development of the disease, the susceptibility of the host and the weather are the more important factors as in the case of all diseases. With respect to blast, the host exhibits a fairly wide range of reaction under different conditions, perhaps much more so than in any other known disease. Apart from the variation in resistance shown by one variety as against another under identical conditions, which is vaiietal or genic in character the same variety shows a range of reaction to blast in its development from seedling to maturity. The rice plant is most susceptible to leaf infection during the vigorous growth and tillering phase which follows transplanting (15–30 days after transplanting). As the plant grows older, it becomes progressively resistant to leaf infection (Padmanabhan and Ganguly, 1954); later at ear-emergence the plant becomes susceptible to nodal and neck infection. In the seed bed also the rice plant is in a vulnerable stage.

Besides the stages of its development, the level of N fertilization under which a variety is raised has a profound effect on its reaction to blast (Krishnaswamy, 1952; Padmanabhan, 1953; Ganguly, Balakrishnan and Padmanabhan, 1954). The rate of increase in susceptibility with increasing levels of N varies with different varieties, and this has been correlated with the accumulation of soluble N in leaf tissues under higher levels, the more susceptible the variety, the greater such accumulation (Hashioka, 1950; Baba, 1954).

The temperature at which rice is grown also alters the reaction of a variety to blast. Generally speaking, at temperatures below the optimum for the growth of rice, say at 20° C., the plant is more susceptible than when grown in the optimum range of 28–32° C. This has been related also to the N metabolism of the plant. At lower temperature the absorbed N tends to accumulate as soluble N in the leaf. Besides, it is reported that very little silica is absorbed under high level of N fertilization especially at lower ranges of temperature (Hashioka, *l.c.*).

Of the climatic factors, which favour blast development, the range of temperature (24–27° C.), a high relative humidity and copious dew formation appear to be the most important. Severe blast infection breaks out in the field when such favourable weather conditions occur when the host is also in a susceptible condition, or in a susceptible stage of development. There are thus two seasons in a year in Cuttack in which blast attains its maximum intensity, September–October in the main crop season and February in the second crop season. The varieties which flower during September–October get neck infection, while the late varieties still in the tillering stage during this period, get only leaf infection and escape neck infection. By delaying the planting, therefore, up to and beyond August, a severe blast incidence is induced, a fact which is utilized in the experiments on loss in yield, mentioned earlier. Similarly, in February, the crop gets generally severe leaf infection. In Madras, the weather is most favourable to blast development in December–January, when most varieties come to ear and thus become exposed to infection in the neck.

(*c*) *Control of blast disease of rice.*—Research on control of blast has been directed towards breeding of resistant varieties and development of economic spraying and dusting schedules for direct control. Data on the time of appearance of disease, the period of peak incidence and the effect of nitrogenous fertilization on various varieties can also be put to intelligent use in avoiding to some extent the loss caused by the disease.

The results so far obtained in India in breeding for resistance to blast have been recently summarised (Padmanabhan, 1956; Ghose *et al.*, 1956). Briefly, the results are as follows: At the Central Rice Research Institute, out of nearly 500 varieties, 14 have been selected as resistant to moderately resistant under artificial infection in the seedling stage and under all stages in the field under natural conditions. These have been tested in more than 40 Rice Research Stations all over India and except in rice stations situated at an altitude of 3,000′ or above they have been found to be more or less resistant in all centres. A second lot of 490 varieties from the genetic stock, all of which are early maturing—*i.e.*, within 110–20 days are being sifted for resistance at the Central Rice Research Institute and in the course of the next two years a few more resistant types will be made available from amongst the short duration types.

In Madras State, Co. 4 and T.K.M. 1 have been isolated as resistant types to blast. In Bombay, 15 improved varieties of the State have been reported to be resistant to blast. B.C.P. 1 and B.C.P. 2 are resistant selections from the Andhra State. H.R. 1 and H.R. 35 have been found to be comparatively resistant to blast in Hyderabad farms.

In hybridization projects to evolve resistant varieties, Madras is the only State which has released successfully resistant varieties, *viz.*, Co. 25, Co. 26, A.D.T. 25 and is in a position to release shortly a few more resistant selections like T. 6517 and T. 6522, T. 6538 and others. Recently G.E.B. 24 and Co. 4 have been crossed and a number of hybrids from the cross are showing great promise. A few selections from hybridization projects are in the final stages of testing in the Andhra State and in Bombay. From the Central Rice Research Institute, where, F. 6, F. 7 and F. 8 generations of plants are under study in crosses made between Co. 25 and Co. 13, a few high yielding early maturing, non-lodging and blast resistant types are likely to be made available within the next 2–3 years.

During the last two years, a very interesting International Co-operative Project is being carried out at Cuttack. This was the outcome of suggestions made in the meetings of the International Rice Commission by the Director of the Central Rice Research Institute. Under this project rice varieties found resistant in different parts of the world are listed and distributed to several testing centres to study their reaction to blast under local conditions in the field and under artificial infection using standard procedures. A few susceptible varieties have also been obtained from each country and included in the tests. A standard procedure for testing and evaluating the reaction of the varieties on the basis of the extent of disease development has been suggested by the Central Rice Research Institute for this purpose.

The results obtained at the Central Rice Research Institute are given in Table I.

The classification of the varieties given in Table I is based upon the first year's trial and it is necessary to confirm the resistant reaction of the varieties by further tests. Further, the significance of the results to international breeding programmes will be apparent only when the results obtained in similar trials, conducted in other centres are available for comparison.

No real significance can, therefore, yet be attached to the differences between the reaction of the varieties in the home country and that noted in the Cuttack tests, though there are not many such differences. Out of the 14 susceptible types studied, 11 were found susceptible and 1 moderately susceptible. Similarly, in the case of the resistant varieties, only Bengawan and Sigadis were resistant amongst the 8 Indonesian varieties, but the Indonesian varieties were not definitely known to be resistant even in Indonesia. Out of the remaining 23 varieties, 22 proved to be resistant and moderately resistant. However, in the second crop season trial, only 10 out of 20 included were resistant.

In spite of the discrepancies noted above, the one important fact that clearly emerges out of the tests is that there appears to be a large reservoir of genic resistance to blast available in rice which can be successfully exploited to reduce the loss caused by blast in rice production in the world. Secondly, the general correspondence of the Cuttack results with the known reaction of the varieties in the countries of their origin suggests that the pathogen *P. oryzæ* does not occur as highly specialised pathogenic races as the rust and other fungi. Apart from specialisation in pathogenicity on the part of the fungus, the interaction of the host with the environment prior to its infection by the pathogen, is also an important factor determining the reaction spectrum of the host especially in a new environment.

Though control of blast through resistant varieties is the most economical method, it must be realised that the task of replacing the present lot of

TABLE I

Showing the list of resistant and susceptible varieties received from different countries which were tested at Cuttack under the International Co-operative Blast-Resistance Trials and their reaction to blast under Cuttack conditions

Sl. No.	Name of variety	Reaction at Cuttack	Name of variety	Reaction at Cuttack
	Reaction of the varieties included in the first crop season based upon artificial infection in seedling stage, and field reaction in post-transplanting (leaf blast) and in flowering stages (neck infection)		Reaction of rice varieties included in second crop season (January–April) based upon field reaction in post-transplanting stage (leaf blast only)	
		(A) Resistant Types		
1	Nahada (Egypt) ..	MR		
2	Agami-Mont (Egypt) ..	R	Agami-Mont (Egypt) ..	R
3	Giza-14 (Egypt) ..	MS	Giza-a14 (Egypt) ..	MS
4	Co. 4 (India) ..	R	Shikare-Shiroke (Japan) ..	MR
5	Co. 26 (India) ..	R	Fujisaka 5 (Japan) ..	S
6	B.J. 1 (India) ..	R	Norin 17 (Japan) ..	R
7	S.M. 6 (India) ..	R	Kanto 51 (Japan) ..	S
8	S.M. 8 (India) ..	R	Sensho (Japan) ..	S
9	S. 67 (India) ..	R	P.I. 1 (Japan) ..	MS
10	A.K.P. 8 (India) ..	MR	Rei-Shi-Ko (Japan) ..	R
11	A.K.P. 9 (India) ..	MR	To-To (Japan) ..	S
12	Peta (Indonesia) ..	MS	Kwang-Fu-I (Taiwan)	R
13	Intan (Indonesia) ..	MS	Chia-Nong-Yo 242 (Taiwan)	S
14	Salak (Indonesia) ..	S	Chia-Nong-Yo 280 (Taiwan)	R
15	Tjahaja (Indonesia) ..	S	Norin 22 (Japan) ..	R
16	Sigadis (Indonesia) ..	R		
17	Remadja (Indonesia) ..	MS		
18	Tjina (Indonesia) ..	S		
19	Bengawan (Indonesia) ..	R		
20	Malik-Kuning (Malaya)	R		
21	Kontor (Malaya) ..	MR		
22	Seri Raja (Malaya) ..	R		
23	Mayang-Sagumpal (Malaya) ..	R		
24	Wag-Wag (Philippines) ..	R		
25	Raminad Strain 3 (Philippines) ..	R		
26	Zenith (U.S.A.) ..	R	Zenith (U.S.A.) ..	R
27	Lacross (U.S.A.) ..	R	Lacross (U.S.A.) ..	MS
28	C.I. 9045 (U.S.A.) ..	R	C.I. 9045 (U.S.A.) ..	R
29	C.I. 9075 (U.S.A.) ..	R	C.I. 9075 (U.S.A.) ..	MS
30	C.I. 9155 (U.S.A.) ..	MR	C.I. 9155 (U.S.A.) ..	R
31	C.I. 9249 (U.S.A.) ..	R	C.I. 9249 (U.S.A.) ..	MS

TABLE I—*Contd.*

Reaction of the varieties included in the first crop season based upon artificial infection in seedling stage, and field reaction in post-transplanting (leaf blast) and in flowering stages (neck infection)			Reaction of rice varieties included in second crop season (January–April) based upon field reaction in post-transplanting stage (leaf blast only)	
Sl. No.	Name of variety	Reaction at Cuttack	Name of variety	Reaction at Cuttack
		(B) Susceptible Types		
1	Nabatat-Asmer (Egypt) ..	MR	Nabatat-Asmer (Egypt) ..	R
2	Sabaini (Egypt) ..	S	Co. 13 (India) ..	S
3	Co. 13 (India) ..	S	Norin (Japan) ..	S
4	A.D.T. 10 (India) ..	S	Kunshan-Wa-Shiang-Ken (Taiwan)	S
5	M.A.S. (Indonesia) ..	S		
6	Nachin 11 (Malaya) ..	S		
7	Siam 29 (Malaya) ..	MS		
8	Serendah-Kuning (Malaya) ..	MR		
9	Buenketan (Philippines) ..	S		
10	Thailand (Philippines) ..	S		
11	Caloro (U.S.A.) ..	R		
12	Fortuna (U.S.A.) ..	R		

Note.—R = Resistant; MR = Moderately Resistant; S = Susceptible; MS = Moderately Susceptible.

cultivated types by resistant ones is truly stupendous and will call forth herculean efforts sustained over a long period for achievement. The possibility of sudden mutation occurring in the pathogen which might set at nought all this effort in a trice is not to be overlooked. Therefore alternative methods have also to be evolved to supplement the results obtained by breeding. Studies made at the Central Rice Research Institute on control of blast by spraying fungicides have shown that the incidence of blast on even a very susceptible variety can be effectively reduced by spraying the crop with copper fungicides. The cost of chemicals involved is Rs. 40–50 per acre with the normal spraying rate of 100 gallons per acre, but only Rs. 10–12·50 with low volume spraying. (Padmanabhan *et al.*, 1956). There is, however, a distinct disadvantage in copper fungicides. Many rice varieties appear to be very sensitive to copper; they react adversely, showing severe symptoms of injury. In the absence of very severe disease the advantage of the protection given the copper fungicides cannot be appreciated.

The organo-mercurial dusts which are generally advocated as seed-dressings have been found to be very effective in checking blast infection when sprayed or dusted, on the crop and they are not associated with any injury. The results of the last two years' results at the Central Rice Research Institute are so encouraging that it is anticipated that dusting with these chemicals may come to stay in India as a standard crop protection practice.

The success of any measure of control of crop diseases by direct application of fungicides depends largely upon timely action. That is to say, plant protection measures are really effective and popular only when they are linked with efficient forecasting service. Through forecasting the cultivators can be notified that conditions are sufficiently favourable for disease outbreaks, and that application of control measures will therefore result in economic gain, or, on the other hand, that the severity of the disease outbreak will not justify the investment involved in the control measure. Forecasting services have been successfully developed in the case of many plant diseases, notably, the late blights of potato and tomato, brown leaf rust (*Puccinia triticina*), vine mildew in France, Blackpod disease of Cocoa (*Phytophthora palmivora*) white-pine blister rust (*Cronartium ribicola*), apple and pear scab (Miller and O'Brien, 1952 and 1954; Anon, 1955).

The Japanese have successfully attempted forecasting blast outbreaks by studying the relationship between sunshine, precipitation and other factors during specific periods and the intensity of the subsequent blast outbreak (Kawada, 1954).

At Nagano Experimental Station, it has been found possible to forecast the degree of outbreak of neck rot and node blast by counting the number of spores "flying in the air" during the head distending stage.

Thirdly, it is also possible to forewarn the farmers about the imminence of blast outbreaks by watching carefully the pattern of disease development in highly susceptible varieties very early in the season. Thus by concerted work in all representative rice growing regions in India it is possible to develop a forecasting or forewarning service as the case may be, for blast, as well as other diseases. This will enable the taking of timely precautionary measures and in mobilising and concentrating all available resources in a region where they are most urgently required. It is to be hoped that it will receive sufficient attention from Agricultural Scientists in India in the immediate future.

The loss caused by blast in India can also be minimised by careful agronomic and cultural practices. Excessive N manuring, especially over 40 lb. N level, is to be avoided till resistant varieties which will not succumb to blast at higher levels become available through breeding. Application of N in split doses should be encouraged. If incidence of blast in each region is carefully studied further it will be possible by some adjustment of planting dates and by choosing suitable varieties to avoid the coincidence of the most susceptible stage of the host with the peak incidence period in that region.

II. Helminthosporium Disease

(*a*) *Sources of infection and development of disease.*—The pathogen survives in the rice seed between harvest in November–February and the next sowing in June–July. However, it has been shown (Thomas, 1941; Padmanabhan *et al.*, 1953) that the seed-borne pathogen infects rice seedlings at germination only when the soil temperature is below 25° C. But the soil temperature in the main sowing season of rice in June-July is above 25° C., and therefore seed-borne infection is of minor significance during this period. The conidia of the fungus are air-borne and are present in the air throughout the off-season and may be responsible for the secondary infection in the seed-beds seen early in July (Padmanabhan *et al.*, 1953). Besides *Leersia hexandra* has been reported by Chattopadhyaya and Chakrabarthy (1953) to be a collateral host and whether this grass helps in the perennation of the fungus and serves as a source of infection for the newly sown crop remains to be investigated.

The range of conditions under which infection of the host takes place has been summarised elsewhere (Ling, 1951; Padmanabhan, 1956). It is of interest to note that contrary to what obtains in blast, the susceptibility of the rice plant to the disease increases with its age and it is most susceptible at flowering and maturing stages (Padmanabhan and Ganguly, 1954).

Serious epiphytotics of the disease have been indeed very rare, and in these years of outbreaks, unusual weather conditions have always been recorded. For instance, late and heavy rains in November and December and the floods which followed were said to have been responsible for first recorded outbreak of the disease in the country in the Godavari and Krishna delta (Sundararaman, 1922). In Indo-China rice was badly damaged by helminthosporium disease after late cold rains in December (Barat, 1931). In Ceylon, a severe outbreak occurred in 1943 and it was reported that unusually wet and humid weather had favoured the outbreak (Anon, 1943). Similarly, in the Bengal epiphytotic of 1942, heavy and unprecedented rains in September and, the floods they caused, were followed by continuous cloudy weather and by wet and humid November.

Helminthosporium disease appears to be very important in the highly humid heavy rainfall submontane areas below the Himalayas in Bengal, in

Eastern Uttar Pradesh, Assam and in the West Coast of India. It would be of great interest to examine how far the heavy rainfall and floods in these regions deplete the soil of its natural reserves of nutrients, especially when the crop is flowering and is most susceptible to infection. It may be mentioned that in the "AKIOCHI" phenomenon of Japan which develops under soils which get leached out of essential nutrients towards August–September, helminthosporium attack is very prominent. Paucity of K in soil, and in-balance of Fe/Mn ratio in the leaves are correlated with the severe appearance of the disease (Baba and Harada, 1954).

(*b*) *Control.*—The work in progress on the isolation of resistant varieties has also been recently summarised (Padmanabhan and Ganguly, 1953; Padmanabhan, 1956). In estimating the relative resistance of several hundreds of rice varieties, it was seen that it was futile to expect any high degree of resistance to the disease in any variety. There are five varieties, CH. 13, CH. 45, T. 141, Co. 20 and B.A.M. 10 isolated at the Central Rice Research Institute out of 500 varieties which do not show severe symptoms of disease under normal range of conditions. They may not behave as resistant under flooded conditions or under excessive heavy rainfall when the soil gets leached out of nutrients. A second dose of fertilizer application, after floods subside or when rains cease, may meet the case. As a matter of fact an experiment is in progress in Orissa in the Agricultural Farm at Bhubaneswar on a sandy soil which gets leached out during rains to test the above hypothesis.

III. Stem Rot

The sclerotia of the pathogen are hardy structures which survive in the old stubbles and straw and serve as the principal sources of infection of the new crop. They are carried from field to field through irrigation water and cause infection. In the case of this disease also excessive application of N predisposes the crop to infection. Therefore, one of the principal methods of avoiding loss caused by the disease is judicious application of fertilizers. Paracer and Luthra (1944) have also demonstrated that incidence of infection in the Punjab could be reduced by late sowing and late transplanting. Resistant varieties are known and their cultivation has to be taken up in areas where the disease occurs regularly to check the loss caused by the disease.

IV. Foot Rot

The loss caused by "foot-rot" can be kept under control by resorting to seed treatment with mercurial fungicides. "Foot-rot" was at one time destructive, but wherever it is prevalent, it is kept under control by regular use of mercurial seed-dressings.

To conclude, prevention of the loss which amounts to 10% of our annual production, caused by rice diseases, is one of the more important and pressing problems needing immediate attention. Effective action is to be formulated and carried out both on the developmental and research side in order to conserve our principal food crop against the damage caused by diseases. The mode of prevalence and spread of the diseases are to be studied thoroughly so that the lacunæ which exist at present regarding these aspects are filled up. Based on such a knowledge scientific control through adoption of agronomical and cultural practices will become feasible. It is now well accepted that nitrogenous fertilization has to be resorted to, to increase the yield per acre of rice varieties, but as most of the released varieties succumb to " blast " or " stem-rot " under higher levels of N fertilization there is urgent need to breed new varieties, which will be resistant to these diseases under high fertility. A scheme for intensifying the breeding programme in this country is under consideration to evolve such blast-resistant types, and it is to be hoped that it will get started quite soon. Though cultivation of resistant varieties is ultimately the most economical method of control, alternative methods have also to be adopted till such varieties become available. Fungicidal spraying and dusting give adequate protection to the crop against " blast ", but the cultivators should be helped to make use of this knowledge. Forecasting and forewarning services are to be organized throughout the country if plant protection by chemicals is to become popular, because timely action before the pathogen establishes itself on the host is most effective and will also give adequate economic return by way of increased yield. Not the least important aspect of the problem is the necessity to manufacture such plant protection chemicals and equipment cheaply in the country.

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