Session V

FORECASTING AND CONTROL OF RICE DISEASES

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The study of the relation of meteorological factors on development of rice diseases has been in progress at the Central Rice Research Institute in respect of blast, helminthosporiose and false smut. As regards blast it was found that a coincidence of low night temperature of 20-26 °C and below, especially 24 °C and below with high relative humidity of 90 per cent and above during the susceptible stages of the crop growth (seedling, tillering and neck emergence) was accompanied by blast outbreak. Data have been obtained to show that timely application of fungicides based on forecasting of the disease will help in effective control of the disease.

Fungicides based on copper, mercury, tin and organo-phosphates (Hinosan, Kitazin) and Kasumin (antibiotic) have been found to be effective in controlling blast.

On local *indica* varieties, application of copper fungicides has been found to be effective and economical, but on account of phytotoxicity copper cannot be recommended for use on high-yielding varieties. Fungicides like Hinosan, Kitazin or Kasumin are suggested for high-yielding varieties.

As regards helminthosporium disease, cloudy days, low sunshine hours, slight drizzle and lower range of daily temperature during the flowering to maturity of crop were associated with higher incidence of the disease.

Severe incidence of false smut of rice was associated with higher percentage of relative humidity and lower maximum temperature during flowering period of rice.

Rice suffers from a number of fungal and other diseases in India. Of the fungal diseases, blast caused by *Pyricularia oryzae* Cav. is the most important. In some regions of the country, the disease is endemic causing severe damage to the crop every year. These areas are confined to higher elevations of 2000–5000 ft or in the valleys where conditions are favourable for blast development throughout the crop season. In other parts of India, blast is seasonal in occurrence, severity of which depends upon prevailing weather factors.

Of the high-yielding varieties of rice approved for release in India, *Adt.* 27, *Jagannath*, *Ratna*, *Cauvery* and *Hamsa* are susceptible to blast; others have been found to be susceptible to the disease in certain localities and this may be due to the existence of physiologically specialized races of the fungus.

As these high-yielding varieties are grown under high nitrogenous fertilization, blast is likely to occur in a severe form if conditions are favourable for development of blast in any region.

Application of nitrogenous fertilizers in higher doses has been intensified in India even in our traditional varieties, which has altogether changed the picture of disease pattern on rice and occurrence of blast in severe form is being reported from various rice-growing areas..

Blast Forecasting

In India, Padmanabhan (1965 *a*, *b*) correlated the occurrence of blast disease of rice with meteorological factors. The incidence of blast disease had been observed in each year between 1950 and 1962 on genetic stocks, varietal susceptibility trials, spraying trials to control blast in other field experiments on blast. Based upon the infection data recorded for in these experiments, each year was classified as 'very favourable', 'unfavourable' or 'moderately favourable', in respect of either foliar or neck infection due to blast.

Various meteorological factors such as minimum temperature ,relative humidity and rainfall recorded at the Central Rice Research Institute, Cuttack, were compared with the intensity of occurrence of blast each year. It was found that blast had occurred whenever there was a coincidence of low minimum temperature of 26°C or below along with the relative humidity of 90 per cent or more during any of the susceptible stages of crop growth viz., seedling stage (beyond 21 days), post-transplating tillering stage and at neck emergence. Infection was higher when the minimum was 24° 22°C or 20°C. It was suggested therefore that outbreak of blast disease of rice could be forecast on the basis of meteorological factors viz., minimum temperature and relative humidity prevailing during the susceptible stages of the crop growth.

In order to confirm the above findings, experiments were initiated in 1962 and are in progress till date (Chakrabarti and Padmanabhan 1958). The data obtained in the trials from 1962–1965 are discussed below.

Experimental

The variety used was *Co.*-13, a short-duration blast susceptible type which matures in 120 days. During *kharif* (June–December) season of 1962–1965, seeds were sown at four different dates at weekly intervals and 30-day-old seedlings were transplanted on four corresponding dates, generally beginning from first or second week ofA ugust. Four rows of 50 seedlings were transplanted in the field in two replications. Nitrogenwas applied @ 60 kg/ha. The plots were examined at intervals for the appearance of blast symptoms on the leaves of plants from 25 days after the first transplanting oft he crop.

The infection was scored by recording type of infection (Padmanabhan and Ganguly 1959) and their number on 40 randomly selected plants, 10 from each planting date. Meteorological data viz., minimum temperature and relative humidity recorded daily at the observatory of the Institute farm were utilized in the study. The relevant data are presented in Tables I–II for leaf blast and neck blast respectively.

It might be observed from Table I that leaf infection due to blast was low during the year 1964 which was characterised by only 5 days of favourable temperature and humidity (minimum temperature of 26°C or below and relative humidity of 90 per cent or above) during later part of September and early October. There was no day with minimum temperature of 24°C in combination of 90 per cent relative humidity during this year. The incidence of neck infection was also very low (Table II), though the number of favourable days with above temperature-humidity combination was quite high. This was perhaps due to low inoculum potential available for neck infection from the earlier foliar infection phase.

TABLE I

Development of leaf infection due to blast on rice variety Co.- 13 and its relationship with the meteorological factors

Date of observation		Leaf infection score	Days with favourable minimum temperature along with R.H. 90 per cent or above	
			20°C and below	24°C and below
1962				
October	1	27.6	4	0
	5	133.1	1	0
November	1	96.4	6	6
	9	56.6	5	5
Total		313.7	16	11
1963				
September	12	12.8	4	1
	19	15.0	5	1
	26	44.3	6	5
October	11	128.5	7	1
	19	151.0	7	4
Total		351.6	29	12
1964				
September	23	15.4	3	0
October	1	24.5	2	0
	7	41.1	0	0
	26	8.0	0	0
Total		89.0	5	0
1965				
September	21	46.4	5	1
	28	112.7	5	1
October	5	128.3	6	1
	13	171.3	7	4
Total		458.7	23	7

The leaf infection was high during the years 1963 and 1965. In 1963 the number of favourable days was 29 (with 26°C and below) and 12 (with 24°C and below) in combination with relative humidity of 90 per cent or more. The neck infection was also highest during the year and number of favourable days with high relative humidity was 26 and 14 days for temperatures 26°C and 24°C respectively. In the year 1965, leaf infection was the highest amongst the years studied, and number of days with minimum tem perature of 26°C or below was 23 days and 7 days with 24°C or below in combination with 90 per cent or more relative humidity. The favourable days during neck infection stage were 28 and 13 respectively and number of infected tillers was 10.

TABLE II

Development of neck infection due to blast and its relationship with the meteorological factors

Date of observation	Date of flowering	No. of infected tillers	Days with favourable minimum temperature along with R.H. 90 per cent or above	
			26°C and below	24°C and below
November 11, 1962	3rd week, Oct.	10	15	8
November 8, 1963	,,	23	26	14
November 21, 1964	,,	3	18	12
November 8, 1965	,,	10	28	13

In the year 1962, the leaf infection was moderately heavy and number of favourable days was 16 (with 26°C or below) and 11 (with 24°C or below) in combination with high relative humidity of 90 per cent or more.

FORECASTING

From the data it might be seen that the forecast of blast disease would be possible on the basis of a concomitant occurrence of minimum temperature of 26°C or below (preferably 24°C below) and a relative humidity of 90 per cent or above during the susceptible stages of crop growth; the more the number of such days, the greater would be intensity of infection.

CONTROL OF BLAST

Padmanabhan *et al.* (1956, 1959,1962 and 1963) worked out an economic spray schedule for the control of blast disease of rice. Fungicides based on copper and organic mercury were found to be effective in controlling neck infection due to blast on the variety *Co.*-13. It was observed that a spraying schedule covering 5–6 sprays viz., one spray at seed bed (on 21-day, old seedlings) two to three sprays at post-tillering phase at an interval of 10–15 days and two sprays at ear emergence, one just before emergence and other 5 days later was effective in controlling blast disease. Recently, Kameswar Row and Padmanabhan (unpublished) observed that tin-based fungicides (triphenyl tin hydroxide), organophosphates (Hinosan and Kitazin) and antibiotic (Kasumin) weree ffective in controlling the blast (Table III).

Application of copper-based fungicides has been recommended for use on local *indica* varieties. On high-yielding dwarf *indicas* application of copper was found to be associated with phytotoxicity. Therefore, spraying of organophosphates (Hinosan, Kitazin) or antibiotic (Kasumin) is being recommended for control of blast on high-yielding varieties. Hinosan was associated with slight amount of phytotoxicity but no such adverse symptoms were recorded when Kasumin was sprayed on rice plants.

TABLE III

Effect of fungicidal application of week infection due to blast and yield at Cuttack in Kharif 1969 (*Variety used—Co.*-13)

Treatment	Per cent neck infection	Yield (kg/ha)
Control	29.21	808
Kasumin (0.5 g)	9.36	1401
Kasumin (1.0 g)	9.17	1663
Aureofungin	26.37	933
Kitazin	11.16	1360
Duter	17.71	1525
Hinosan	3.82	1694
Fytolan	11.99	1239
C.D. (0.5)	6.50	490

Economics of spraying fungicides and antibiotics in control of blast

The relatively low phytotoxicity of Cu-based fungicides on local *indica* varieties and the relatively lower cost of Cu fungicides i. e., Rs. 67/ha are important economical factors favouring the use of Cu fungicides for control of blast on *indica* varieties.

TABLE IV

Economics of spraying

Chemical	Price (in Rs/kg)	Dosage of spray fluid (per litre)	Quantity of chemical/ha	cost of chemical (in Rs/kg or lit.)	Operational charges/ha	Total cost per application/ha	Cost for 5 applications/ha
Blitox	12	0.5 g	0.50 kg	6.0	7.50	13.50	67.50
Hinosan	72	1.0 ml	1.0 l	72.0	7.50	79.50	397.50
Kasumin	50	(a) 1.0 g	1.0 kg	50.0	7.50	57.50	287.50
		(b) 0.5 g	0.50 kg	25.0	7.50	32.50	162.50

The range of yield obtained by these varieties is 2000–3000 kg/ha. A return of 131–750 kg/ha by way of increase in yield could be obtained in the variety *Co.*-13 during the years 1964–1969. Thus the cost of chemicals and spraying could be met from the increasing return obtained with local varieties. The cost of Rs. 287.50 in the case of Kasumin and Rs. 397.50 in the case of Hinosan for five sprayings could easily be met by the rate of increased returns obtained through high-yielding varieties, where average yield ranges from 5000–7000 kg/ha. Even if a loss of 10–15 per cent could be prevented, the spraying of the new chemicals will be economical.

Spraying linked with forecasting will minimise the cost of fungicides and spraying. Kameswar Row (unpublished)carried out trials on sprayings of fungicides, Duter, Kita-

zin and antibiotic Kasumin to control the blast by linking the time of application with forecasting of favourable weather factors for the development of blast disease. In one treatment, five sprayings were given as per recommended schedule and in the other, two sprayings were given according to the time of onset of blast outbreak as forecast from meteorological factors, at both leaf and neck infection stages. The results obtained indicated that both from the point of view of reduction of infection and the yield increase, two sprays linked with forecasting were as effective as five sprayings given as per recommneded schedule. This shows that effectiveness of spraying would be increased enormously by linking the time of spray with forecasting. Side by side the cost of spraying (chemicals and application) will be brought down by more than 100 per cent.

HELMINTHOSPORIOSE

Helminthosporiose of rice caused by *Cochliobolus miyabeanus* (Ito et Kurbi). Dreschler ex Dastur (=*Helminthosporium oryzae* Breda de Haan) is another serious fungal disease of rice mostly widespread in Assam, West Bengal, parts of Bihar, Orrisa Andhra pradesh, Madras, Mysore, Kerala, Uttar Pradesh and the Punjab. The disease assumes a serious proportion in certain years. In 1918–1919 there was a severe incidence of the disease in Krishna and Godavari deltas. The disease was considered to be a major factor contributing to the Bengal famine of 1943 as it resulted in a loss in yield amounting to 50–90 per cent of 1942 harvest due to its outbreak.

A comparative study of the meteorological factors and incidence of the disease at three centres in Bengal during the years 1942, 1943 and 1944 was carried out by Padmanabhan (1963) to find out the nature of the abnormal weather factors of 1942, which might have brought about the epiphytotics. It was found that in the year 1942, a set of unusual weather conditions occurred. During the *kharif* of 1942, there was an excessive rainfall in September, uniformly favourable temperature range of 25–30°C continuously for two months, unusually cloudy weather and rain in November and higher minimum temperature (lower range of daily temperature) than usual in November and low sunshine hours. In a separate study carried out on spore population of *H. oryzae* in the air, it was found that cloudy days low sunshine hours, light drizzle and low range of daily temperature were very favourable for spore dispersal of *Helminthosporium oryzae* (Chandwani *et al.* 1963). Therefore it was concluded that the abnormal weather conditions which prevailed in Bengal in 1942 had contributed towards the development of epiphytotics of helminthosporiose. The indication obtained in the study might be useful for keeping a watch for such abnormal trends in weather conditions as were seen in 1942.

Control of the disease

The pre-sowing treatment of seeds with organomercurial fungicides at 1/500 by weight has been suggested.

Spraying with copper-based fungicides during tillering phase to booting stage have been reported to have lowered the level of infection due to helminthosporiose (Chattopadhyay and Chakrabarti 1961). Since the above fungicides are of prophylactic nature application of Cu sprays linked with forecasting might yield better results.

False Smut Disease

Rao (1964) observed that rice varieties of medium duration group (130 –145 days) developed maximum infection due to false smut disease of rice caused by *Ustilaginoidea virens* (Cke.) Tak., while those of shorter and longer duration groups had comparatively less infection. The meteorological factors like relative humidity, rainfall during the flowering period of the three successive years (1960, 1961 and 1962) were correlated with the disease incidence.

It was found that the fortnight covering the flowering period of the medium duration group (16–31 October) was characterised by a higher percentage of relative humidity and lower maximum temperature during the year 1962 in comparison to 1961, when the infection was comparatively less. In 1960 also, the percentage of relative humidity and maximum temperature showed a similar trend as in the year 1962. Some correlation between the incidence of the disease and the number of cloudy days was also obtained.

From the limited observations carried out it was seen that actual precipitation had less effect on the disease incidence than cloud amount and low maximum temperature but lowering of temperature and clouds are phenomena associated with precipitation.

Control of the disease has been attempted in a limited scale by prophylactic spraying of copper-based fungicides.

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