THE GREAT BENGAL FAMINE

❖3563

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Bengal, which prior to partition of India covered the state of West Bengal in India and Bangladesh, suffered from a calamitous famine in 1943, when it was estimated that two million people died of starvation. The author was appointed as Mycologist in Bengal in October 1943 when the famine was at its height. When he travelled to join his new assignment on 18th of October 1943, he could see dead bodies and starving and dying persons all along the way from Bahudurabad Ghat on the Brahmaputra to Dacca. This horrendous situation of several thousands of men, women, and children dying of starvation continued throughout October, November, and December in and around all the important cities in Bengal, especially Calcutta and Dacca.

There was a war raging in many theaters in the world. The British empire was visibly crumbling. The victorious Japanese army, in collaboration with Indian National Army, was knocking at the eastern gates of India. It is in this context that a serious shortage in rice production occurred in 1942. As there was very little marketable surplus from 1942 harvest, the price of rice started rising from the beginning of 1943 in all parts of Bengal. The civil administration could not and did not cope with the situation created by the shortage. Soon the cost of rice was beyond the reach of ordinary people. Most of the rural population migrated to the cities in the hope of finding employment and rice. Finding neither, they slowly died of starvation.

Though administrative failures were immediately responsible for this human suffering, the principal cause of the short crop production in 1942 was the epidemic of helminthosporium disease which attacked the rice crop in that year. This was caused by *Helminthosporium oryzae* Breda de Haan[=*Cochliobolus miyabeanus* (Ito & Kuribayashi) Drechsler *ex* Dastur. Nothing as devastating as the Bengal epiphytotic of 1942 has been recorded in plant pathological literature. The only other instance that bears comparison in loss sustained by a food crop and the human calamity that followed in its wake is the Irish potato famine of 1845.

The loss sustained by the rice crop in 1942 might be judged from Table 1, which gives the yield of the principal rice varieties widely grown in Bengal as recorded at the rice research stations of Chinsura and Bankura for the years 1941 and 1942. It may be seen that the loss sustained by the early maturing

Annual Review of Phytopathology 11 (1973) 11–24

Table 1 Yield of rice per hectare at the Rice Research Stations at Bankura and Chinsurah in the epiphytotic year (1942) compared with yield per hectare in the stations in a normal year (1941).

Variety of Paddy		BANKURA			CHINSURAH		
		Yield kg/ha		Percentage Loss in Yield	Yield kg/ha		Percentage Loss in Yield
		1941	1942		1941	1942	
Bhutmuri	*Aus* (Early)	1289	1242	6.81	372	1252	
Kataktara	*Aus* (Early)	1421	1205	15.1	1250	1215	
Tilakkachri	*Aus* (Early)	1867	1328	28.9	1713	965	43.7
Marichbati	*Aus* (Early)	1365	723	46.9	1365	674	50.3
Dharial	*Aus* (Early)	1323	669	49.5	1323	669	49.6
Charnok	*Aus* (Early)	1208	443	59.2	762	446	41.5
Dudsar	*Aman* (med late)	2105	559	73.5	2102	1274	39.5
Badkalamkati	*Aman* (med late)	1504	909	39.5	1737	686	60.5
Indrasail	*Aman* (med late)	2962	755	74.5	3094	755	75.6
Nonaramsail	*Aman* (med late)	1693	426	74.7	1691	424	74.8
Chinsurah	*Aman* (med late)	3778	880	76.7	2501	713	79.1
Sundermukhi	*Aman* (med late)	2599	267	76.9	2362	272	88.5
Latisail	*Aman* (med late)	5427	1122	79.3	2906	1125	61.3
Ajan	*Aman* (med late)	3168	600	81.1	3173	561	82.3
Badshabhog	*Aman* (med late)	1938	316	83.2	1189	757	59.9
Juijasail	*Aman* (med late)	2499	331	85.5	2252	306	86.4
Boldar	*Aman* (med late)	2426	306	87.3	2426	309	87.3
Raghusail	*Aman* (med late)	2563	328	87.4	—	—	—
Rupsail	*Aman* (med late)	2156	284	87.7	2166	284	86.9
Patnai	*Aman* (med late)	2751	336	87.8	2256	336	85.1
Dandkhani	*Aman* (med late)	1722	152	91.2	1725	159	91.1

"Aus" varieties, though substantial, was in general less than that of medium late "Aman" varieties.

Certain abnormal trends in weather conditions have always been reported as being associated with severe outbreaks of helminthosporium disease. For instance, according to Sundararaman (25), unusually heavy rains at the time of ear formation followed by flooding and poorly drained conditions had favored the epiphytotic of 1918–19 in the delta of the Krishna and Godavari. Barat (2) reported that the rice crop suffered serious damage due to *H. oryzae* in Indochina, and mentioned that the outbreak followed untimely rainfall, late in the cold season. Similarly, a serious outbreak of the disease in Ceylon was reported to have been caused by wet humid weather, presence of sufficient inoculum, and poor growth of plants (1). Agricultural scientists in Bengal noted that weather conditions were unusual during 1942. Continuous cloudiness at the time of flowering and maturity of the crop was emphasized.

The nature and extent of the abnormal weather trends in 1942 were studied to see whether they could explain the outbreak. Relevant meteorological data, on (*a*) maximum and minimum temperature, (*b*) average range of daily temperature, (*c*) relative humidity at 8 hours and 17 hours, (*d*) cloud amount at 8 hours and 17 hours, (*e*) number of rainy days, and (*f*) rainfall for the months of October, November, and December 1941, 1942, 1943, and

1944 were obtained from the Director of Agricultural Meteorology, Poona, for three centers in Bengal where the disease was severe in 1942. Data of sunshine hours were available only from the observatory at Alipur in Calcutta. A comparative study of these data was made and the significant departures in weather conditions of 1942 deduced.

Secondly, the biology of the host and pathogen was examined to determine how the disease could have grown to epiphytotic proportions under the conditions that existed in 1942. During this exercise it was seen that on certain aspects of the phenomenon of infection sufficient data were not available; for example, the effect of weather conditions on spore release, leaching of nutrients, disease development, age of host on infectivity of *Helminthosporium oryzae*, etc. Some of these aspects were taken up for study at the Central Rice Research Institute, Cuttack, India by the writer and his colleagues, and have been integrated with the evidence in pathological literature in order to determine how the weather conditions of 1942 had favored the epiphytotic.

A Comparison of the Meteorological Factors of 1942 with Those of Other Years

MAXIMUM TEMPERATURE The maximum temperature varied from 25.0–32.2°C in 1942 and showed more or less the same trend in the other three years, though it was slightly less in the months of September and October in 1942 at two of the centers, compared to 1943 and 1944.

MINIMUM TEMPERATURE There was a difference between the monthly average minimum temperatures of 1942 for the period under study compared with those of 1941, 1943, and 1944. The average minimum for September and October were not different, but that of November was much higher in 1942. The minimum temperature in November 1942 on Sagour Islands was 21.1°C, whereas in other years it ranged from 18.9–20.0°C. The temperature in Calcutta was 20°C in November 1942, whereas in other years it ranged from 17–18°C. In Burdwan, the minimum was 19.4°C in November 1942; in other years it ranged from 16.7–17.2°C. This increase in average minimum temperature was also reflected in the average range of daily temperature which was much less in November 1942 (Table 2). The higher average minimum temperature of November 1942 and the lowering of the average daily range of temperature represent, therefore, a highly significant departure of weather conditions in 1942.

CLOUDINESS AT 8 HOURS AND 17 HOURS The cloudiness in daytime was greater in September 1942 than in 1941, 1943, and 1944, but it was not very different in October. There was an increase in cloudiness in November 1942 as compared to 1941, 1943, and 1944 (Fig. 1), at all the three centers for 17 hours and also at 8 hours, except in Burdwan where there was an increase in November at 8 hours.

Table 2 Mean minimum temperature and range of daily temperature (centigrade) in 3 locations during 1941, 1942, 1943, & 1944 in Bengal.

Mean Minimum Temperature	1941				1942				1943				1944			
	Sept.	Oct.	Nov.	Dec.	Sept.	Oct.	Nov.	Dec.	Sept.	Oct.	Nov.	Dec.	Sept.	Oct.	Nov.	Dec.
Sagour Islands	26.7	24.4	19.4	17.2	25.6	25.0	21.1	16.7	26.7	25.6	20	17.2	26.7	25.0	20	17.2
Calcutta	26.7	23.3	18.3	15.6	25.6	23.9	20.0	13.9	26.1	24.4	17.8	15.0	26.1	24.4	17.2	14.4
Burdwan	26.1	23.3	17.8	14.4	25.6	23.3	19.4	13.3	26.1	24.4	17.2	14.4	26.1	23.3	16.7	13.9
Range of Daily Temperature																
Sagour Islands	13.9	12.2	10.0	9.4	13.3	12.2	11.1	8.9	14.4	12.8	8.9	8.9	13.9	12.8	8.9	8.3
Calcutta	11.1	9.4	6.7	5.0	12.2	9.4	8.3	4.4	11.7	9.4	5.0	5.0	11.1	10.0	4.4	3.9
Burdwan	11.1	10.0	6.7	4.4	11.7	9.4	7.8	4.4	11.7	9.4	5.0	4.4	11.1	10.0	3.9	3.3

Table 3 Total hours of bright sunshine in 1942 as compared to 1941, 1943, & 1944, in Calcutta (Bengal).

Month	1941		1942		1943		1944	
	No. of sun-shine hours	Percentage of total sunshine hours	No. of sun-shine hours	Percentage of total sunshine hours	No. of sun-shine hours	Percentage of total sunshine hours	No. of sun-shine hours	Percentage of total sunshine hours
September	189.0	51	121.0	33	130.8	37	174	71
October	239.8	67	250.9	70	242.0	67	213	59
November	247.2	75	208.8	63	295.4	89	278	84
December	271.8	81	271.8	81	274.6	82	278	84

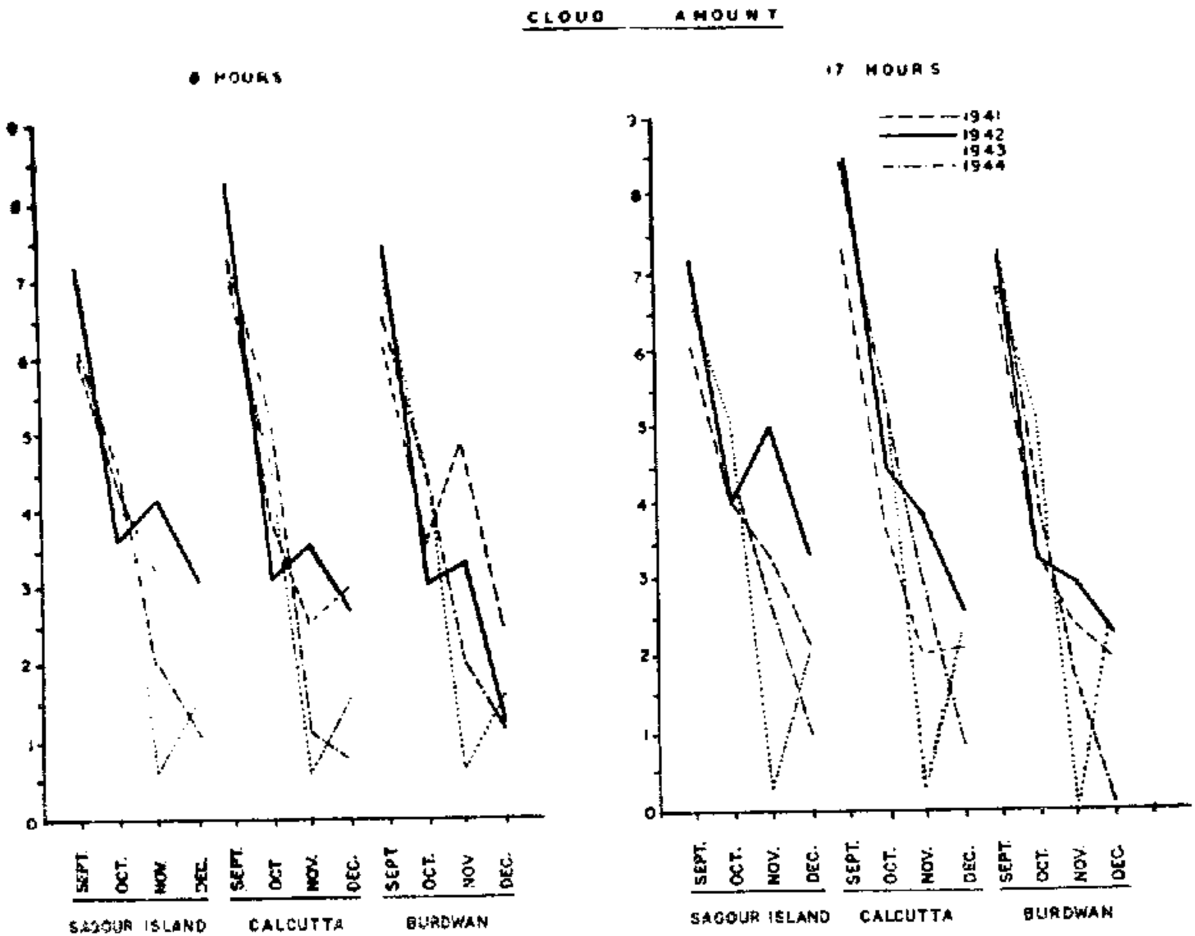

Figure 1 Degree of cloudiness at three localities in Bengal, September through December, 1941 through 1944, at 8 and 17 hours, expressed as hours of solar radiation.

NUMBER OF HOURS OF BRIGHT SUNSHINE The data on the "hours of bright sunshine" gives a better insight into the cloudy conditions than the data on cloudiness which are recorded at fixed times of the day over different sectors of the sky. The number of "bright sunshine hours" was lower in September, 1942 than in other years, but the November record of 63% out of possible sunlight of 208.8 hours for the whole month was the lowest record for November during the years under review (Table 3). Thus the low number of bright sunshine hours of September and November 1942 constituted a striking abnormality in that year.

NUMBER OF RAINY DAYS There were no rainy days in November during 1943 and 1944, but there were 2–6 rainy days in November 1942 in the 3 centers and 2–3 days in 1941. In this respect also, the weather factors of 1942 were somewhat different from those of the other two years (Fig. 2).

RAINFALL September 1942 was characterized by an exceptionally heavy rainfall of 40.6–65 cm whereas the rainfall in 1941, 1943, and 1944 during September varied from 8.9–33.8 cm. Similarly in October 1942 the rainfall was 17.5–20.0 cm while in the other 3 years it was 5.1–12.7 cm during this month, except in Calcutta where there was 26.9 cm. The most significant difference was seen in the figures of November. November and December were rainless during 1943 and 1944 whereas there were 2–6 days of rain with 0.8–10.4 cm of rainfall in November 1942 (Fig. 2). In 1941 there was some rainfall, especially in Burdwan (2–10.7 cm).

RELATIVE HUMIDITY AT 8 HOURS The average relative humidity was much higher during the whole of September 1942 in the morning, and similarly the relative humidity at 17 hours also was higher in the month of September 1942 when compared to other years.

To summarize, the epiphytotic year 1942 was different from the nonepiphytotic years of 1941, 1943, and 1944 in (*a*) unusually heavy rainfall in September, (*b*) unusual and prolonged cloudy weather in November, with very low sunshine hours and occasional rains, (*c*) higher minimum temperatures than normal (i.e., 19.4–21.4°C in November, whereas the normal average range of minimum temperature was 16.7–20.0°C in other years).

The Normal Crop Season and Disease Cycle in Bengal

There are three rice crop seasons per year in Bengal, *Aus*, *Aman*, and *Boro*. *Aus* is an upland direct-seeded crop maturing in 110–120 days. The seeds are sown broadcast towards the end of June with the commencement of monsoon, and the crop is harvested in September or early October. This crop occupies about 10–11% of rice area in Bengal. The *Aman* crop is transplanted in July-August and harvested in November-December. In waterlogged low-lying areas, a spring crop *Boro* (December-April) is grown when water recedes in November-December.

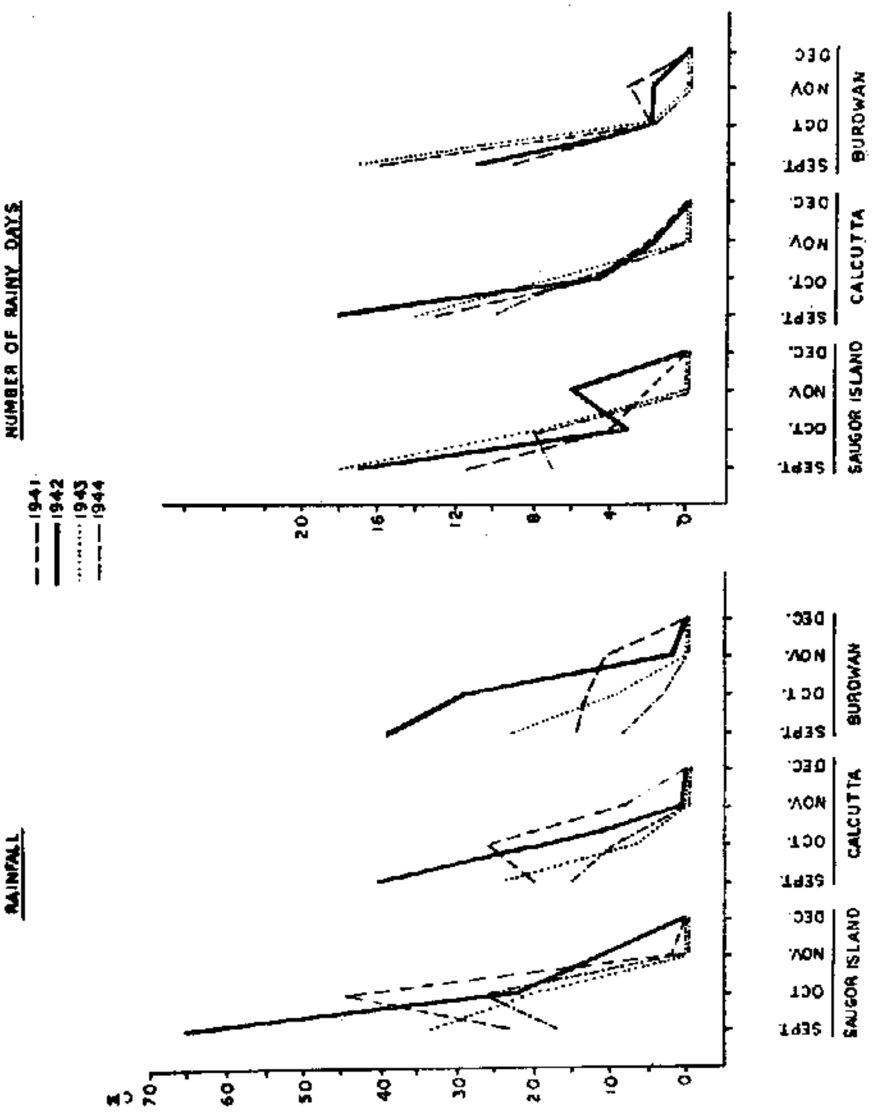

Figure 2 Rainfall (cm) at three localities in Bengal, September through December, 1941 through 1944.

In a normal season the monsoon starts in the third week of June, strengthening into heavy and continuous rainfall in July-August, and tails off towards the end of September, with a few occasional showers in October. November and December are rainless months. The total rainfall is about 152–200 cm except in North Bengal near the foothills of the Himalayas, where it is about 250 cm. The clear sky and favorable maximum of 28–30°C and the minimum of 17–20°C, November in Bengal represents an optimum condition for grain filling and maturity of the main *Aman* varieties.

Infected seeds (19, 22), alternate hosts (6, 21), and occasional air-borne conidia (4) are the probable sources of infection for the new crop sown in June-July.

The seed-bed infection is seen in a very mild form in June-July but is quite severe in the *Boro* seedlings raised during December-January. Very little infection is noticeable in *Aman* seedlings in transplanted fields during July-August and part of September. Toward the end of September, leaf-spots appear in the maturing *Aus* and in the *Aman* crop, and in some years the disease may be seen in a fairly severe form in the late *Aman* types towards November and December (Fig. 3).

Factors Favoring an Epiphytotic Outbreak of a Plant Disease

For intensification of cycles of infection of an air-borne pathogen like ***H. oryzae*** to produce an epiphytotic, there must be (*a*) multiple foci of infection from which an enormous quantity of propagules are released over a (*b*) prolonged continuous period of favorable conditions for establishment of infection on the host. (*c*) This process is greatly accelerated when the host is in the susceptible stage, preferably predisposed to infection by earlier conditions.

Critical Examination of the Meteorological Factors of 1942 in Relation to Development of the Epiphytotic

SOURCE OF INFECTION The crop season may have started normally with only slight incidence of *Helminthosporium oryzae* disease till the end of August.

The *Aus* crop that matures in normal seasons towards the end of September and first week of October, shows heavy infection at maturity. This infected crop provides a good source for spread of infection to the adjacent *Aman* crop which flowers and matures in November and December. During 1942 the early maturing varieties must have been heavily infected (compare data on loss of yield, Table 1) and must have provided the necessary multiple foci for spread and infection on the later *Aman* varieties.

FACTORS FAVORABLE FOR SPORE RELEASE OF CONIDIA OF H. ORYZAE The relation between production of conidia in nature and the weather conditions were studied at Cuttack (4). Once a week greased slides were exposed in 6 aeroscopes in 6 different locations at the Institute farm for a period of 24

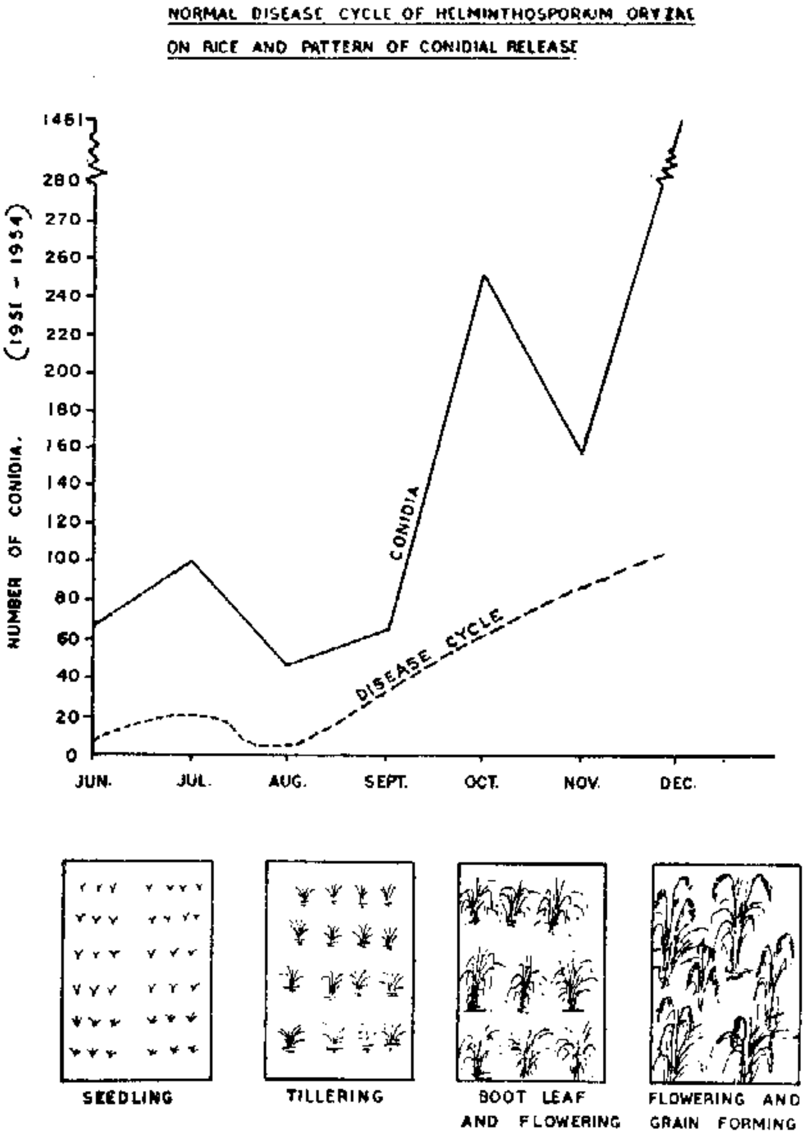

Figure 3 (Top) Average number of conidia of *H. oryzae* released from infected *Aus* and *Aman* rice, June through December, 1951–1954 in Bengal. Progress of disease is also shown. (Bottom) Corresponding stages in the development of a rice crop.

hours and the number of spores of *H. oryzae* trapped in the slides was determined. The study was continued for a period of 218 weeks from January-August, 1950 and then from April 1951 till December 1954.

The number of spores caught was generally lowest in May through August, while maximum spore-catch was in October through December. The spore-catch was thus very low during the summer and heavy rainy season. There was a very low population of spores in the air during the seedling stages of the crop; they were practically absent in the vigorous growth stage after transplanting, but appeared at time of flowering and maturity of the early varieties (September-October); the maximum population was attained at the time of flowering and maturity of the principal transplanted *Aman* crop (November-December) (Fig. 3).

To study the correlation between the weekly spore-catch and the meteorological factors, three apparently important factors, range of daily temperature, relative humidity, and solar radiation were taken into consideration. Three distinct periods that probably have an influence on spore production were studied with respect to the above factors: (*a*) the week ending with the days when spores were caught, (*b*) the last 4 days of that week and (*c*) a week before that in which the slides were exposed. Though no exact correlation could be established for all years between the spore-catch and factors for the different periods studied, some significant relationship could be seen in some years with respect to average relative humidity, range of temperature, or solar radiation. There was a correlation between these meteorological factors and spore-catch for one or the other of 3 periods studied (Table 4). The meteorological factors of the week ending with spore-catch, of the last 4 days of that week, and of the previous week, apparently had some relation to the number of spores trapped. The relevant data are presented in Table 5.

Though it might be difficult to establish statistical correlation between meteorological conditions and variations in spore-catch with data collected for only 218 weeks, yet a few associations between weather trends and a sudden rise in spore-catch were seen. In these weeks (principally in October, November, December, and March) there was a sudden enormous increase in spore-catch on the slides.

The periods prior to the days of slide exposure were characterized by (*a*) a sudden rise in relative humidity followed by a few dry days, (*b*) fall in the daily temperature range (difference between the maximum and the minimum for each day), (*c*) low solar radiation and cloudiness, and (*d*) intermittent light showers.

Conidia of *Helminthosporium* closely resembling those of *H. oryzae* were collected and counted. As the slides were exposed over rice fields close to the infection site, the assumption of identity was considered to be justified.

Spore release data from Cuttack indicate that the occurrence of even a few days with clouds and slight drizzle during the period, October to March, would result in an enormously increased spore release. Since these favorable conditions occurred continuously over the whole month of November in

1942 in the three centers studied it is probable that an unprecedented spore release occurred continuously during November 1942, thus providing one of the most essential conditions for the development of an epiphytotic.

INFECTION OF RICE BY H. ORYZAE The optimum temperature for germination of conidia, growth of the fungus in the culture, and infection of the host lies between 25–30°C (9, 13, 14, 17, 18).

Contact with water at the leaf surface is essential for germination and infection of rice leaves by the pathogen, depending upon the prevailing temperature. The period of continuous contact with water necessary for establishment of infection is 8 hours at 20°C, 4 hours at 25–30°C, and 6 hours at 35°C (9). Sherf et al (24) however, have stated that 10 hours of continuous contact with water was necessary for establishment of infection by *H. oryzae* at 20°C. Naito (16) and Imura (11, 12) found that penetration of rice

Table 4 Relation between weather conditions and spores of *H. oryzae* caught in different weeks. Correlation coefficient between weekly catch of spores of *H. oryzae* and weather factors. Significant figures shown by*.

Year	Number observations	Daily average relative humidity for the week	Daily average relative humidity for the last 4 days of the week	Daily average relative humidity for the previous week
1951–52	32	0.3553*	−0.5122*	0.0335
1952–53	34	0.2860	0.2308	0.2532
1953–54	34	0.1298	0.1788	−0.0766
1954–55	14	0.002228	0.4086	0.1439
Year	**Number observations**	**Range of temperature for the week**	**Range of temperature for the last 4 days of the week**	**Range of temperature for the previous week**
1951–52	32	−0.1312	−0.2353	0.01497
1952–53	34	−0.4950	−0.3775*	−0.395*
1953–54	34	0.1632	0.0751	—
1954–55	14	0.2224	0.0918	—
Year	**Number observations**	**Solar radiation (hours) for the week**	**Solar radiation (hours) for the last 4 days of the week**	**Solar radiation (hours) for the previous week**
1952–53	34	−0.5369*	−0.1252	−0.2705
1953–54	34	0.1437	0.0615	0.190
1954–55	14	0.0965	−0.0088	−0.5991*

Table 5 Daily weather record of weeks in which there was a sudden increase in the spore-catch of *Helminthosporium oryzae*.

No. of spores trapped	Date	Relative humidity	Range of temperature	Hours of solar radiation	Remarks
17	21-11-1951	90	21.0	—	Foggy
	22-11-1951	97	22.5	—	
	23-11-1951	73	25.5	—	
	24-11-1951	64	22.3	—	
	25-11-1951	75	13.3	—	Cloudy
	26-11-1951	95	7.0	—	Cloudy and rain
75	27-11-1951	92	9.0	—	Cloudy
	21-11-1951	92	18.5		
46	5-12-1951	73	23.5	—	
	6-12-1951	81	23.4	—	
	7-12-1951	80	20.0	—	
	8-12-1951	79	23.3	—	
	9-12-1951	57	18.0	.	Cloudy
	10-12-1951	57	17.0	—	Cloudy
450	11-12-1951	63	11.5	—	Cloudy light rain
	12-12-1951	61	15.0	—	Cloudy breezy
4	7-3-1952	—	—	—	
	8-3-1952	86	21.3	9	
	9-3-1952	90	27.0	9	
	10-3-1952	84	22.5	9	
	11-3-1952	84	17.5	9	
	12-3-1952	81	30.8	3½	Cloudy
54	13-3-1952	80	19.0	8	Cloudy
	14-3-1952	77	19.2	6½	Cloudy and dust storm on previous night
	8-10-1952	98	4.0	Nil	Cloudy
7	9-10-1952	98	4.5	Nil	Cloudy and drizzle
	10-10-1952	91	8.4	1.0	Cloudy and drizzle
	11-10-1952	91	5.0	Nil	Cloudy
	12-10-1952	83	12.0	6½	Cloudy
	13-10-1952	85	4.0	6	Cloudy
162	14-10-1952	87	10.0	7	Cloudy
	15-10-1952	91	11.5	5½	Cloudy
5	8-12-1954	71	28.8	10.0	Cloudy
	9-12-1954	90	24.8	9.0	Cloudy (slight)
	10-12-1954	89	23.5	9.0	Cloudy and foggy
	11-12-1954	75	19.3	8.5	Cloudy
	12-12-1954	56	13.5	0.5	Cloudy
	13-12-1954	48	14.5	4.25	Cloudy
138	14-12-1954	65	21.1	7.75	Cloudy
	15-12-1954	66	28.0	10.0	Scattered cloudy

leaves and development of lesions were favored by darkness or partial shade, and retarded by sunlight. According to Hemmi & Suzuki (10), both excessive soil moisture and drought conditions favor development of the disease.

From the multiple infection foci provided by the *Aus* crop and the stubble left in the field, spores would be continuously released in 1942, as in a normal season. The temperature factor (maximum-minimum being 24.4–29.4° C) was quite favorable for infection in the *Aman* crop, the few cloudy days in October affording more favorable conditions for spore release and infection than the corresponding month in other years. In November 1942 the weather condition—cloudy days, slight drizzle, and high minimum temperature—provided exceptionally favorable conditions for abundant continuous spore release and infection.

HOST FACTOR Padmanabhan & Ganguly (23) have shown that the susceptibility of rice to *Helminthosporium oryzae* increases with age, and that it is most susceptible to infection at the time of flowering and maturity. Therefore, the third important condition for the development of an epiphytotic—the presence of a susceptible host—was apparently satisfied since the crop was at flowering and maturing stages throughout Bengal in November-December.

PREDISPOSING FACTORS Leaching of nutrients from the soil (5), low potassium status (20), upsetting of the iron-manganese ratio (3), low nitrogen status of the soil (7, 15), excessive soil moisture (10), and, waterlogged soil (8) favor the disease.

Evidence for the amount of nutrient loss sustained in normal rice soil in monsoon season under moderate rainfall is given in Table 6.

From the above data it might be inferred that leaching by heavy rainfall in 1942 must have been particularly large. The waterlogged condition that must

Table 6 Average loss of nutrients through leaching in flooded soil cropped to rice in 10 weeks during *kharif* (June–December 1972) at the Central Rice Research Institute, Cuttack (Shinde, Vamadevan, and Asthana, Unpubl.)

Nutrient	Leaching loss kg/ha.	Rainfall received during the crop growth in mm.
Nitrogen[1]	45.64	724.4
Iron	46.48	
Manganese	17.00	
Potassium[2]	10.08[3]	

[1] Applied at 150 kg/ha level in 3 splits (1) 37.5 kg at transplanting, 60 kg at tillering, and 52.5 kg at panicle initiation.

[2] Applied at 40 kg $K_{2}O$/ha at final puddle.

[3] Data for 2 months only.

have followed is another predisposing host factor. Therefore, the crop was in a susceptible stage in November and also heavily predisposed for infection.

The scales were apparently heavily loaded against the host and in favor of the pathogen in the interaction of the host, pathogen, and environment in the 1942 rice crop season in Bengal, with the result that the most devastating recorded epiphytotic of helminthosporium disease of rice broke out in that year.

The Possibility of Forecasting Outbreaks of Helminthosporiose in India

Though exact correlations of disease outbreaks with meteorological conditions (macro- and micro-climatic factors) could only be established by studying a number of such epiphytotics, the indication obtained in this study might be useful for watching for such weather conditions as those of 1942. Cloudiness, light rainfall, heavy dew, and temperature of 20–29.4°C throughout the days continuously for a week with reduced hours of sunshine (say below 75% of normal during October or November) should constitute a warning that a severe epiphytotic of helminthosporiose is likely to occur.

A comparative examination of the meteorological data of 1942 with those of 1941, 1943, and 1944 revealed that the 1942 season had excessive rainfall in September, uniformly favorable temperatures of 20–30°C continuously for two months, unusually cloudy weather and rains in November, and a higher minima than usual in November (20°C). Experimental evidence on the temperature relations of germination, growth, infectivity, spread of lesion, and spore production in nature, and predisposition of the host show how the unusual weather trends of 1942 would have helped the rapid spread of the disease and led to an epiphytotic.

Acknowledgment

My thanks are due to Dr. L. A. Ramdas, and Mr. P. Mallik, Agricultural Meteorology, Poona, for providing meteorological records for the years 1941 through 1944 for the different centers in Bengal, and to Dr. M. Gangopadhyaya, for furnishing the "sunshine records" of Calcutta from the Alipore Observatory.

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