Seed Infection and Seedling Blight of Paddy in the Dry Zone

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THE TWO most important diseases of paddy in Ceylon and also in other rice growing countries are Paddy "Blast" caused by the fungus *Piricularia oryzae* and "Brown spot" or "Helminthosporiose" caused by the fungus *Helminthosporium oryzae*. The *Piricularia* disease has been really the more important of the two for a long time in Ceylon, but during recent years *Helminthosporium oryzae* has assumed increasing importance especially in the dry zones of the Island. *Helminthosporium oryzae* may occur on any part of the rice plant at any time during its entire life. Thus, germinating seedlings may be attacked causing the phase known as seedling blight. Ocfemia (1924) found the mortality amongst seedlings in the Philippines to vary from 10 to 58 per cent. while Tucker 1923 recorded 15 per cent. kill of seedlings in Puerto Rico. The second phase of the disease is the appearance of spots on the leaves. Sometimes the intensity of spotting may be such as to reduce the effective leaf surface, causing a marked weakening of plants, and the foliage may present a scorched appearance. The most important phase is when the inflorescence and the earheads are attacked, causing spotting in various degrees and reduction of the crop. Normally the damage caused is not very serious but under favourable conditions for the disease wide-spread epiphytotics may result in considerable losses.

Paddy Disease Survey

During the course of the year a survey of paddy samples from various parts of the dry zone was carried out to determine the amount of seed infection present with special reference to *Helminthosporium oryzae*. Representative random samples of seed paddy harvested from the *maha* 1953-54 crop were drawn, taking care, where large stocks are involved, to derive the final sample from a mixture of the contents of 20-25 bags.

Visual methods of separation of a sample into spotted, discoloured or healthy grains, which was first attempted, was found to give only a very rough assessment of the amount of seed infection in a sample, as even apparently healthy seed may contain infection. For infection rating therefore another technique was used. This consists of surface sterilizing the seed in mercuric chloride, washing in sterile water and plating a random 100 seeds on sterilized dextrose agar plates. The plates were incubated for 7 days at room temperature and the number of seeds yielding fungal growth was recorded. Not only is an accurate assessment of the infection rating thus

Table 1.—Paddy Disease Survey— Maha 1953–54

Station	Variety of Paddy	Percentage of Infection				
		Helminthosporium	*Curvularia*	*Trichoconis*	*Fusarium*	*Mucor*	*Penicillium*
Anuradhapura	V. I.	12	2	—	—	—	—
	H. M. C. 20	14	1	—	6	2	—
Bathmedilla	V. I.	2	5	7	—	—	—
	Dickwi	4	10	—	—	—	—
Hingurakgoda	V. I.	32	6	—	—	—	—
	H. M. C. 20	26	8	—	—	—	—
	Mas	24	4	—	—	—	—
	P. T. B. 16	46	—	—	—	—	—
	Murungakayan	12	—	—	—	4	—
Horana	Hondarawal	—	—	5	—	4	—
	Dickwi	49	8	—	—	—	—
Karadian Aru	V. I. S 2	30	—	—	—	—	—
	V. I.	36	1	—	—	—	2
	Perillanel	27	—	—	—	—	—
	Uvar Vellai	63	—	—	5	—	—
	Murungakayan	24	—	—	—	—	—
Kilinochchi	V. I.	3	1	—	—	—	—
Maha Illuppallama	P. P.	48	4	—	—	14	—
	V. I.	14	20	—	—	6	4
	V. I. (Range)	34	14	—	—	2	4
	Heenati	12	3	15	—	—	3
	H. M. C. 12—S 4	2	1	—	9	—	—
	Sulai	19	—	—	—	3	—
	H. M. C. 20	12	3	—	—	—	—
	V. I. (S 4)	18	1	—	6	3	—
	V. I. (S 3)	5	—	7	—	—	—
Minneriya	H. M. C. 20	20	—	—	—	8	2
Murunkan	V. I.	14	3	—	—	—	2
Nalanda	P. P.	—	—	—	14	12	4
	Molagusamba	6	—	—	12	—	4
	Mas	10	3	16	—	—	—
Nikaweratiya	V. I. (Wet)	6	—	—	—	5	—
	V. I.	26	3	—	—	6	—
	Murungakayan	11	4	4	—	4	—
Okkampitiya	V. I.—S. A.	6	5	—	—	—	—
	V. I.—S. B.	3	4	—	—	—	—
Paranthan	V. I. S 1. Bl. A	17	—	—	—	—	—
	V. I. S 2. Bl. B	12	—	—	10	16	—
	V. I. S. 3. Bl. C	14	—	—	8	14	—
	V. I. S 4. Bl. D	28	—	4	—	12	—
	V. I.	16	2	—	—	—	—
	S. R. 26B	—	2	—	—	—	—
	Periya Vellai	26	2	—	—	—	—
	S. R. 26	—	3	—	—	—	—
Polonnaruwa	P. P.	55	8	—	6	—	—
	Podiwi A S	—	4	—	8	—	—
	P. T. B. 16	14	10	—	—	—	—
	Molagusamba	28	2	—	—	10	—
	Kohumawi	5	2	—	6	—	—
	H. M. C. 20	16	5	—	4	—	—
	Kurulutuduwi	6	—	—	3	—	—
	V. I.	24	2	9	—	10	—
Tabbowa	V. I.	3	9	36	—	—	—
	Dickwi	—	—	21	—	2	—
Unichchai	Oddavalan	38	4	—	—	—	—
	V. I.	33	—	—	4	—	—
Vakaneri	V. I.	22	2	—	—	—	—
Vavuniya	V. I.	14	2	—	—	—	—
	V. I. Highland	5	6	12	—	—	—

possible, but the actual fungi themselves could be identified by this method. Table I gives the results of the examination of 59 samples of paddy comprising of various varieties collected from different localities.

It would be seen that the percentage numbers denote the amount of internal seed infection of the samples as any surface infection would have been controlled by the effects of mercuric chloride. The fungi that are most commonly associated with the material examined were *Helminthosporium oryzae, Curvularia lunata, Trichoconis* sp. and the saprophytes *Murcor, Fusarium* and *Penicillium* sp. *Curuvularia* and *Trichoconis* could be considered weak parasites and have not been of any economic importance so far in our paddies. *Helminthosporium oryzae* is most consistently associated with the samples, the percentage of infection varying from 0—63 per cent. A point of some significance is that none of the localities from which the samples were collected were completely free from *Helminthosporium.* It is also interesting that none of the samples tested yielded *Piricularia oryzae* although *Piricularia oryzae* occurs sporadically in these areas. Certain workers Aoki (1937), Hemmi *et al.* (1937) and Anderson *et al.* (1947) have observed indications of an antagonism between *Piricularia oryzae* and *Helminthosporium oryzae* and it may well be that even if *Piricularia oryzae* were present in the samples it was unable to express itself in the presence of *Helminthosporium oryzae.*

Seed Disinfection

The question of disinfecting paddy seed infected by *Helminthosporium oryzae* has engaged the attention of numerous workers in the past. The results have been rather conflicting. For example Nisikado and Miyake (1922) claimed that dressing with mercuric choride, silver nitrate, copper sulphate, formaldehyde, &c., gave partial or entire control. Maung Thet Su (1932) found formalin, copper sulphate, sulphur, ceresan and hot water treatment gave no control at all. On the other hand Bugnicourt (1934) found treatment with formaldehyde effective and Cralley and Tullis (1937) using formaldehyde, organo-mercurials and red copper oxide got control only with the organo-mercurials. Reyes (1939) and Ocfemia (1924) found disinfection by chemicals ineffective.

It would be noted that inasmuch as infection can occur within the glumes of the grain, most fungicides like copper derivatives which will disinfect any fungus or spores that are found outside the seed will not exert much influence on the infection within the seed. The organo-mercurials which are volatile, however, are at an advantage in this regard inasmuch as they can exert a fumigant effect which could reach to some extent the fungus within the glumes. A number of laboratory experiments have been carried out to evaluate the efficacy of various available seed dressings on the control of seed-borne infection. In all cases seed naturally infected with *Helminthosporium oryzae* was used. The samples were treated with the various liquid or dry fungicides at the recommended rates and stored for a week. They were then put under pressure and the germinating seedlings were planted out in replicated glass dishes containing paddy soil. The seed dressings used were cupric oxide, cuprous oxide, copper carbonate,

Table II—Effect of Various Fungicides on the Control of Seedling Blight of Infected Paddy

Fungicide	*Active ingredient*	*Test 1*	*Test 2*	*Test 3*	*Test 4*	*Test 5*	*Test 6*	*Text 7*
		Vellai-illankalayan	*VI*	*VI*	*Pachchai-perumal*	*HMC20*	*Pachchai-perumal*	*Odda-valan*
		Percentage of Healthy Seedings						
Ceresan	Organo-mercurial	58·4	53·2	54·0	38·0	47·3	38·6	73·3
Agrosan	Organo-mercurial	59·6	53·6	36·0	54·6	59·3	56·0	84·3
Tillex liquid	Organo-mercurial	66·0	62·8	44·6	72·0	58·6	62·0	80·6
Tillex dust	Organo-mercurial	52·0	48·0	25·3	62·0	44·0	38·6	—
Copper lime	Copper carbonate	44·4	42·0	—	—	—	—	—
Fernasan	Thiram	—	—	26·6	16·0	38·0	23·3	—
Shell copper	Copper oxychloride	—	—	—	—	—	—	—
Cupravit	Copper oxychloride	—	—	—	—	—	—	—
Perenox	Cuprous oxide	50·8	46·8	44·0	48·0	36·6	30·0	—
Yellow cuprocide	Cupric oxide	—	—	—	—	—	—	47·3
Control	—	38·0	30·0	14·6	18·0	29·3	21·3	58·6

copper oxychloride, thiram and organo-mercurials Ceresan, Agrosan and Tillex. Untreated controls were kept as checks. The basins were placed near an open window in the laboratory. As the seedlings grow out the fungus also emerges causing varying proportions of seedling mortality in the various treatments. Table II summarizes the results of a number of such experiments giving the various percentages of healthy survivors that remained after three weeks from planting. The fungus growing at the collar of diseased seedlings was observed to be in the main *Helminthosporium oryzae*. The percentage of germination was not materially altered by any of the fungicidal treatments. The table shows that a rather high mortality of seedlings could be expected under the conditions of the experiment which obviously were conducive for attack by the fungus. The following conclusions could therefore be drawn :—

(1) Infected seedlings contained a high potentiality for seedling blight.

(2) The organo-mercurial fungicides have been more effective than copper or thiram fungicides in controlling this potential infection.

(3) Even with organo-mercurials, although a high degree of disinfection was obtained, 100 per cent. efficiency was not obtained.

Padmanabhan and others (1948) have shown that spotted seed is slightly lower in weight when compared to healthy seed. Inasmuch as the method of seed disinfection employed in the Japanese method of paddy cultivation incorporates prior to disinfection with copper fungicides, the immersion in a salt solution of S. G. 1.13 to separate out healthy seed, this method was explored to find out the extent of possibility of eliminating the infected seed from a seed sample. Three infected varieties *Pachchaiperumal, Velladi Illankalayan* and *Murungakayan* were treated with the salt solution method and the chemical method using Ceresan, keeping also untreated controls. The lots were grown

Table III.—Effect of Salt and Chemical Treatment on Infected Seed

Variety	*Murungakayan 32 per cent.* H.oryzae	*Vellai Illankalayan 32 per cent.* H.oryzae	*Pachchaiperumal 55 per cent.* H.oryzae
Control	30·6 ± 9·2	18·6 ± 1·1	24·6 ± 5·2
Salt treatment	24.6 ± 6.4	22.6 ± 6.1	12.0 ± 4.0
Ceresan	5.3 ± 3.8	10.6 ± 3.5	8.0 ± 2.0

in basins containing soil, in three replications. The seedling mortality per 100 seeds is shown in Table III.

It is evident that adequate separation of infected seed is not possible with the salt solution S.G. 1.13 alone. The organo-mercurial Ceresan gave the best control. In the Japanese method of seed treatment the salt water treatment is followed by treatment with a copper fungicide (Perenox) which controls a certain proportion of infection. Inasmuch as copper fungicides have been shown to be less effective than organo-mercurials in this respect it would be more advantageous to use the organo-mercurials in preference to the copper fungicides, using the precautions in handling that are prescribed in the use of organo-mercurials.

Field Trials

Field trials using seed treated with Ceresan, Yellow cuprocide, Agrosan and Tillex as against untreated controls have been characterized by two important features : (1) compared with the potential infection in the seed used there is an overall low infection rate in the seedlings in the various treatments and controls ; (2) there was no measurable difference in the seedling infection between the treatments and the untreated controls. Table IV summarizes the percentage of infected seedlings obtained in these trials.

It is clear that in the field a high seed infection has not brought about the high seedling infection observed in laboratory experiments.

Table IV— Percentage of Infected Seedlings in Field Trials on Control of Seedling Infection

Locality	*Season*	*Variety*		*Control*	*Agrosan*	*Fernasan*	*Ceresan*	*Tillex*	*Yellow cuprocide*
Hingurakgoda ..	Yala 1954 ..	Wanni Dahanala 44 per cent.	Wet sowing ..	1·06 ..	1·49 ..	— ..	1·53 ..	1·14 ..	1·11
Karadian Aru ..	Yala 1954 ..	Oddavalan 38 per cent.	,, ..	3 ..	1·8 ..	— ..	1·2 ..	1·4 ..	2·4
	Maha 53/54 ..	Vellai Perenal ..	Dry sowing ..	9·68 ..	7·9 ..	8·16 ..	— ..	3·92 ..	4·72

Greenhouse Trials

Inasmuch as under field conditions accurate measurement of seed mortality presents considerable difficulties, other experiments were carried out to check the negative results obtained in the field. Infected seed containing 38 per cent. *Helminthosporium* was treated with various fungicides and planted out in basins in soil. One set of replicates was maintained under laboratory conditions while another set was placed in the open in the greenhouse and the seedling infection recorded. The results obtained are shown in Table V.

These further confirm the results obtained in the field trials that seedling blight is reduced in paddy grown in the open in comparison with the laboratory trials.

Discussion

Ocfemia (1924a) has shown an interesting relation between the development of the disease and soil temperature. Although the optimum temperature for the growth of the fungus is 28°C. he has demonstrated that the maximum mortality occurs between 16-24°C. when the seeds emerge slowly. Indeed 100 per cent. mortality could occur at 16°C. At 28°C. mortality is greatly reduced while raising the temperature still further to 36°C. results in negligible loss. The quality of the seed (as regards infection) affects the germination at soil temperatures from 16-24°C. Thomas in India has found a similar result. Padmanabhan and others (1949) also report that when they sowed seed infected to varying proportions no significant differences were observed as regards seedling

TABLE V

Variety of Paddy	*Treatment*	*Dosage*	*Estimation of internal contamination per cent. by plating*	*Germination*		*Seedling Blight*	
				Lab.	*Plant House*	*Laboratory Temp. 24.5-27.5°C.*	*Green Hou Temp. 25 -32.5°C*
Oddavalan ..			.. 38 per cent. H				
	Perenox	4 oz/10 gallons	..	.. 90·6	.. 88·0	.. 18·6	.. 2·6
	Shell Copper	4 oz/10 gallons	..	.. 90·0	.. 90·0	.. 26·0	.. 3·3
	Cupravit	4 oz/10 gallons	..	.. 88·0	.. 89·3	.. 26·0	.. 3·3
	Ceresan Wet	1 oz/1gallon/1 cwt.	..	.. 81·3	.. 77·3	.. 25·3	.. 1·3
	Control	—	..	.. 83·3	.. 86·6	.. 31·3	.. 5·3
Vellai Illankalayan ..			.. 63 per cent. H				
	Ceresan Wet	1 oz/1 gallon/1 cwt.	..	.. 86·0	.. 84·8	.. 17·2	.. 0·6
	Perenox	4 oz/10 gallons	..	.. 68·0	.. 59·2	.. 19·2	.. 1·6
	Control	—	..	.. 63·6	.. 66·4	.. 32·0	.. 6·8
Vellai Perenel..			.. 28 per cent. H				
	Agrosan	4 oz/1 cwt.	..	.. 93·0	.. 93·5	.. 17·0	.. 1·0
	Ceresan Wet	1 oz/1 gallon/1cwt.	..	.. 91·0	.. 88·5	.. 22·5	.. 3·0
	Perenox	4 oz/10 gallons	..	.. 87·0	.. 87·5	.. 25·0	.. 4·5
	Control	—	..	.. 89·0	.. 88·0	.. 25·0	.. 8·5

blight when compared with healthy seed. They conclude that the seedling blight phase is not likely to cause extensive damage in Bengal.

Temperature records for Hingurakgoda show that the maximum air temperature in the shade is above 32.5°C. up to about the middle of October when it starts dropping below this figure. The soil temperature in the open fields is however unavailable but could be expected to be even higher. It would therefore be reasonable to conclude that the depression of the seedling blight phase of the disease is due to the high soil temperatures obtained during germination. The position is that although dry zone seed is known to contain a high potential for causing seedling blight, when grown under normal field conditions with a high soil temperature of over 28°C. the seedling blight phase is reduced. This phase of the disease caused by *Helminthosporium* has so far been of no importance in the dry zone.

The reduction in seedling blight at temperatures above 28°C. is ascribed by Ocfemia to the rapid growth of the seedlings at this temperature which enables them to outgrow the fungus. There is no indication, however, that the fungus is killed. It is therefore reasonable to infer that any condition which helps the quick and vigorous growth of the plant would help the seedlings to outgrow the fungus. Under conditions which are far from ideal for seedling growth the fungus can be expected to assert itself. It may be possible on this assumption to explain the observation made last *maha* that infected seed gave severely attacked plants when grown on newly cleared highland but when grown under normal mud-sown conditions resulted in much milder infection.

Either with seed dressings or without it is evident that a small proportion of seedlings do give rise to primary infection which under suitable climatic conditions of intermittant rains as obtaining in *maha* at Hingurakgoda may be able to build up to an epiphytotic. The ideal should therefore be to use clean seed as far as possible or at the most seed of low infection rating, disinfected with an organo-mercuric fungicide.

It may also be pointed out that although seed dressing does not appear to have any advantage over the untreated paddy in the control of seedling blight under the favourable conditions of temperature, where a stock of paddy is distributed for growing under widely differing conditions, seed dressings are a necessary insurance against seedling blight. There are indications that when severe epiphytotics of *Helminthosporium* occur in the dry zone it is generally at the flowering stage of the paddy plants. Control of this secondary infection has really to be approached from the angle of ameliorating soil conditions and selection of resistant varieties.

Summary

1. A survey of paddy seed stocks in the dry zone has shown a high incidence of infection with *Helminthosporium oryzae*.

2. In laboratory experiments organomercurials have shown considerable efficiency in controlling this seed infection from causing seedling blight.

3. In the field, however, in spite of the high infection in the seed, seedling blight phase of the disease is relatively low.

4. The high soil temperature of over 28°C. obtaining in the dry zone is shown to play an important part in suppressing the seedling blight phase of the disease.

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