SHEATH BLIGHT DISEASE OF RICE IN THE LOW COUNTRY WET ZONE OF SRI LANKA: EFFECT ON YIELD AND FACTORS INFLUENCING SPREAD AND DISTRIBUTION

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ABSTRACT

Sri Lanka, a tropical island, is agro-ecologically divided into several regions. The low country wet zone comprises land up to 300m above mean sea level with a mean annual rainfall of 2500mm-5000mm.

Sheath blight disease caused by *Rhizoctonia solani* Kuhn., is considered to be the most prevalent disease of rice in this region. Grain and leaf spotting, sheath rot and to a lesser extent leaf and neck blast are the other diseases of rice observed.

Research investigations have revealed that sheath blight causes yield losses. The factors that predispose the rice crop to this disease are high seed rate and high nitrogen with low potash inputs. Fungicides Pencycuron and Tri-phenyl-tin-hydroxide have effectively reduced sheath blight infection. Screening for disease resistance has not yielded a single resistant line.

Field reports indicate a marked increase in sheath blight infection over the last five years. However yield losses have not been substantial. Chemical methods of control have been used to a limited extent while cultural practices are favored by farmers.

Introduction

Sri Lanka which is a tropical island situated at the tip of India to the South is surrounded by the Indian ocean between 6°-10° N latitude and 79°-82° longitude. The 625,000 km^2 land area of Sri Lanka covers a wide range of soil types and climatic zones, on the basis of which the island is divided into several agroclimatic zones (Fig. 1).

Sri Lanka experiences a typical bi-modal rainfall. This gives rise to two planting seasons namely 'Yala' and 'Maha'. Yala season gets its rainfall from the southwestern monsoon and extends from March to August with the peak rainfall in April-May. The Maha season gets its rainfall from the northeastern monsoon and extends from September to February with its rainfall peak in October-November. In consideration of this rainfall pattern and its distribution, the island is broadly divided into three zones. The dry zone receiving 1270-1904 mm of mean annual rainfall, the intermediate zone receiving 1905-2540 mm of mean annual rainfall and the wet zone receiving over 2540 mm (Balasuriya, 1987). The dry and intermediate zones receive the major part of their rain during the Maha season and the wet zone during the Yala season. Rainfall in Yala in the dry zone does not warrant a second crop of rice within the same year unless there is sufficient water collected in reservoirs from Maha rains. In the wet zone in this respect double cropping with rainfed rice can be implemented during the same year. Regional and local phenomena determine the rainfall pattern in Sri Lanka. Monsoonal rains are brought about by regional phenomena while convectional rains result from local phenomena according to Panabokke (1980) who further sub-divided the dry, intermediate and the wet zones based on elevation. The land below 300 m elevation is designated as 'low country', between 300 m and 1,000 m as 'mid-country' and the land above 1,000 m as 'up-country'. This demarkation is shown in the agroecological map of Sri Lanka by Panabokke (1980) and is given in Fig. 1. The low country wet zone is shown separately in Fig. 2. He has also made

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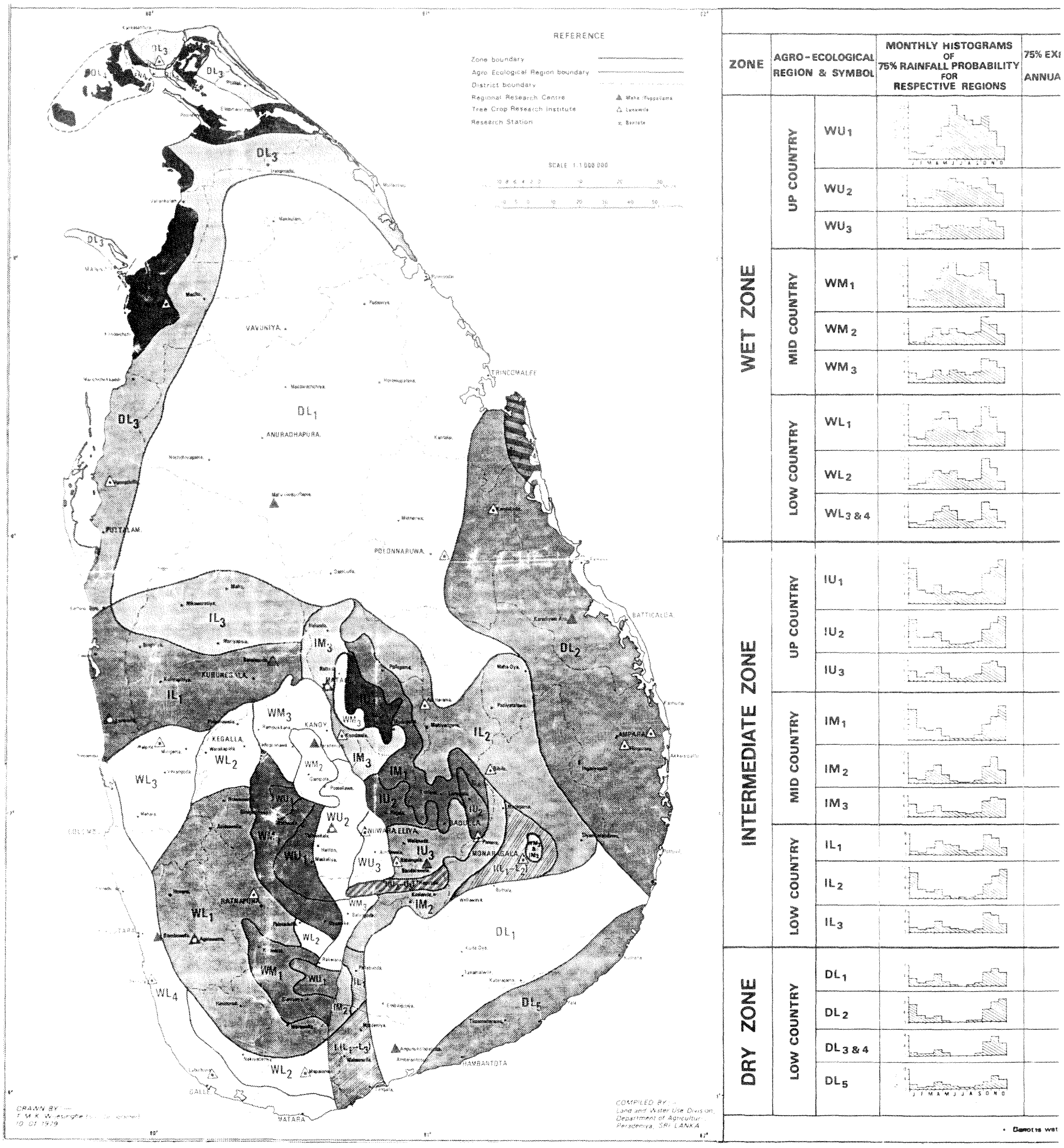


Fig. 1 Agro-ecological regions of Sri Lanka.

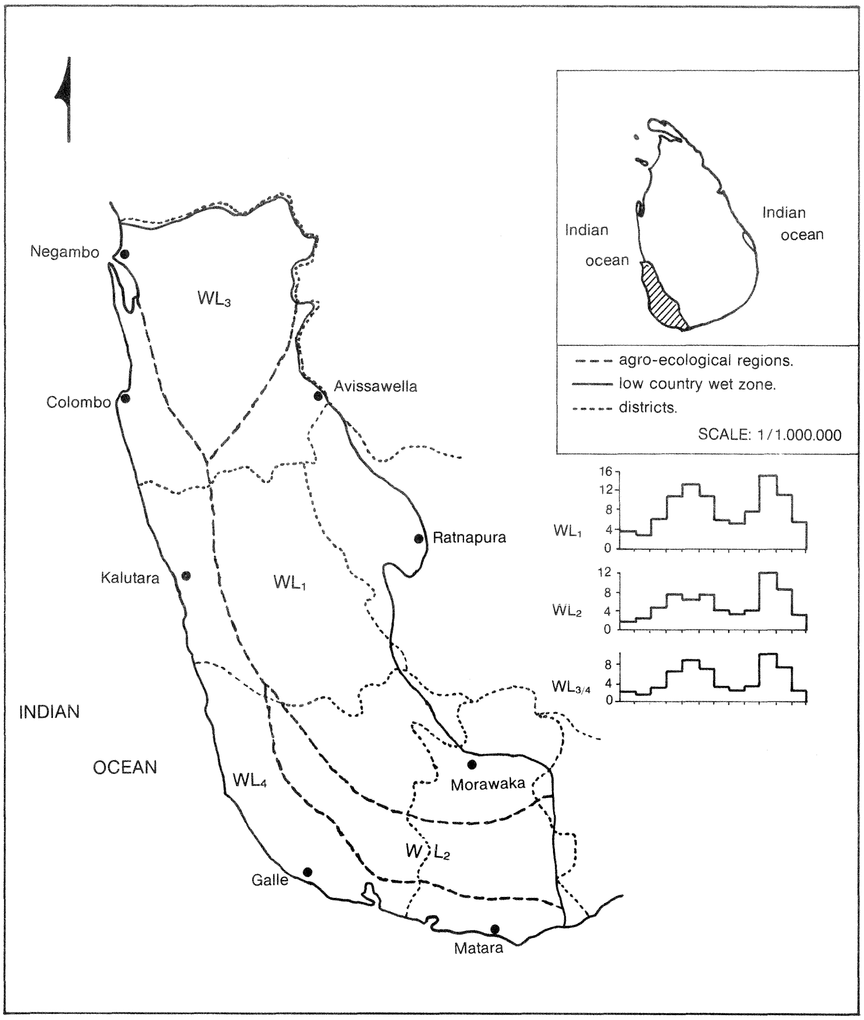


Fig. 2 Agro-ecological regions in low country wet zone of Sri Lanka.

recommendations on plantation, arable and tree crops most suitable for these agroecological regions. The annual sequential rainfall probability histograms for the respective regions are also shown in Fig. 1.

To supplement the shortage of water in the dry zone, the government of Sri Lanka has embarked on a massive irrigation project funded by several donor countries. This project involves the largest river in Sri Lanka, the 'Mahaweli' river which extends over 331.7 km and flows over 160 km. The waters of Mahaweli are to be used for the development of large amounts of unused land. The gross area covered by this project is 2.5 million ha which accounts for 55% of Sri Lanka's dry zone and 39% of the whole island (Blackenburg, 1980). The project envisages the irrigation of 350,000 ha of land out of which 225,000 ha are new land. Fifteen reservoirs are to be set up by the construction of 15 dams located on the Mahaweli, its tributaries and the 'Maduru' river. Eleven of these will operate hydro-power stations giving a total of 2,037 kwh per year. (Fig. 3).

Fig. 3 Map of Sri Lanka showing the Mahaweli development project areas and boundaries.

The population of Sri Lanka in 1986 was 16.1 million giving an average of 249 persons per km^2. Densities are higher in the urban areas like the capital city, Colombo which has recorded 1,187 persons per km^2 (Central Bank, 1986). Thirty six percent of the country's population is distributed in the low country wet zone which comprises 5 out of the 24 districts of the island. The area covers about 1/8 of Sri Lanka and has about 150,000 ha of rice lands. This is out of a total of 720,000 ha of rice lands in the whole country (Balasuriya, 1987). The rainfall of over 2500 mm distributed over 150 days makes agriculture in this region both uncertain and risky.

Fifty percent of the labour force in Sri Lanka is engaged in agriculture, while six out of seven persons are directly or indirectly connected to agriculture. Agriculture in Sri Lanka is highly specialized, tea, rubber, coconut and rice being the four main crops (Fig. 4). Rice for two seasons covers 895,000 ha while tea is planted over 231,000 ha, rubber over 205,000 ha and coconut over 416,000 ha. Minor export crops which include cocoa, cinnamon, cardamon and pepper account for about 48,000 ha (Central Bank, 1986 — Table 1). In general agriculture in Sri Lanka is confined to the wet zone even though the majority of rice lands is in the intermediate and dry zones. This is due to the availability of irrigation water which is bound to increase with the completion of the Mahaweli scheme. The 72% of the country's rice lands which lie in these two zones are rarely cultivated under rainfed conditions during both seasons in the same year (Mendis, 1973).

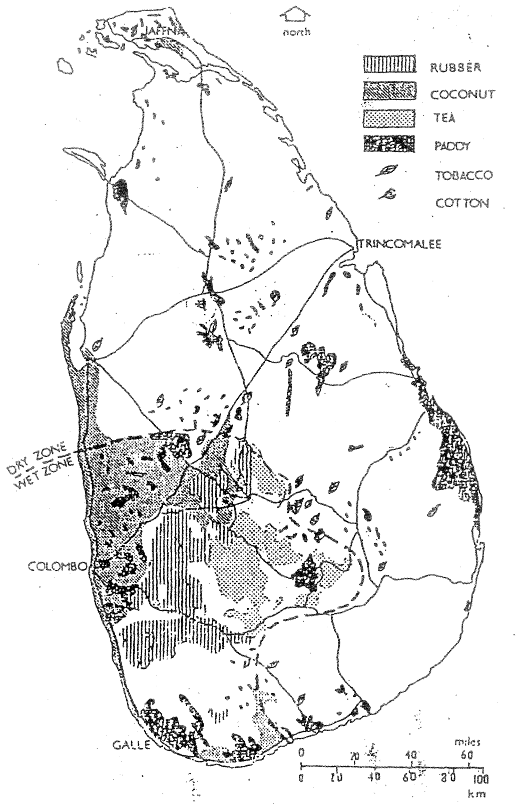


Fig. 4 Sri Lanka : Cultivated land.

Table 1 Land and land use by districts 1985

District	1985				Major export crops (hectares)[a]			Minor export crops (hectares)[b]				
	Total land Km²	Large inland waters Km²	Forest Km²	Forest as percent of total land	Tea	Rubber	Coconut[c]	Cocoa	Cinnamon	Cardamom	Pepper	Paddy[d] (Hectares)
1. Colombo	694.6	21.9	13.1	1.88	319	23,173[e]	9,222	-	363	-	159	12,251
2. Gampaha	1,398.7	46.2	13.9	0.90	-	-	57,050	4	274	-	1,146	26,370
3. Kalutara	1,615.5	9.0	179.0	11.08	4.123	47,678	12,358	29	1,422	-	337	36,266
4. Kandy	1,891.3	23.5	317.3	26.77	72,668	5,318	8,306	2,956	12	1,757	3,820	34,277
5. Matale	1,995.0	41.1	598.7	30.01	7,177	6,519	9,296	3,842	88	2,034	3,697	22,060
6. Nuwara Eliya	1,703.4	35.0	485.7	28.51	40,898	-	833	18	-	301	239	10,782
7. Galle	1,689.3	15.5	179.0	10.59	16,415	19,927	13,244	-	9,096	-	244	41,003
8. Matara	1,246.4	-	168.0	13.47	16,033	8,340	14,370	-	5,902	-	386	37,104
9. Hambantota	2,623.0	29.8	173.0	6.59	120	87	20,430	-	1,242	-	753	34,868
10. Jaffna	2,157.6	85.4	341.0	15.80	-	-	10,027	-	-	-	-	37,002
11. Mannar	2,013.5	11.3	1,121.0	55.67	-	-	1,181	-	-	-	-	14,521
12. Vavuniya	2,645.2	-	1,104.0	41.73	-	-	425	-	-	-	-	9,934
13. Mulathivu	2,065.7	99.7	1,513.0	73.24	-	-	2,205	-	-	-	-	11,381
14. Batticaloa	2,633.1	244.0	517.3	19.64	-	-	4,090	-	-	-	-	47,536
15. Ampara	4,433.1	192.8	1,696.1	38.26	-	-	3,886	-	-	-	-	90,106
16. Trincomalee	2,714.3	96.2	1,138.0	41.92	-	-	1,807	-	-	-	-	21,805
17. Kurunegala	4,775.9	191.6	184.8	3.86	360	5,121	149,106	485	15	13	819	119,761
18. Puttalam	3,035.8	59.0	856.0	28.19	-	-	51,781	2	-	-	20	19,111
19. Anuradhapura	7,274.3	145.2	2,083.0	28.63	-	-	5,728	-	-	-	-	57,803
20. Polonnaruwa	3,448.9	157.8	1,851.7	53.68	-	-	3,003	-	-	-	-	62,605
21. Badulla	2,822.0	34.0	683.4	24.21	35,435	4,126[f]	885	51	34	16	411	27,404
22. Monaragala	5,659.9	79.0	2,054.0	36.29	-	-	4,170	681	-	-	85	15,979
23. Ratnapura	3,238.8	-	472.0	14.57	27,000	36,872	12,430	1	2,199	356	624	31,015
24. Kegalle	1,641.2	8.2	116.6	7.10	11,102	48,642	20,420	283	68	764	1,071	21,780
25. Other Areas[g]	-	-	-	-	-	-	-	-	-	-	-	52,595
Total	65,415.4	1,626.3	17,849.6	27.28	231,650	205,504	416,253	8,352	20,715	5,241	13,811	895,319

(a) 1985
(b) 1986
(c) 1982 Census of Agriculture.
(d) Yala and Maha.
(e) Includes Gampaha District.
(f) Includes Monaragala District.
(g) This represents the area of the Mahaweli System "H" and Uda-Walawe Project which has not been demarcated according to the district boundaries.

Sources: Surveyor General's Department.
Department of Census and Statistics.

Rice diseases

The rainfall from the southwestern monsoon has its direct impact on the low country wet zone of Sri Lanka. All the districts in this region have a very high rainfall average which is extensively distributed over 150 days (Meteorology Department Data). Day humidities range form 75% - 80% while the night humidities have reached up to 95%. The mean maximum temperature in this region is 27.5°C and the minimum 23°C. Under these climatic conditions which are ideally suited to pathogens especially fungi, the rice crop in the low country wet zone is faced with the diesease constraint in addition to the other constraints. The diseases of rice mainly observed in this region are: leaf spotting caused by two fungal pathogens — *Helminthosporium oryzae* and *Cercospora oryzae*; grain spotting caused by a complex of fungi which include *Helminthosporium* spp., *Curvularia* spp., *Alternaria* spp., *Fusarium* spp., *Trichoconis* spp. and others (Wickremasingha, 1983); sheath rot caused by *Sarocladium oryzae*; and sporadic occurrence of leaf and neck blast caused by *Pyricularia oryzae*. The latter disease is very often reported from areas with high humidity and a cool climate like the Ratnapura district.

The most prominent and widely spread disease in this region is sheath blight disease of rice as reported by the Assistant Directors of Agriculture of the respective district. They have observed that the incidence of this disease has increased through the last few years. This disease which is caused by *Rhizoctonia solani* Kuhn, is not only present in Asia but has also been reported from Brazil, Surinam, Venezuela and Madagascar (Ou, 1972). The increase in the incidence of sheath blight of rice has also been reported form tropical Asia and according to Toriyama (1972), lack of progress in breeding for resistance to this disease is due to the unavailability of donor parents with suitable levels of resistance.

A series of experiments has been conducted at the Bombuwela Regional Agricultural Research Centre of the Department of Agriculture, Sri Lanka to investigate various aspects of sheath blight disease of rice which are presented in this paper in a summarized form.

The disease is characterized by greyish green lesions starting on the sheath of the plants at the water level. These lesions enlarge and coalesce with one another on the culm and extend upwards. The leaf blades are also very often affected when they droop down and come into contact with the infected sheaths. In severe cases the symptoms reach the flag leaf which may even become completely desiccated and destroyed, thereby affecting the yield considerably (Mithrasena *et al.*, 1987).

Previously the consensus in the Department of Agriculture was that sheath blight of rice does not lead to a yield reduction since in most cases it occurred after the plants had headed as shown by the yield experiments conducted by Seneviratne (1972) (unpublished). However recent work at the Bombuwela Regional Agricultural Research Centre, has shown different results. The increase in the incidence of the disease as reported by the Assistant Directors mentioned previously may be the reason for the yield losses.

Yield experiments were carried out in farmers' fields in some districts of this zone. The fields were selected in relation to the incidence of the disease. Fields planted with the same variety and different levels of disease incidence were selected. Quadrats of 1m × 1m were taken from each site and panicles collected. Five quadrat counts were made from each level of infection, each level corresponding to the rating number in the standard evaluation system of the International Rice Research Institute for sheath blight (IRRI, 1980). Statistical analysis of the results revealed that those samples selected from fields with the highest level of infection showed significantly lower yields than those without infection. The plants with an intermediate and low level of infection did not show any significant differences in yield loss (Mithrasena *et al.*, 1987).

Seed rates of 50, 100, 150 and 200 kg/ha were tested for sheath blight infection using two varieties in a factorially designed replicated and randomized experiment. The varieties used were Bg 400-1 a long-grained variety and BW 100 a small round-grained one. Correlation curves drawn for disease incidence against seed rates as shown in Fig. 5, gave regression lines showing a positive

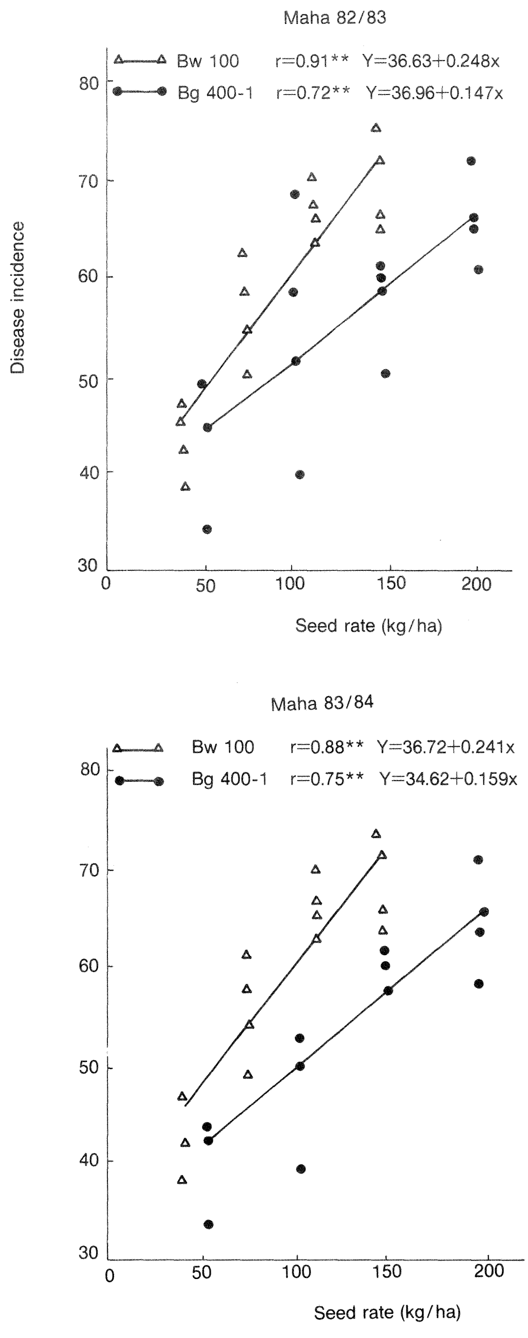


Fig. 5 Disease incidence at different seed rates. Drawn by Kalyani Wasala, Botany Division, Cari.

relationship which was statistically significant.

Nitrogen and potassium fertilizer experiments were conducted in the same way as before using 3m × 3m plots. Three levels of N and K_2O were tested. The first level tested was both N and K_2O at 65 kg/ha. The second level tested was twice the first and the third level tested was three times the first. The first is the current level recommended by the Department. The combination of highest N and lowest K_2O resulted in the highest disease incidence and the lowest yield (Table 2).

For control measures, resistance has still to be achieved. Several hundreds of varieties which have been screened have failed to show a high resistance. Therefore fungicides were evaluated. Preliminary laboratory methods using the filter paper disc technique eliminated the non-effective ones. The selected fungicides were then evaluated in the field in a factorial experiment. Disease incidence was determined by the use of artificial inoculation with rice husk/grain, 1:1 culture. Pencycuron 25% and Tri-phenyl-tin-hydroxide were found to be the most effective.Spraying at 24 hours after inoculation gave the best results. However since this is not practically possible for the farmer, spraying at the first sign of the disease was recommended (Mithrasena *et al.*, 1987).

Table 2 Effect of different combinations of nitrogen and potassium on sheath blight disease incidence and grain yield of rice

Fertilizer combination	Disease incidence 1986 Yala	Disease incidence 1986/87 Maha	Grain yield (t/ha) 1986 Yala	Grain yield (t/ha) 1986/87 Maha
N1K1	2.54 bc	2.96 cd	4.51 a	2.82 c
N1K2	2.30 cd	2.35 e	4.89 a	3.55 ab
N1K3	2.69 ab	2.51 de	4.21 a	4.07 a
N2K1	2.19 d	2.93 cd	4.25 a	3.28 bc
N2K2	3.09 a	3.48 bc	4.42 a	2.77 cd
N2K3	3.05 ab	3.32 bc	4.55 a	2.90 c
N3K1	3.04 ab	4.18 a	2.83 b	1.24 b
N3K2	2.97 ab	3.60 ab	2.86 b	2.08 e
N3K3	3.13 a	3.07 bcd	3.69 ab	2.26 de
CV	9.36%	10.57%	1.60%	9.75%

Values followed by a common letter in a column are not significantly different at 5% level of probability using Duncan's Multiple Range test.

Fertilizer levels: N1 & K1 = Department recommendation
N2 & K2 = Twice the department recommendation
N3 & K3 = Three times the department recommendation

Department recommendation: N = 65 kg/ha
K_2O = 65 kg/ha

From the above observations and information it appears that sheath blight disease of rice has caused yield reductions, the disease appears to be more virulent at high N and low K_2O levels of fertilizer application and to be more severe when the sowing density is high. Since resistant varieties have still to be developed, fungicidal control measures could be used with success.

The spread of sheath blight disease over the different districts of the low country wet zone was studied by collecting data from the Assistant Directors of Agriculture of the various districts. These districts as seen in Fig. 2, are Gampaha, Colombo, Kalutara, Galle, Matara and Ratnapura. Details of past occurrences of the disease were extracted from past records and are summarized below.

Extent of damage (in hectares) of rice by sheath blight disease in the districts of the low country wet zone of Sri Lanka in the last 5 years.

Year District	1987	1986	1985	1984	1983
Gampaha	245,105	275,95	240	—	—
Colombo	0,5	15,20	0,0	20,0	0,0
Kalutara	0,41	—	—	—	—
Galle	0,40	405,150	0.3,8	4,15	64,0
Matara	321,22	120,27	40,18	10,32	16,3
Ratnapura	170,45	90,05	05,15	30,05	60,0

These reports show an increase in the incidence of sheath blight over the last few years. Rainfall conditions have been near normal while a change from the use of indigenous varieties to the new improved varieties was observed. The control measures mentioned in the reports included cultural practices such as appropriate density, proper weed control, recommended fertilizer use and good management practices.

References

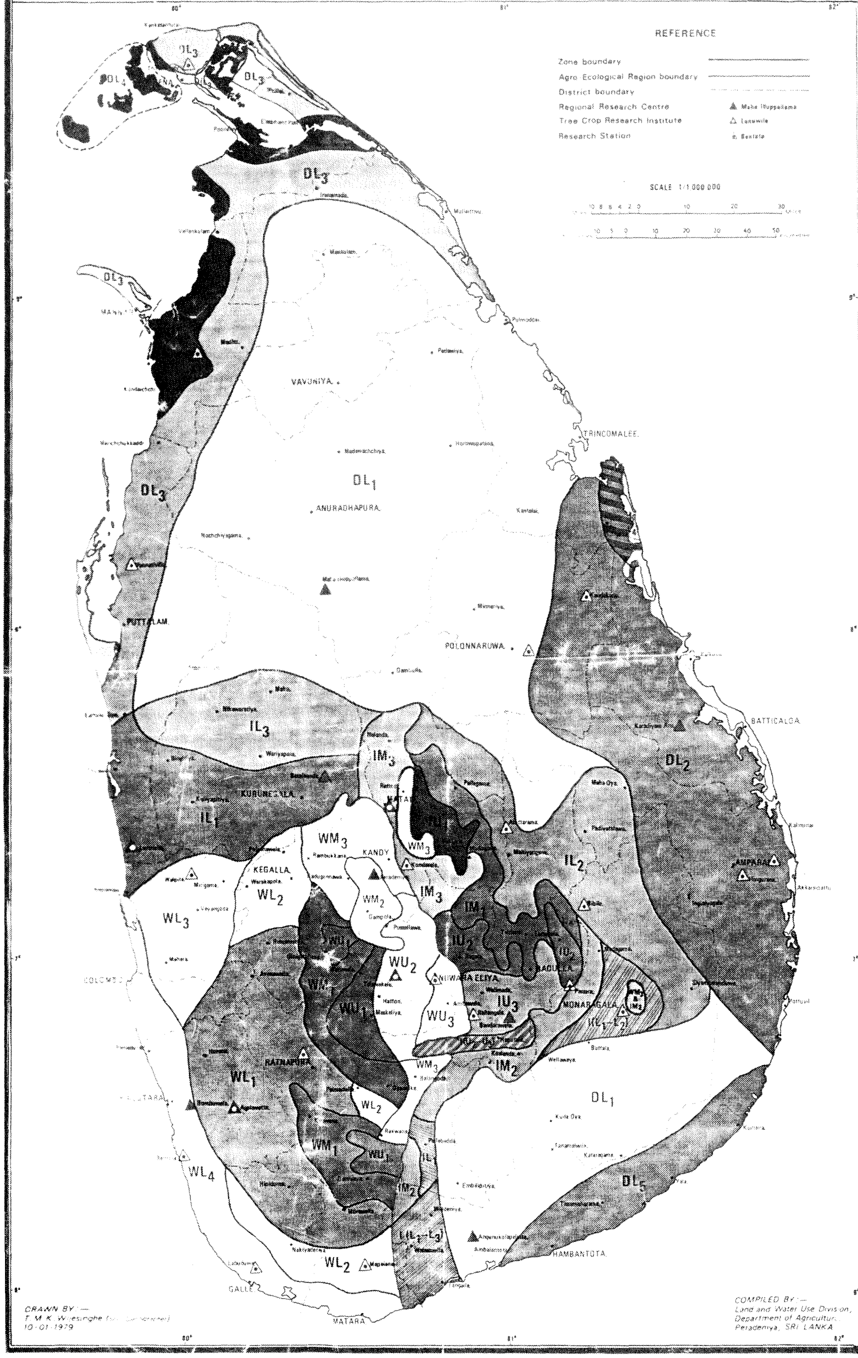
1) Assistant Directors of Agriculture: Reports from districts.
2) Balasuriya, I. (1987): Double cropping of rice in Sri Lanka. Tropical Agriculture Research Series No. 20.
3) Blackenburg, Peter van and Nagel, Uwe Jeus (1980): The Mahaweli ganga development project, a solution to Sri Lanka's energy and food problems. Internationales Asteuforum. Vol. II (1980) No 3/4. pp 269-286.
4) Central Bank of Sri Lanka, Statistics Department: Economic and Social Statistics of Sri Lanka. Vol IX, Dec. 1986
5) Mendis, N.W.J.G. (1973): The planning implications of the Mahaweli Development Project in Sri Lanka. Thesis submitted for the degree of Master of Science, in Urban and Regional Planning at the University of Strathclyde, Glasgow, U.K.
6) Mithrasena, Y.J.P.K., Adhicari W.P. and Wickremasingha, D.L.: (1987) A review of investigations on sheath blight of rice in the low country wet zone of Sri Lanka. Proceedings, Rice Research Workshop 1987, C.R.B.S. Batalagoda, Sri Lanka.
7) Ou, S.H. (1972): Rice Diseases, C.M.I., Kew, England, 368 pp.
8) Panabokke, C.R. (1980): Soil and land management in small scale cash crop farming in Sri Lanka. Paper presented at FAO/DANIDA seminar on the improvement of small cash crop farming in Sri Lanka.
9) Toriyama, K. (1972) *In*. "Rice Breeding." IRRI, Los Banos, Philippines. pp 253-281

Discussion

Kajiwara, T. (Japan): Did you observe any difference in the severity of sheath blight among the varieties usually cultivated in Sri Lanka?

Answer: Yes. For example at the Bombuwela Regional Agricultural Research Center, BW 267-3 a medium tall less tillering variety of 105 days exhibits less severe symptoms of sheath blight than BW 351, a short high tillering variety of 105 days.

AGRO-ECOLOGICAL REGIONS OF S



ZONE	AGRO-ECOLOGICAL REGION & SYMBOL		MONTHLY HISTOGRAMS OF 75% RAINFALL PROBABILITY FOR RESPECTIVE REGIONS	75% EX ANNUA
WET ZONE	UP COUNTRY	WU1		
		WU2		
		WU3		
	MID COUNTRY	WM1		
		WM2		
		WM3		
	LOW COUNTRY	WL1		
		WL2		
		WL3 & 4		
INTERMEDIATE ZONE	UP COUNTRY	IU1		
		IU2		
		IU3		
	MID COUNTRY	IM1		
		IM2		
		IM3		
	LOW COUNTRY	IL1		
		IL2		
		IL3		
DRY ZONE	LOW COUNTRY	DL1		
		DL2		
		DL3 & 4		
		DL5		

• Denotes wet