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Some common rice diseases of Machmara ADC village, north Tripura

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The occurrences of rice diseases in the agricultural fields of Machmara ADC village of north Tripura was surveyed. The occurrences, symptomes, predisposing factors of blast, sheath blight and bacterial blight of rice were deseribed along with their control measures.

Key words : Rice, blast, sheath blight, becterical blight, control measures

INTRODUCTION

Rice the major staple food for nearly one half of world's population, suffers from a number of diseases. Among these the blast or rotten neck which might be existed long before it was noticed and reported, is most widely distributed, occurring in the every rice growing area of the world. Losses due to blast may range up to 90% depending upon the part of plant infected (John 1977, Anonymous, 1983; 1995). Sheath blight of paddy is an important fungal disease which leads to withering of the entire plant body. The disease firstly occurs in the ground side of stem in the rainy season and progresses up through sheaths. Bacterial blight of rice has become one of the most serious problems of rice cultivation in India.

The blast, sheath blight and bacterial blight diseases are noticed in Uttar Machmara ADC village of Tripura and their occurrence, host range, factors favouring the disease, disease cycle and common practices adopted by the local farmers are surveyed as well as some investigations are attempted to combat these diseases by eco-friendly methods.

GEOGRAPHICAL FEATURE OF STUDIED AREA

Tripura state is situated in the eastern part of India bordered by Bangladesh to the west south and north, by Assam to the north east and by Mizoram to the east. The studied area i.e. Machmara ADC village lies between 22º56' and 24º32' North latitude and 91º10' and 92º21' East longitude. Physiographically the area is divisible into three distinct zones namely i) hill ranges ii) undulating high lands of narrow and broken plateau and iii) low land and river flats. The climate is characterized by moderate temperature and high humid atmosphere. The average annual rainfall in the state is 2100 mm. About 63% of the annual rainfall is received in the South-West monsoon season. From the beginning of March temperature continues to rise till July and August, day temperature is the highest is April. The cold weather starts by about the end of November, January is the coldest month. In the summer, the relative humidity is between 50% and 75% while during South-West monsoon it is over 85%. Soils are broadly classified into two categories namely i) soiis of high land and ii) soils of low land. The high land soils are developed from sand stones and shales and are podsolic and laterite. The low land soil is developed on the alluvium deposited river and colluvial wash glided down the slope and carried away by run off.

OBSERVATIONS

Causal agents

Rice blast : *Pyricularia grisea* (Cooke.) Sacc. perfect state is an Ascomycete *Magnoporthe grisea* (T.T. Hebert) M.E. Barr.

Sheath blight: *Rhizoctonia solani* Kühn perfect teleomorph state is a Basidiomycete–*Thanatepho-rus cucumeris.* (Frank) Donk

Bacterial blight: *Xanthomonas oryzae* pv. *oryzae* (Ishiyama) Dye

A survey work has been done in Manchmara regarding the host ranges of the studied causal agents.

Aside from the rice plant, the blast causing fungus also survives on *Agropyron repens* (L) Gould, *Cynodon dactylon* (L.) *Pers.* and *Eleusine indica* (L.) Scop. No other hosts have been recorded in case of sheath blight. The causal agent of bacterial blight has been found on *Leersia oryzoides* and *Cyperus rotundus* (Chattopadhyaya and Mukherjee. 1968). A sporadic occurrence has been recorded in *Leersia hexandra* (Rao and Kauffman, 1971).

Blast is favoured by excessive nitrogen fertilization, aerobic soil and drought stress which add much to the common predisposing factors. (Mc. Elhaney *et. al.*, 1998)

Sheath blight is found to be basically a disease of wet condition and is especially of heavy rains, flooding and severe wind. This disease develops rapidly above 25ºC (Huber and Gillespie, 1992)

Occurrence

Blast disease has been reported from almost 70 rice growing countries of the world. It has for a long time, been recognized as major problem of rice production in Japan, Taiwan, USA and many other countries. It is a major disease of rice and more destructive in Andhra Pradesh, Tamil Nadu, Orissa, Jammu and Kashmir and Uttar Pradesh and other rice growing areas of the country. (Mehta, 1963; Nagarajan, 2000). The blast disease of rice is also noticed in Tripura (Machmara, ADC Village). Padmanabhan (1966) has critically reviewed the methods that could be adopted for estimating the loss caused by blast. Sheath blight becomes an important and destructive disease of rice, particularly since the introduction of high yielding varieties in the 1960s. This is widest of all rice diseases in distribution at least in Asia. Losses due to disease are more when seedlings are attacked. The sheath blight is noticed in Tripura (Machmara ADC Village) causing a great damage. Bacterial leaf blight of rice is widespread in Asia. It has been reported from Sri Lanka, China, Kampuchea, India, Japan, Indonesia, Taiwan, Vietnam, Philippines and Thailand. It has not been reported from any rice growing areas outside Asia. In Japan it is known as White withering disease. The bacterial nature of the disease was established by Ishiyama in 1922. In India, this disease first recorded in 1951 in the Khopoli area in the erstwhile Bombay state (Bhapkar *et al.*, 1960). Srinivasan *et al.* (1959) have reported the bacterial blight to be caused by a strain of *Xanthomonas oryzae.* Studies have shown the disease to be present in most of the rice growing states of India (Mizukumi, 1964; Srivastava and Rao, 1964, Srivastava, 1967). Since introduction and cultivation of new high yielding but susceptible rice varieties over a large acreage in recent year, the disease has become one of the most serious problems of rice cultivation in India (Srivastava, 1972). Devadath (1992) has reviewed the work done on this disease. In India the losses has been estimated to vary from 6–60 per cent by various authors (Srivastava and Rao, 1966; Kaufman, 1971. Ahmad and Singh, 1975). The bacterial blight of paddy is recorded from Machmara ADC village.

Symptoms

Rice blast : The typical symptoms appear on leaves, leaf sheath, rachis, culms joints and even in the glumes. The lesions on leaves appear as small, bluish, water soaked flecks of about 1–3 mm in diameter. These lesions rapidly enlarge and become several centimeter long and about 1 cm broad and spindle shaped. The centre of the spots appear pale green on dull greyish green changing to grey and the periphery has a dark brown band with a yellow halo around the lesion. Lesions may kill the entire leaf in susceptible varieties but they remain as minute, pin head sized brown specks in the resistant one. An early seedling infection may give a burnt appearance to the crops. More or less similar spots also develop on leaf sheath. Nodal infection is usually observed after heading, when sheath pulvinus rots and turns blackish and culms may break at the infected node. Lesions may also develop on internodes in severe infection. As the flower emerges, the pathogen attacks the peduncles, which are engirdled and the lesions become brownish-black. This stage is commonly referred to as rotten neck or neck rot or neck blast. In early neck infection, there is no grain filling and panicle remains erect. In late panicle infection there is panicle grain filling and rachis may break down. Partial infection of the panicle may also occur. Small, brown to black spots may also appear on glumes of heavily infected panicle.

The symptoms are in different parts of the rice plant and characterized by site specific features which are as follows :

Leaf blast : Leaf lesions are usually diamond shaped with a grey or white centre and brown or reddish brown border and are 1.0-1.5 cm long and 0.3-0.5 cm wide. Newly formed lesions may have a white or grey centre and a darken green border. Their shape, colour and size can vary depending on varietals resistance, age of the plant and lesion age. Leaf blast may sometimes cause the complete death of young plants up to the filling stage.

Collar rot : Infection at the junction of leaf blade and sheath results in the typical brown "collar rot" symptom. A severe collar infection may cause the leaf to die completely. When collar rot kills the flag or second to last leaf it may have a significant impact on yield.

Neck rot and panicle blast : Infection just below the panicle, usually at the neck rot cause a typical neck rot or rotten neck blast sysmptom which is very injurious to the crop. If neck rot occurs early, the entire panicle may die prematurely, leaving it white and completely blank. Later infection cause incomplete grain filling and poor milling quality. Other parts of the panicle including panicle branches and glumes may also be infected. Panicle lesions are usually brown but may also be black.

Node infection : Stem node may be attacked causing complete death of the stem above the infection. Diseased nodes are brown or black, collar rot, neck rot and node infection are commonly observed in the studied area.

Sheath blight : Symptoms occur in seedling as well as in adult plants. The seedlings at about two weeks after sowing may be rottened at the base resulting into dead patches particularly where seed borne inoculum is high. Adult plants are usually attacked at mid tillering or during late filling and early internodes elongation. Lesions first appear on leaf sheaths, at or above water level, generally 0.5–3 cm below leaf collar in the wetland crop or generally at or above ground level and any where in the upland crop. Water soaked circular to oblong, ellipsoid or ovoid or even irregularly elongated 3 cm × 1 cm discoloration appear. They turn into discrete lesions with pale greenish grey to greyish white centre and narrow blackish to dark brown margin. Finally, 4 – 5 such lesion coalesce and girdle the whole sheath, culms, boot and flag leaf, whereby the tillers is enriched to death. A series of characteristic coppery bands may appear across the lesions, hence the fine silvery threads of mycelium after about one week on or near the lesion or between leaf sheath and culms, within lumen of culms, and within large cells of the sheath are detected easily at maturity.

Bacterial blight : The disease usually noticeable in the field at the heading stage. In severe cases, it may appear earlier but it is rare in the seed bed. The disease is a typical vascular wilt; leaf blight is only the mild phase of the disease which results from secondary infection.

In seed bed it first appears as tiny water soaked spots at the margin of fully developed lower leaves. As the spots enlarge the leaves turn yellow, dry rapidly and wither. On leaf blade, lesions usually begin at margin; a few are formed at the tip as water–soaked stripes. The lesions enlarge both in length and width, have a wavy margin and turn yellow within a few days. The region adjoining the healthy parts shows water soaking lesions may start at one or both edges of the leaves. As the disease advances the disease cover the entire blade turn white and later become greyish due to growth of saprophytic fungi. In susceptible varieties the lesions extends to the leaf sheaths where they may reach lower end. The infected blades in the susceptible varieties wilt and roll as the diseased portion enlarge while the leaves are still green. The entire plant may soon become involved and gets dried up. On more resistant varieties a yellow stripe appears just inside the margin of the leaf blade with no formation of necrotic lesions. On the surface of the young lesions, milky or opaque tiny drops may be observed in the early morning. These dry up in the form of yellowish spherical bead which fall down in the field, the infection may reach the grain. The glumes get discolored and water soaked spots develop on them. Srivastava and Rao (1964) have described the symptom in detail. Bacterial exudates can be seen from the leaf blade or sheaths (Goto, 1964). The bacteria spread through xylem vessels to the growing point and infect the bases of the other leaves.

In Indonesia, the disease has been known for a long time by the name 'Kresek'. In Japan, the disease becomes noticeable only late in the season at the tillering stage. In Sri Lanka, where the disease was first reported in 1958, symptoms are best seen on the flag leaf where the typical undulate marginal necrosis occur (Seneviratne, 1962).

Predisposition and Epidemiology

Blast is favoured by excessive nitrogen fertilization, aerobic soil and drought stress. Ammonium nitrogen is converted to nitrate when fields are drained and aerated. (Sakamito, 1948; Huber and Watson, 1974) Conidia infect the plant under conditions of high humidity. Sporulation occurs at the grey area of the lesion under conditions of high relative humidity. Conidia are produced on conidiophores that usually project through stomata, through extrusion, through the epidermal cell wall can also occur. In India, air bones conidia available throughout the year are the source of primary infection. When conditions are favourable, a single cycle can be completed in about a week. The fungus can go through many diseases cycles and produces a treamendous load of spores by the end of the season. This high inoculum level can be very injurious to a susceptible rice crop.

Sheath blight is basically a disease of wet conditions and is especially destructive under condition of high humidity and high temperature. Besides, weed hosts, the pathogen survives in seeds, in the soil as well as plant debris left in the field. The fungus mainly survives as sclerotic and/or mycelia. (Parameter, 1978) The seeds may carry inoculum and produce 4-6.5% seedling infection in India. The seeds on the lodged panicles catch inoculum from soil. The disease cycle takes place predominantly through sclerotia which remain viable for fourteen days to two years (Dasgupta, 1992).

Bacterial leaf blight is principally a vascular disease. It enters the leaf through wounds, through broken roots and transplanting or through hydathodes. Bacterial exudates are produced on the surface of the leaves and during rain storms. These bacteria disperse and come in contacts with other leaves or fall into the water. Bacteria are also carried by irrigation water from one field to another. The bacteria appear to be soil born in Japan. The organism may live in soil for one to three months depending upon soil moisture and acidity (Tagami and Mizukami, 1962; Mizukami, 1964; 1966). Several Japanese workers have reported the perpetuation of the pathogen in the infected straw left over in the field or bran and also in stable (Ishiyama. 1928. Goto *et al.,* 1953; Wakimoto, 1955, 1956, 1956b; Inoue *et al.,* 1957; Tagami *et, al.,* 1963) Several workers have demonstrated seed infection and the survival of the bacteria in the seeds for varying length of time up to the next growing season (Seki and Mizukami, 1955; Fang *et. al.,* 1956; Srivastava and Rao, 1963; Anonymous, 1968) However, there have been fewer attempts to demonstrate the successful transmission of the disease from such seeds. Detailed studies conducted by Kauffman and Reddy (1975) on the seed transmission of *Xanthomonas campestries* pv. *oryzae* indicate that the bacteria remain viable in the infected seeds for only two months. In India, the pathogen is progagated from season to season through infected seeds (Devadath, 1992) In India, the disease develop readily above 25ºC. The rice plant is susceptible to infection at all stages of its growth but with age the susceptibility to vascular infection decreases (Anonymous, 1964; Pandey, 1970). There are several reports that an excess of nitrogen or unsuitable combination of NPK favour disease development. High dose of silicate, magnesium and shale have been reported to increase disease severity (Inoue and Tsude, 1959), whereas potassium has been shown to decrease the disease. On the other hand, Kim and Cho (1970) have reported that potassium and phosphorus applications at twice the normal level tend to stimulate the disease development.

Control measures

Rice blast Farmers in Machmara adopted the methods of destruction of weed as precautionary method and early planting shown less disease incidence. The commonly used fungicides are Blitox and Agrosan. Seed treatment with Agrosan GN is effective in eliminating externally seed borne inoculums. But according to Thirumalachar (1967; 1968) a mixture 200 ppm Copper sulpate mixed with 20 ppm of Aureofungin is effective in controlling seed borne inoculums. There are some systemic fungicides which have strong systemic action against the rice blast. Kappor and Singh (1982) have reported the seed treatment with Benomyl (1 : 400 w/w) gives protection to the seedling because it

inhibits the spore germination and appreasorium formation. Venkata Rao and Muralidharan (1983) and Saikia (1991) have confirmed the same findings.

Three varieties Tetep, Tadukan and Zenith, have been found to be resistant to all the physiological races of the pathogen occurring in the country and may be used as donors. (Chakrabotry *et al.*, 1966).

Sheath blight : Common practice is the destruction or burning of crop residues to eliminate sclerotia. Weed hosts growing in and around rice field are being eradicated for reduction of disease incidence. Balanced nutrition especially NPK has also been recommended. Soil application of Thiram before transplanting followed by single Edifenphos spray at maximum tillering proved effective. Mixtures of fungicides (Mancozeb + Thiobencarb and Iprodione + Carbendazim) are found more effective than single chemical. (Bruehl, 1975). Organic amendments like oilcakes, farmyard manure, agriculture and industrial wastes are known to reduce viability of sclerotia and disease incidence.

Bacterial blight : As the disease in seed borne, seed treatment is advocated. Soaking seeds for 12 hrs in Agrimycin 100 followed by hot water treatment for 30 minutes at 52º–54ºC is very effective. It was found that the preliminary soaking of seeds can be done in plain water (Sinha and Nene, 1967). Jain *et al.* (1966) have suggested an alternative method of hot water treatment. This involves an eight hours soaking in Streptocycline at 0.3 g/liter spraying in the field is also advocated. A combination of 60–120 ppm Chloramphenical with an organomercurial such as at 10–20 ppm has been found effective. Another mixture used is 100 ppm each of Dithianone and Cellucidin. Padmanabhan and Jain (1966) have suggested the chlorination of irrigation water which could help in reducing infection.

Sometime back, the antibiotic preparation called streptomyciline was used on a large scale in India (Thirumalachar, 1968). But various trials with antibiotic showed that it is not at all effective against this disease (Srivastava, 1972).

Singh (1975, 1976) has recommended five spraying of Agrimycin + Copper oxychloride at twelve days intervals. Fungicides TF-130 and RH – 893 are also quite efficacious in controlling the disease. Eliminating volunteers and Raton rice is recommended in the Philippines (Anonymous, 1967).

Srivastava (1969) and Kauffman (1971) have suggested that the sowing of nursery beds on disease free, isolated areas to prevent the inflow of primary inoculum into the field might reduce the disease occurrence and arrest the buildup of an epidemic.

In is well established that nitrogenous fertilization is an important predisposing factor for the occurrence of bacterial blight (Kulkarni, 1962; Devadath and Padmanabhan, 1970). Nitrogen application at the tillering stage increase the incidence of the disease but a similar application at the time of flower initiation results in lower incidence of the disease (Have and Kauffman, 1972).

CONCLUSION

The studied rice diseases causing a great loss (up to 75%) to the farmer may be reduced substantinally by proper cultural practices and judicious application of nitrogenous fertilizers. Seed treatment as a prophylactic measure is necessary to combat the disease. Recommended dose of fungicides and antibiotics is helpful in controlling the severity of the disease. In addition proper storage of seeds must be maintained. Cropping of recommended disease resistant varieties in each respective case is advocated.

Proper propaganda covering the predisposing factors should be an awareness programme for the farmets who are dependent on cultivation.

REFERENCES

Ahmad, K. M. and Singh R. A. 1975, Disease developoment and yield loss in rice verities by bacterial leaf blight. *Indian Phytopath.* **28** : 502-507.

Anonymous 1964. ICAR, Final Report of the scheme for investigation into bacterial & paddy in Maharastra State published by the Maharastra State. p. 40

Anonymous 1983. Symposium on estimating yield reduction of major food crops of the world. *Phytopathlogy***73** : 1575-1600.

Anonymous 1995. Epidemiology, crop loss assessment phytopathometry : A collection of papers. *Can. J. Plant Pathol.***17** : 95-189.

Bhapkar, D. G., Kulkarni, M.B. and Chavan. 1960. Bactarial blight of paddy, Poona, *Agri. Coll. Mag.* **51** : 36-46.

Bruehl, G. W. 1975, Biology and Control of soil borne plant pathogen. APS press, S. L. Paul, M. N.

Chakraborty, N. K. Mathur, S. C. Veeraraghawan J and Padmanabhan S. Y. 1966. The present position of Physiologic, races of *Pricularia oryzae* Cav. in India, *Bull. Indian Phytopath. Soc.***3** :102-109.

Chattopadhyay S. B. and N. Mukherjee. 1968. Occurrence in nature of Collateral hosts (*Cyperus rotundus* and *C. defformis)* of *Xanthomonas oryzae*, incitant of bacterial blight of rice. *Curr. Sci.* **37** : 441-442.

Dasgupta M.K. 1992. Rice Sheath blight : The Challenge continues in "plant diseases of international Important". Vol–I pp. 130-157, Prentic Hall Englewood Cliffs, N.J.

Devadath S. and Padmanabhan, S.Y. 1970. Approaches to control of bacterial blight and streak diseases of rice in India. *Ind. Phytopath. Soc. Bull.* **6** : 5-12.

Devadath, S. C. 1992. Bacterial blight of rice in plant disease of international Importance. Vol–I, Disease of cereals and pulses Prentice Hall, Engle wood cliffs N.J. 158-185.

Fang C. T., Liu, L.F. and Chu C.L. 1956. A preliminary study on the the disease cycle of bacterial leaf blight of rice. *Acta. Phytopath Sinica*, **4** : 173-185.

Goto, M., Fukalse R. and Ohata K. 1953. Over wintering of the casual bacterial of rice leaf in rice plant and grasses *Agr. Hart.*, **28** :207-208.

Goto M. 1964. Kresek and pale yellow leaf systemic symptom of bacterial leaf blight of rice caused, by *Xanthomonas oryzae, Pl. Dis. Reptr.* **48** : 858-861.

Have, H. and Kauffman, W.E. 1972. Effect of nitrogen and spacing on bacterial leaf blight of rice, *Indian Farming* **21** : 8-13.

Huber, D.M. and Watson, R. D. 1974. Nitrogen form and plant disease. *Annu. Rev. Phytopathol.***12** : 139-165.

Huber, L. and Gillespie, T. J. 1992. Modeling leaf wetness in relation to plant disease epidemiology. *Annu. Rev. Phytopathol.* **30** : 553-577.

Inoue Y. Goto K. and Ohata K. 1957. Over wintering and mode of infection of leaf blight bacteria on rice plant. *Bull. Tokai-Kindi Agr. Exp. Sta.***I** : 78-82.

Inoue Y. and Isude Y. 1959. Assessment of the decrease in yield due to bacterial leaf blight of rice. *Bull. Tokai-Kinki Agr. Exp. Sta.* **6** : 154-164.

Ishiyama, S. 1922. Studies on bacterial leaf blight. *Rep. Agr. Exp. Sta.*,**45** : 233-261.

John, V. T. 1977. Rice disease of major economic importance in India. *Seed and Farms.* **3(5)** : 5-8.

Kauffman, H.E. 1971. Second International Symp. Pl. Pathol. IARI. New Delhi, pp. 138.

Kauffman H. E. and Reddy, A. P. K. 1975. Seed transmission studies of *Xantomonas oryzae* in rice. *Phytopath,* **65** : 663-666.

Kim C. H. and Cho, Y. S. 1970. Effect of NPK fertilizer levels and growth condition on the development of bacterial leaf blight of rice plant. *J. P. I. protect,* KoreA. **9** : 7-13.

Kulkarni, N. B. 1962. A note on disease of paddy in Maharashtra. Dhulia. *Agri. Coll. Mag.* **1** : 65-67.

Mc.Elhaney. R. Alvarez. A. M. and Kado. C.I. 1998. Nitrogen limits *Xathomonas campestris* pv. *campestris* invasion of host xylem. *Physiol. Mol. Pl. Pathol.* **52** : 15-24.

Mehta P. R. 1963. Plant Pathology in India-past, present and prospect. *Indian Phytopath.* **16** : 1-7.

Mizukami, T. 1964 Occurrence of bacterial leaf blight disease in India. *J. Protection,* Tokyo. **18** : 179-181.

Mizukami, T. 1966. Epidemiology of bacterial leaf blight of rice and use of phages for forecasting. XIth Pacific Science Congress Symposium on plant disease in the Pacific 15-32.

Nagarajan, S. 2000. Plant pathology and Indian Agriculture past, present and future. *Indian Phytopath* **53 (2)** : 121-128.

Padmanabhan. S. Y. 1966. Prospect of control of plant disease by forecasting and direct application of fungicides and antibiotic. *Indian Phytopath.* **16** : 307-308.

Pandey, K. R. 1970. Studies on Ecology of *Xanthomonas oryzae.* PhD. Thesis Submitted to IARI. New Delhi.

Parameter, J. R. 1970. *Rhizoctonia solani*-Biology and Pathology. Univ. of California Press Berkley.

Rao, P. S. and Kauffman H.E. 1971. A new Indian host of *Xanthomonas oryzae* incitant of bacterial leaf blight of rice. *Curr. Sci.* 40 : 271-271.

Sakamito, M. 1948. On the relation between nitrogenous fertilizer and resistance to rice blast. *Ann. Phytopath. Soc.* Japan. **13** : 53.

Seki, M. and Mizukami T. 1955. On the longevity of *Bacterium oryzae* Nakata under some conditions. *Kyushu. Ag. Re.* **16** : 102.

Srinivasan M. C., Thirumalachar, M. J. and Patel, M. K. 1959. Bacterial blight diseases of Rice. *Curr. Sci.* **28** : 469.

Seneviratne, S. N. 1962. Bacterial leaf blight of rice. *Trop. Agriculturist.* **118** : 123.

Srivastava D. N. and Rao Y. P. 1964. Seed transmission and epidemiology of bacterial blight disease of rice in North India. *Indian Phytopath* **17** : 77-78.

Srivastava, D. N. 1967. Epidemiology and control of bacterial blight of rice in India. Symp. On Rice diseases and their control by growing resistant varieties and other measures. Ministry of Agri and Forestry, Japan, Sept. 25-28, A-1-A-15.

Srivastava, D. N. 1969. Bacterial blight and streak diseases of Rice. *Indian Phytopath. Soc. Bull.* **5** : 61-64.

Srivastava D. N. 1972. Bacterial Blight of Rice. Indian Phytopath. **25** : 1-16.

Tagami, Y. and Mizukamo, T. 1962. Historical review of the researches on bacterial leaf blight of rice caused by *Xanthomonas oryzae.* Special Report of the Plant diseases and Insect pest forecasting service. Pt. Prot. Div. Mins. of Agri. and For. No. 10. PP-1-112.

Tagami Y., Kuhara, S. Kurtia, T. Fujii, H. and Sekiya N. 1963. Epidemiological Studies on bacterial leaf blight of rice *Xanthomonas oryzae* Dowson-I : Overwintering of Pathogen. *Bull. Kyushu Agr. Exp. Sta.* I : 89-122.

Wakimoto 1955. Overwintering of *Xanthomonas oryzae* on unhulled grains of rice. *Agri. Hort.*, Japan. **30** : 1501.

Wakimoto 1956. Overwintering of rice leaf blight bacteria in soil. *Agri. Hort.* Japan, **31** : 1413-1415.

Wakimoto 1956. Studies on overwintering of *Xanthomonas oryzae* in dried state. Proc. Assoc. Pl. Protec. *Kyushu* **2** : 107-109.

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