



Review on Banded Leaf and Sheath Blight Disease of Maize

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ABSTRACT

In India maize ranks fifth position in area and fourth in production among the major cereals grown. Being a C4 plant and having very high yield potential, it is called queen of cereals. One of the main deterrents to high grain yield in maize is its susceptibility to several diseases. Of 112 diseases of maize reported so far from different parts of the globe, 65 are known to occur in India. Banded leaf and Sheath blight (BLSB) is one of them caused by most widespread, destructive and versatile pathogen *Rhizoctonia solani* f. sp. Sasakii (teleomorph: *Corticium sasakii*, syn *Thanatephorus cucumeris*) which claims significant yield loss (Saxena, 2002). It was first reported by Bertus (1927) in Sri Lanka under the name Sclerotial disease. The epidemics of this disease were first reported in the warm and humid foot hills of Himachal Pradesh by Thakur *et al.* (1995). Singh and Sharma (1976) recorded a loss in grain yield in the range of 11 to 40 per cent due to this disease while Lal *et al.* (1985) reported a reduction to the extent of 97.4 per cent in severe condition. A range of 25 to 30°C (Ahuja and Payak, 1981) coupled with an average relative humidity of 90-100% (Ahuja and Payak, 1981) is most suitable for development of this disease. These conditions prevail in the plains of N.E. region of India during the months of July-August, a time when the crop is in vulnerable growth stage. In India the disease was first recorded in the Tarai (foot hill plain areas) region of Uttar Pradesh (Payak and Renfro, 1966). Maize plant is affected by as many as 61 diseases, out of which 16 have been identified a major ones which occur both in tropical and temperate regions of India (Sharma and Payak, 1986). Among these, banded leaf and sheath blight (BLSB) incited by *Rhizoctonia solani* is gaining economic importance. Grain yield loss, depending on severity varies between 11 to 40 per cent (Singh and Sharma, 1976). Now banded leaf and sheath blight is considered as one of the major diseases of Maize (Payak and Sharma, 1985).

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Introduction

In India it is known to be present in the states of Himachal Pradesh, Uttar Pradesh, Bihar, Haryana, Punjab, Madhya Pradesh, Rajasthan, West Bengal, Meghalaya, Assam, Nagaland, Andhra Pradesh and Orissa. Yield losses vary from 11 to 40 per cent (Singh and Sharma, 1976). This disease has been reported in Germany, USA, Nigeria, Venezuela, Sierra Leone, Ivory Coast and England. In particular, BLSB is recognized as a serious impediment to maize production in China, South Asia and Southeast Asia (Sri Lanka, Indonesia, Cambodia, Bangladesh, Pakistan, Nepal, Myanmar, Thailand, Laos, Vietnam, Philippines, Taiwan, Malaysia, Korea and Japan. Surprisingly, in China, yield losses close to 100% have been attributed to BLSB.

Economic Losses

The disease was earlier reported as a minor disease on maize (Payak and Renfro 1966). The importance of the disease was only realized in early 1970s when an epidemic occurred in warm and humid foot hill areas in the Mandi district of Himachal Pradesh Thakur *et al.*, (1973). In country like India, Lal *et al.* (1980) have estimated in ten cultivars a loss in grain yield ranging from 23.9 to 31.9%, whereas Singh and Sharma (1976) estimated 10-40% in other cultivars. Lal *et al.* (1985) had suggested that grain yield loss can go up to an

extent of 90%. The disease results in the direct loss exhibiting premature death, stalk breakage, and ear rot. Losses to the extent of 11-40 per cent were reported while evaluating 10 different varieties of maize. Losses in grain yield showed a high positive correlation with premature death of plants and disease index that caused drastic reduction in grain yield to the tune of 97 per cent (Butchait, 1977). A direct correlation with other yield parameters was exhibited in a yield loss of 5 to 97.4 per cent at disease score levels ranging from 3.0 to 5.0, Lal *et al.* (1980); Liang *et al.* (1997). In Indonesia, (Sudjono 1995) reported that it caused a yield loss of up to 100 percent. (Dela Vega and Silvestre 2003) reported that as the disease intensities increase, the yield loss and yield reduction also enhance with a directly proportional relationship.

Symptoms

It was, generally, reported that this disease appears at pre flowering stage in 40-50 days old plant (Saxena, 2002). The disease develops on leaves, sheaths, and stalks and can spread to the ears. Typically, disease develops on first and second leaf sheath above the ground as this disease is soil borne and eventually extends to the ears that ultimately lead to ear rot. When infection reaches ear, light brown cottony mycelial growth and small round mustard seed sized small round black sclerotia are observed. Premature drying and

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caking of ear sheath is also observed. Crop damage is caused by loss of photo-synthetic leaf area due to foliar infection and stalk rot which lead to crop lodging Lu *et. al.*, (2012). Similarly (Ahuja and Payak 1982) found that maximum damage is caused when ears are infected. In addition to ear rots, kernels are often wrinkled, dry, chaffy and light in weight. These symptoms are stalk lesions, stalk breakage, clumping and cracking of silk and horse shoe shaped lesions on caryopsis. Hirrel *et. al.* (1988) noted the symptoms as reddish eye spot lesions with dark red to purple margin on stalks near the soil line. Prolific sclerotial and hyphal development was also recorded on older sheaths which appeared as yellow green discoloration with a thin black border. Sharma *et al.* (2004) reported the pathogen affects all the aerial plant parts of maize except the tassel. The symptoms appeared within 4-5 days after inoculation, which were irregular, water-soaked, straw-coloured lesions on leaf bases and sheaths. The lesions enlarged rapidly resulting in discoloured areas alternating with dark bands, apparent on lower leaves after 7 to 8 days. The symptoms appeared on inoculated plants as irregular shaped spots. Typical banded leaf and sheath blight symptoms were observed as small purplish brown lesions or greenish olive brown large continuous patches on leaf sheath and pale olive brown lesions on stalk as well as rotting of ears (Akthar *et. al.*, 2009). The symptoms and morphological characters observed in the present investigations have also been recorded and described by several workers (Duggar, 1915, Reyes, 1941, Sohi *et al.*, (1965), Singh and Sharma, 1976)

Causal Organism

Banded leaf and sheath blight (BLSB) caused by *Rhizoctonia solani f. sp. sasakii* (Ahuja and Payak, 1982) is considered as an important disease of maize. *R. solani* is generally identified by characteristics of the mycelium and sclerotia as it lacks spores formation. Mycelium often is colorless at young stage, while turns to light brown as it matures. The characteristics of hyphae of *Rhizoctonia* are branching near distal septum of cells in young vegetative hyphae; formation of septum in the branch near the point of origin, construction of branch; dolipore septum; no clamp connection; no conidium; sclerotium not differentiated in rind and medulla and no rhizomorph (Ogoshi, 1975). It is the combination of its competitive saprophytic ability and high pathogenic potential that makes *R. solani* persistent and destructive plant pathogen (Saxena, 1997). The diameter of vegetative hyphae is 8-12 µm and is constricted at the point of branching. The mature hyphae branch at right angle and sclerotia are produced abundantly in culture and on infected plant parts. Mostly, sclerotia are 1 to 5 mm in diameter with spherical shape, and dark brown to black colour.

Host Range

The pathogen has wide host range and infects plant belonging to over 32 families in 188 genera. *H. sasakii* infects by artificial inoculations a number of crop plants belonging to families Graminae, Papilionaceae and Solanaceae : *Paspalum scrobiculatum*, *Pennisetum purpureum*, *Setaria italica*, *Panicum miliaceum*, *Coix lachryma jobi*, *Echinochloa frumentacea*, *Pennisetum americanum*, *Zea mays*, *Oryza sativa*, *Saccharum officinarum* *Sorghum bicolor*, *Arachis hypogea*, *Glycine max*, *Pisum sativum*, *Vigna radiata* and *Lycopersicon esculentum*. *Rhizoctonia* very likely has a widest host range and differences among isolates are not obvious (Leach and Garber, 1970). However, with the concept of interspecific groups (ISGs) and anastomosis groups

(AGs), the potential for breeding resistant varieties has improved. The scheme of anastomosis group was first suggested by (Schultz in 1937) and later developed by (Richter and Schneider in 1953). Presently at least 14 anastomosis groups have been reported in *R. solani*. Rice and maize isolates are, however, indistinguishable on the basis of cross inoculation tests, host range, virulence, number of nuclei per hyphal cell, and other morphological characters including pathogenicity. Comparison studies of rice maize, sugarcane and sorghum isolates revealed that maize and rice are similar than those isolates of sugarcane and sorghum (Saxena, 1997).

Disease Cycle and Favorable Condition

R. solani survives in the soil and on infected crop debris in form of sclerotia or mycelium. Sclerotium acts as primary source of inoculum. Sclerotia are known to survive for several years in the soil. The fungi spread by irrigation, movement of contaminated soil and infected plant debris. At the onset of the growing season, in response to favorable humidity and temperatures (15 to 35°C), the fungal growth is attracted to newly planted crops by chemical stimulants. Genetics of resistance to BLSB stimulants released by growing plant cells. Secondary spread of this disease occurs by contact of diseased leaves or sheaths with healthy plants. Although horse shoe shaped lesions are caused by the pathogen on kernels, the kernels are not considered as source of inoculums. High relative humidity and rain fall significantly favors development and spread of this disease. An optimum temperature about 28°C and high relative humidity (88 to 90%) in the first week of infection favor rapid disease progress. If the relative humidity goes below 70%, disease development and spread becomes slow (Sharma, 2005). Additionally, high crop densities impact disease severity.

Integrated Disease Management

Due to ambiguity in understanding of inheritance of resistance and non-availability of widely adapted and stable source of resistance to BLSB, control of disease by cultural, biological and chemical procedures is extremely important to minimize the destruction of crop and to prevent economically crop losses. (Saxena 2002) tested efficacy of chemicals (viz, Propaconazole, 0.1%, and Carbendazim, 0.05%), by applying as foliar sprays at 30, 40 and 50th day of planting, alone or in combinations. Effectiveness of Propaconazole was markedly observed when the chemical was applied at initial stages at 30th or 40th day after planting and the second spray at 10 days after first. Foliar sprays of Carbendazim showed the ineffectiveness against BLSB. On in vitro evaluation, three often used fungicides, namely Bavistin, Rhizolex, and Thiophenate M, have shown absolute control of mycelial growth with 100% inhibition. It is, therefore, envisaged that under field conditions a high level of control of BLSB could be achieved using these three fungicides Sharma *et al.*, (2002). The antibiotic Validamycin was able to give only 56.3% inhibition at 30 ppm. Several micro-organisms are known to parasitize *Rhizoctonia* species. These are mainly fungus of species *Trichoderma*, *Gliocladium*, and *Laetisaria*, bacteria (*Pseudomonas fluorescence*), and nematodes (*Aphelenchus avenae*). Reduction in disease incident of BLSB was observed when *P. fluorescence* was used in seed and soil treatment and in foliar application Meena *et al.*, (2003). Seed treatment and soil application of this antagonist not only reduces the disease to more than 50%, but additionally Sharma *et al.* (2002) recorded consequent increase in grain yield approximately 1.4-times of the yield of the control. Another biocontrol agent, named *Trichoderma harzianum*, also provided as high as 68% of

inhibition of the mycelia of *R. solani*, under in vitro conditions, compared to the control of BLSB (Sharma et al, 2002). Formulations of anti-biotic Validamycin also show good control against BLSB Jiang et al, (1991) but due to high cost, Validamycin does not appear to be profitable proposition Sharma et al, (2002). For the cultural control of *R. solani*, selection of a well drained field and planting on raised beds are important aspects to avoid contact of water with seeds and faster growth of seedlings. Composting of hard-wood on Rhizoctonia-infested soil has been found to reduce disease severity, apparently by promoting the growth of *Trichoderma* and other antagonistic micro-organisms (Hoitink, 1980). Biocontrol agents are applied to soil as inoculated oil cake, FYM, granules, tablets, talc based formulations and crude spore suspensions. It has been known about 70 years that *Trichoderma spp.* produces a wide range of antibiotic substances that affects other microbes, and act as biocontrol agents (Weindling, 1934). (Dennis and Webster 1971) reported production of volatile and non volatile antibiotics by *Trichoderma sp.* effective in controlling *R. solani*. Dalmacio et al., (1990) were conducted three experiments on the mechanical, biological, and chemical control of banded leaf and sheath blight in corn caused by *Rhizoctonia solani*. In case of mechanical control the defoliation of corn plants proved to be effective in controlling the upward spread of lesion. Among the chemicals and biocontrol agents validamycin gave the best control, followed by *T. harzianum*. Validamycin afforded the best control in terms of reduction in lesion spread. (Singh Akhilesh and Singh Dhanbir, 2011) was conducted a field trial using cultural practices, bioagents and fungicides. Out of 11 treatments, minimum disease intensity (1.36 on 1–5 scale) and maximum yield (42.28 q/ha) was found in case of foliar spray of validamycin (0.25%) followed by Tilt (0.1%) and bavistin (0.1%). Foliar spray of Indofil M-45 (0.25%) was found to be least effective among all chemicals, but showed significantly lower disease severity and higher grain yield over check. Use of bioagents given as foliar spray showed more effective response against the disease when compared with seed treatment. *Trichoderma viride* was found more effective than *Pseudomonas fluorescens*. In all the treatments, there were significant increase in yield over check. Carbendazim, neem oil and *Trichoderma harzianum* were evaluated as seed treatment (ST) and also as ST plus spray in various combinations for managing the banded leaf and sheath blight of maize. Treatments with combination of ST and spray application were more effective than ST alone. The maximum grain yield (52.0 q ha⁻¹) with significantly reduced disease (46.8%) and increased grain yield (51.6%) were recorded in the Seed Treatment+spray of carbendazim (0.1%), followed by treatment with neem oil (0.2%), over other treatments and control. Use of neem oil as seed treatment and spray could be a cost effective and eco-friendly strategy in managing the BLSB. Bunker et al., (2012).

References:

- Ahuja SC, Payak MM, (1982). Symptoms and signs of banded leaf and sheath blight in maize. *Phytoparasitica*. 10: 41-49.
- Akthar, J., Kumar Jha, V and Lal, H.C. (2009). Occurrence of Banded Leaf and Sheath blight of Maize in Jharkhand with Reference to Diversity in *Rhizoctonia solani*. *Asian Journal of Agricultural Sciences*. 1 (2): 32-35.
- Bhavana P, Gadag RN, (2009). Evaluation of maize genotypes for resistance to banded leaf and sheath blight. *Annals of Plant Protection Sci* 17: 498- 499.
- Bertus LS, 1927. Year book, pp. 44-46. Department of Agriculture, Ceylon.
- Bunker, R. N., Amit Trivedi and Kusum Mathur.(2012). Integrated management of banded leaf and sheath blight of maize caused by *Rhizoctonia solani* f.sp. *sasakii*. *Journal of Mycology and Plant Pathology*. 42(3): 367-371.
- Butchaiah, K. (1977). Studies on Banded Sclerotial diseases of maize. M.Sc. thesis, G.B. Pant University of Agriculture and Technology, Pantnagar, India. 65 p.
- Dalmacio, S.C., Lozano, G.P., De La Pena, R.S. and Candole, B.L. (1990). Mechanical, biological and chemical control of banded leaf and sheath blight on maize caused by *Rhizoctonia solani* [Philippines]. *Plant Disease Research*. 20.
- Dela Vega, A.P. and J.C. Silvestre. (2003). Yield loss estimate in USM var 9 due to banded leaf and sheath blight caused by *Rhizoctonia solani* Kuhn. *Philippine Society for the Study of Nature (PSSN)*.
- Dennis, C and Webster, J. (1971). Antagonistic properties of species groups of *Trichoderma* III hyphal interactions, *Transaction of British Mycological Society* 57: 363-369.
- Duggar, B.M. (1915). *Rhizoctonia crocorum* (Pres.) D.C. and *R. solani* Kuhn (*Corticium vagum* B and C) with notes on other species. *Annual Mel. Bot. Gard.*, 2: 403-458.
- Garg A, Prassana BM, Sharma RC, Rathore RS, Saxena SC, Chauhan SVS, (2007). Identification of resistance source to banded leaf and sheath blight (*Rhizoctonia solani* F. sp. *sasakii*) in maize. *Indian Phytopathol* 60: 162-166.
- Hirrel, M.C., Lee, F.N., Dale, J.L and Plunkett, D.E. (1988). First report of sheath blight (*Rhizoctonia solani*) on field corn in Arkansas. *Plant Disease*. 72: 644.
- Hoitink HAJ, 1980. Composted bark a light weight growth medium with fungicidal properties. *Plant Dis* 64: 142-147
- Jiang HL, Ding X, Ma H, (1991). The occurrence and chemical control of maize sheath blight (*Rhizoctonia solani*) in Ragao of Jiangsu. *Plant Prot* 6: 11-12
- Kumar R, Singh IS, (2002). Inheritance of resistance to banded leaf and sheath blight (*Rhizoctonia solani* F. sp. *sasakii*) of maize (*Zea mays* L), pp 356- 365. *Proceedings of the 8th Asian Regional Maize Workshop, Bangkok, Thailand*.
- Lal, S., K. Butchaiah and P. Baruah. (1985) Comparative efficacy of some fungicides and antibiotics in control of banded sclerotial disease of maize. *Pesticides*; 19 (2):17-19.
- Lal, S.; P. Baruah and K. Butchaiah (1980). Assessment of yield losses in maize cultivars due to banded sclerotial disease. *Indian Phytopath.* 33:440-443.
- Leach LD, Garber RH, (1970). Control of *Rhizoctonia solani*, pp 189-198. In: *Rhizoctonia solani*, Biology and Pathology. Parmeter JR Jr ed.
- Liang- JiNong, Chen-HonDe, Zhu-H, Liu-W.J., Y.F. Huang Liu-J. and G.D. Zhao (1997). Yield losses of maize caused by sheath blight and its occurring pattern. *Acta Phytophylacica- Sinica*. 24:101-1067.
- Lu YL, Xu J, Yuan ZM, Hao ZF, Xie CX, Li XH, Shah T, Lan H, Zhang SH, Rong TZ, Xu YB, (2012). Comparative LD mapping using single SNPs and haplotypes identifies QTL for plant height and bio-mass as secondary traits of drought tolerance in maize. *Mol Breeding* 30: 407-418.
- Ogoshi A, (1975). Grouping of *Rhizoctonia solani* Kühn and their perfect stages. *Review on Plant Protection Res* 8: 93-103.

22. Payak, M.M and Sharma, R.C. (1985). Maize diseases and their approach to their management. *Tropical Pest management*. 31: 302-310.
23. Payak, M.M. and Renfro, B.L. (1966). Diseases of maize new to India. *Bulletin Indian Phytopathology*. 3: 14-18.
24. Reyes, G.M. (1941). Notes on diseases affecting maize in Philippines. *Journal of Agriculture*. 12: 61-69.
25. Sahar, A., El-Sayed., Rania, Z., El-Shennawy and Tolba, A.F. (2009). Efficacy of chemical and biological treatments for controlling soil borne pathogens of soybean. *Journal of Agricultural Science*. 17 (1): 163-173.
26. Richter H, Schneider R, 1953. Untersuchungen zur morphologischen und biologischen Differenzierung von *Rhizoctonia solani* K – *Phytopathol Z* 20: 165–226.
27. Saxena SC, (2002). Bio-Intensive Integrated disease management of banded leaf and sheath blight of maize, pp. 380-388. In: *Proceed of 8th Asian Regional Maize Workshop: New Technologies for the New Millennium*, Bangkok, Thailand.
28. Saxena, S.C. (1997). Banded leaf & Sheath blight of maize. In: Agnihotri, V.P.; Sarbhoy, A.K. and Singh, D.V. eds. *Management of threatening plant diseases of national importance*. Malhotra Publishing House, New Delhi, pp. 31-50.
29. Schultz H, (1937). Vergleichende Untersuchungen zur Ökologie, Morphologie und Systematic des "Ver-mehrungspilzes". *Arb Biol Reichsanst Land Forst-wirtsch Berlin-Dahlem* 22: 1-41
30. Sharma RC, (2005). Banded leaf and sheath blight (*Rhizoctonia solani* F. sp *sasakii*) of maize, In: *Stresses of maize in Tropics*. pp. 159- 171.
31. Sharma RC, Vasal SK, Gonzalez F, Batsa BK, Singh NN, (2002). Redressal of banded leaf and sheath blight of maize through breeding, chemical and biocontrol agents, pp. 391-397. In: *Proceed of the 8th Asian Regional Maize Workshop: New Tech-nologies for the New Millennium*, Bangkok.
32. Sharma, R.C. and Payak, M.M. (1986) Disease management in maize plant protection in field crops (Lead papers of National seminar on plant protection in field crops; CPPTI, Hyderabad. pp. 113-118.
33. Sharma, R.R., Gour, H.N and Rathore, R.S. (2004). Etiology of banded leaf and sheath blight symptoms on maize. *Journal of Mycology and Plant Pathology*. 34 (1): 56-59.
34. Singh Akhilesh and Singh Dhanbir (2011). Integrated disease management strategy of banded leaf and sheath blight of maize. *Plant Disease Research*. 26(2):192.
35. Singh, B.M. and Sharma, Y.R. (1976). Evaluation of maize germplasm to banded sclerotial disease and assessment of yield loss. *Indian Phytopathology*. 29: 129-132.
36. Singh, B.M. and Y.R. Sharma. (1976) Evaluation of maize germplasm to banded sclerotial disease and assessment of yield loss. *Indian Phytopathology*; 29:129-132.
37. Sohi, H.S., Sharma, S.L and Verma, B.R. (1965). Diseases of maize occurring in HP. *Proceeding of Maize Improvement Conference*, New Delhi, pp: 122-124.
38. Sudjono, M.S. (1995). Effectiveness of antagonists against sheath blight and ear rot caused by *Rhizoctonia solani* Kuhn. *Proceeding Kongres Nasional XII dan Seminar Ilmiah PFI*. Jogjakarta. pp. 545-549.
39. Thakur, M.S., S.L. Sharma and R.L. Munjal (1973). Correlation studies between incidence of banded sclerotial disease and ear yield in maize. *Indian J. of Mycol. & Pl. Pathol*. 3:180-81.
40. Weindling, R. (1934). Studies on lethal principle effective in the parasitic action of *Trichoderma lignorum* on *Rhizoctonia solani* and other soil fungi. *Phytopathology*. 24: 1153-1179.
41. Yang JP, Tang HT, Yang JX, Li X, Chen DQ, Zhang B, Shi YG, Huang YX, (2005). Identification and inheritance of resistance of maize germplasm to sheath blight (*Rhizoctonia solani*). *Acta Phyto-pathologica Sinica* 35: 174-178.