INTERNATIONAL JOURNAL OF APPLIED BIOLOGY AND PHARMACEUTICAL TECHNOLOGY

www.ijabpt.com Volume-4, Issue-4, Oct-Dec-2013 Coden : IJABPT

ISSN : 0976-4550

Received: 09th August-2013 *Revised: 20th August-2013* *Accepted: 24th August-2013*

Review article

REVIEW ON BANDED LEAF AND SHEATH BLIGHT OF RICE CAUSED BY *Rhizoctonia solani* KÜHN

P. Srinivas[1], Ved Ratan[2], Atm Prakash Patel[3] and G. Bindu Madhavi[4]

[1] Department of Plant Pathology, College of Agriculture, Rajendranagar, Hyderabad, India.
[2,3]Department of Plant Pathology, Chandra sekhar Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India.
[4] Scientist, Agricultural Research station, Lam, Guntur.
Corresponding Authour: E-mail- srinivaspathology@gmail.com

INTRODUCTION

Rice (*Oryza sativa L.)* is a graminaceous crop. It is one of the important staple foods for Asian countries. Sheath blight disease is an important fungal disease of rice. Currently, this disease is distributed in almost all the rice growing states. The disease is alarming due to its intensive cultivation of modern high yielding varieties with high doses of nitrogenous fertilizers. Crop with a high plant density and close canopy associated favors disease build up from panicle initiation onwards. Poor weed management practices and increase in frequency of irrigation have aggravated, incidence of the disease due to modified micro climatic conditions. The disease was first recorded from Japan (Miyake, 1910). In India, the disease was first reported from Gurudaspur, Punjab (Paracer and Chahal, 1963) and later it was reported from Uttar Pradesh (Kohli, 1966). The management of this disease is possible only after the detailed study of different aspect of this disease and the pathogen. Management of the disease below its economic threshold is important for increasing the production, productivity and quality of the produce. Recognizing the importance of the problem, need for the effective and socio economically feasible management of the pathogen, the present review presented by keeping the above stated factors of the disease into consideration.

SYMPTOMATOLOGY

Ou (1972) studied in detail the symptoms of sheath blight under field conditions. Initial symptoms of sheath blight appear in the form of circular, oblong or ellipsoid, greenish-grey water-soaked spots about 1cm long that occur on leaf sheath near the water level. These lesions enlarge and become oblong and irregular in outline, the center of which become grey white with brown margins. Lesions may also appear on any part of sheath and several lesions may unite to encircle the whole Culm. Under humid conditions, the infection may spread to upper leaf sheaths and leaf blades, which ultimately results in rotting of leaf sheath and drying up of the whole leaf. In severe cases, most of the leaves in a plant may be blighted. Sclerotia were formed in the lesions and were easily detachable. The size and color of the sclerotia depend on the soil factors, rice variety involved and environmental conditions. The lesions enlarge the centers of which become pale-green or grey and are surrounded by an irregular purple border (Webster and Gunnel, 1992). Heavy infected plants produce poorly filled grains and may die immature panicle (Dasgupta,1992). Initial symptoms consist of lesions on the sheaths of lower leaves at late tillering or early inter nodal elongation growth stages. Under favorable conditions of low sunlight, high humidity (≥ 95%) and warm temperature (28-32˚C), the infection spreads rapidly by means of runner hyphae to upper plant parts. Lesions may coalesce to encompass the entire leaf sheath and stem (Rush and Lee, 1992). Singh *et al.* (2003) reported about the growth of mycelium on the affected parts of the plant under humid conditions and this aids in the spread of the disease to a considerable distance in the field through irrigation water. Lodging may occur in diseased plants, particularly in taller varieties (Rangaswamy and Mahadevan, 2005).

Morphological Characters of Imperfect State and Mycelial Characters

Young colonies on the media may be nearly white but all older colonies have some shades of brown. For these reasons, the brown pigment appears to be stable diagnostic character. Any mycelia remaining permanently white or showing pigmentation other than any shade of brown are not considered as *R.solani* (Palo, 1926).

Coden : IJABPT Copyrights@2013 ISSN : 0976-4550

Hyphae diameter varies widely both within and among the isolates. Measurements by Matsumoto (1921), Thomas (1925), Ritcher and Schneider (1953) indicated that most isolates fall within 5-14µmrange. The diameter of hyphae with in a colony varies widely according to age and composition of medium and temperature (Palo, 1926; Dahl, 1953). Bracker and Butler (1963) reported that the dolipore septa are a prominent feature of *R. solani*. This apparatus is also common in many other basidiomycotina members and its presence in a non-sporulating mycelium is not itself indicative of *R. solani.* Right angle branching sometimes cited as a diagnostic feature but it is not considered reliable. Other features of branching are diagnostically more important. Branching almost invariably occurs near the distal septum of a cell in young and advancing hyphae. In older hyphae, branching may occur at any place along the cell. Constriction of branch hyphae at the point of origin and formation of septum at right angle in the point of origin appear to be stable and reliable characteristics of *R. solani* (Parmeter, 1970). Thind *et al.* (2008) reported that *R.solani* isolates of rice grew 66.6 percent faster than potato isolates. Hyphal width of isolates from both hosts varied from 7.2 to12.1µm and rice isolates formed larger sclerotia (1.5-2.0 mm in diameter) and of potato isolates produced 0.5-1.0 mm diameter sclerotia.

Monilioid Cells

Monilioid cells may be hyaline or brown, barrel-shaped, pyriform, irregular or lobate, rare or numerous, loosely grouped or tightly clamped (Duggar, 1915; Dodge and Stevens, 1924; Palo, 1926). Saksena and Vaartaja (1960, 1961) have placed considerable emphasis on the use of monilioid cells in distinguishing species of *Rhizoctonia.* However, the wide variation in dimensions of monilioid cells reported by Matsumoto (1921) and Saksena and Vaartaja (1960) that, such measurements do not provide suitable criteria for distinguishing the species. In addition, many fungi, including both Ascomycetes and Basidiomycetes produce monilioid cells similar to those of *R. solani.*

Sclerotia

Several workers have reported that sclerotia are first grey white, later brown to black in color, sub-globose slightly flattened in shape and vary from 0.5-5.0 mm in size [Matsumoto and Yamato(1935); Ryker (1939) and Palo (1926)]. Sclerotia of *R.solani* are quite variable.Studied by Exner and Chilton (1943); Whitney and Parameter (1964) on variation among single spore isolates showed that sclerotia of sibling isolates varied widely in size, shape, shade, surface texture and distribution on culture medium.

Perfect State

The perfect state, *Thanatephorus cucumeris* is known under different names and includes familiar names like *Hypschnus cucumeris, Hypschnus solani, Corticium solani, Corticiummicrosclerotia (Rhizoctonia microsclerotia)* and *Pellicula*riafilamentosa. Other possible synonyms are *Corticiumsasakii* and *Corticiumaerolatum, Thanatephorus particolus* (Kotila) Flintje which were earlier considered as distinct species have also been included in *Thanatephorus cucumeris* by Talbot (1965). The perfect state of *Rhizoctonia solani* is considered to be *Thanatephorus cucumeris* (Frank.) Donk. The taxonomy and nomenclature of *Thanatephorus cucumeris* (Frank) Donk is discussed by Talbot (1970). He placed the genus *Thanatephorus cucumeris* in the family, Tulasnellaceae and order, Tulannellales and recommended that sub-classes, Heterobasidiomycetidae and Homobasidiomycetidae should no longer be recognized.

Mode of Survival of Pathogen

Muller (1924) observed that sclerotia remained viable for more than 18 months in soil. Palo (1926) reported survival for several months in soil. Itaka and Hitomi (1930) observed exclusive presence of sclerotia *Hypochnus sasakii* from rice plants in the field. The pathogen survives in the field as sclerotia and infects the rice crop in the following season. At room temperature on dry or moist soil, the sclerotia survived for at least 130 days and for 224 days when submerged under deep tap water (Park and Bertus, 1932). The survival and inoculums potential of the *R. solani* is directly related with severity and incidence of disease. Sclerotia are the most important source of inoculums (Allison, 1951). The survival of *R.solani* and its transmission through seed tuber is well known for black scurf of potato (Baker, 1947 and Neergaard, 1958). Strains of *R. solani* from weed hosts have been reported to be pathogenic to several crop plants (Herzog, 1961; Deniels, 1963 and Oshima *et al*., 1963). Kulkarni (1967) observed that sclerotia of *Claviceps microcephala* remained viable for longer time if buried at deeper levels in soils. Saksena and Chaubey (1973) observed the external as well as internal seed borne nature of *R. solani* in case of banded blight disease of paddy. The sclerotia of *Corticium sasakii* kept at depth of 2.5, 5.0, 7.5, 10.0 cm in different soil types (clay, sandy and red loam) remained viable for 200, 220 days irrespective of conditions of treatments. In the treatment where the sclerotia were placed on the surface of the soils, they lost viability after 160 days, thus indicating that the viability of sclerotia was increased when buried in soil (Mahendra Pradhat *et al.*, 1974).

Coden : IJABPT Copyrights@2013 ISSN : 0976-4550

Onesirosan and Sagay (1975) reported that the aerial strain of *R. solani* survived for some period only in diseased leaves on the soil surface, but in the buried leaves infectivity was lost with the disintegration of leaves. Kanniyan and Prasad (1978) reported that there was 100% viability of sclerotia of *R.solani* up to 240 days followed by gradual decrease when they were buried in soil or floated on water. On the other hand, 100% viability of sclerotia placed on surface of soil was observed up to 120 days followed by a drastic decrease during the subsequent period. The sclerotia lost viability after 210 days when they were placed on surface of soil and remained viable for 390 days when buried in soil at 5 cm depth. Tu *et al.* (1979) found that on the surface of the field soil, sclerotia of *R. solani* survived for more than 16 months but while buried just under 2 cm of soil longevity came down to 8 months. Sclerotia may be produced loosely externally on the sheaths or between the sheath and Culm (Gangopadhyay and Chakrabarti, 1982). High correlation with increase in disease index with the number of viable sclerotia of *R.solani* was observed. There was no correlation between the pathogen from plant debris and damping off of sugar beet. But, there was high correlation between the number of viable sclerotia and damping off incidence. These workers concluded that sclerotia and plant debris are the main source of inoculum (Hyakumachi and Ui, 1982). Sclerotia of coffee isolate of *R. solani* placed on soil surface of coffee nursery beds, survived up to 225 days but those buried in soil survived up to 375 days (Venkatasubbaih and Safeeulla, 1983). Dash (1985) observed that population of sclerotia in ploughed field was higher 6-12 cm than in upper layers and the sclerotia buried deep in soil have better buoyancy and viability. Maiti (1978), Ahuja and Payak (1988) reported that the fungus *R.solani* f.sp. *sasakii* (Kühn) Exner survives in the form of sclerotia which serve as primary source of inoculum. Sudhakar *et al.* (1998) reported that *R. solani* sclerotia remained 100% viable up to 120 days of incubation in dry soil when buried at 5 cm depth. The viability of sclerotia was 78.5% at 150 days and 31.5% at 180 days after incubation. Tan Genjia *et al.* (2000) studied the germination rate and underground infectivity of *R. solani* sclerotia was studied. The germination rate of sclerotia increased with temperature and can infect rice plants at a soil depth of 1-3 cm. Li Shi Dong (2004) reported that 60.9% sclerotia could survive after 265 days of being buried in natural sandy loam under field conditions in Beijing, while colonized rice straw debris (0.5-10 cm long) could not yield the fungus on medium plates after 88 days of being buried under same conditions. Singh and Singh (2008) reported that the infected leaf pieces incubated at 10 and 28˚C also showed a steady reduction in fungus survival with an incubation period from an initial 100% to 53.3% and 63.3% respectively after a period of 5 months. At all observations time, except 150 days after incubation, 10 and 28˚C recorded significantly more survival than at 0 and 40˚C.

Role of Basidiospore in the Secondary Spread of Disease

Basidiospores were shown to be a major factor in dissemination of aerial strain of *R.solani* (Carpenter (1949, 1957); Kotila (1945b); Lorenz (1948). It was observed that the fungus grow from leaf to leaf (Luttrell, 1962) and from cotyledon to stem (Weber and Abrego, 1958) through basidiospore. According to Saksena (1961), basidiospore was germinated by one germ tube and rarely by two from any point of spore wall. He also reported that in rare case, basidiospore germinated by repetition. The rapid spread of web blight of common bean in warm humid conditions can also be explained by efficient production and dissemination of basidiospore (Echandi, 1965). The rapid spread of leaf sheath blight of paddy in this country can also be explained due to abundant production of basidiospores (Saksena and Chaubey, 1973). The early infection in the field came from *R.solani* stage of the organism and the secondary spread of the disease took place through basidiospores where the fungus known to produce perfect stage (Dwivedi and Saksena, 1974, 1975 and Chaubey, 1976.). In the tropics, where the telomorph of *R. solani* develops regularly, the pathogen spreads rapidly by the production and dissemination of basidiospores (Galindo *et al.,* 1983). Naito (1984) reported foliar blight of sugarbeet by *T. cucumeris* spread by formation of replicated hyphae and basidiospore.

Host Range

Kozaka (1961) from Japan recorded 188 species of plants from 32 families that can be infected by this fungus. Two virulent isolates of *Thanatephorus cucumeris* could infect and survive on several weed hosts which are commonly found in rice fields namely *Echinocloa crusgalli, E. colonum, Fimbristylis littoralis, Cyperus rotandus.* Kozaka (1965), Tsai (1974) observed that rice fungus infected 20 species which are from 11 families and observed that the sclerotia from diseased tissue of weed hosts produced typical symptoms of sheath blight on paddy plants. Singh and Saksena (1980) found that aerial strain causing banded blight disease in bajra infected 22 plants species of both crop and wild plants belonging to 6 different families. Kannaiyan and Prasad (1980) have listed 30 monocot weed species as host of *Thanatephorus cucumeries (Rhizoctnia solani).*Goswami *et al.* (2010) reported that isolate SYL-13 possessed narrow host range and low avirulent while DIN-8 and GAZ-18 had wide host range and considered as virulent isolate of *Rhizoctonia solani.* The isolate GAZ-9 had highly virulent and wide host range of 35 different crops.

Coden : IJABPT Copyrights@2013 ISSN : 0976-4550

Screening of Chemical Fungicides against test Pathogen

Prophylactic and therapeutic sprays of Carbendizm, Carboxin and Kitazin using as soil drenching with Carbendizm, Carboxin and PCNB effectively controlled sheath blight disease (Viswanathan and Mariappan, 1980). ArunYanart *et al.* (1986) have observed the effectiveness of Pencycuron, Jingumycin, Validamycin and Carbendizm against *Thanatephorus cucumeris.* Das and Mishra (1990) obtained best disease control with Topsin-M (Thiophanate methyl) seed treatments followed by foliar sprays of same fungicide. Akter *et al.* (2001) reported that six fungicides namely Bavistin 50 WP (Carbendazm), Contaf 5 EC (Hexaconazole), Forastin 50 WP (Carbendizm), Anvil 5 SC (Hexaconazole), Tilt 25 EC (Propiconazole) and Thiovit 80 WP (Micronized sulfur) and fertilizer, Muriate of Potash were tested in Gazipur, Bangladesh against sheath blight of rice (cv. Swarna) caused by *R. solani*. Contaf appeared to be the best in reducing the percent relative lesion height, per cent disease index and tiller infection.

Lixili *et al.* (2001) reported that the toxicity of Carbendazm, Thiram, Tolcofos-methyl and mixtures of Carbofuran + Thiram + Tolcofos-methyl (20% CTR) and 20% Carbofuron + Carbendazim + Tolcofos methyl S (20% CSR) to the rice pathogen *R. solani* was determined in laboratory experiments. Tolcofos-methyl provided a good control for *R. solani.* Ali *et al.* (2002) reported the seed treatment with Mancozeb, Copper oxy chloride, Captan and Contaf reduced sheath blight incidence. Three sprays of Bavistin (0.1%) and Mancozeb (0.1%) + seed treatment reduced disease incidence significantly. Tiwari *et al.* (2002) used 7 fungicides to control sheath blight of rice and reported that Carbendazim + Epoxiconazole (0.2%), Hexaconazole (0.2%), Epoxiconazole (0.24%) and Propicanzole (0.2%) were significantly more effective in controlling disease severity than other fungicides. Chahal et al. (2003) managed sheath blight of rice by using 8 fungicides Propiconazole (0.1%) minimized the disease to maximum extent followed by Edifenphos (0.1%), Iprodine (0.3%) and Carboxin (0.2%).

Screening of Bioagents against test pathogen

Trichoderma viride has been attributed to their production of antibiotics as well as mycoparasitism reported by (Dennis and Webster, 1971). *Trichoderma harzianum* and *T. viride* have been reported as effective antagonists against *R. solani in vitro* (Elad *et al.,* 1980; Gokulapalan and Nair, 1989). Baby and Rao (1993) reported that soil application of *T. longibrachiatum* and wheat bran dust survived well in the soil and reduced *R. solani* population, and increased yield. Foliar sprays with *T. harzianum, T. viride* and *Aspergillu sterreus* significantly reduced sheath blight severity (Das *et al.,* 1996). Das *et al.* (1998) reported that application of *T. viride* and *B. subtilis* as seed treatment showed reduction in sheath infection percentage. Das and Hazarika (2000) reported that seed treatment with antagonistic fungi *T. viride* and *T. harzianum* showed significant reduction in sheath infection grain yield. Among them, *T. harzianum* was more effective than *T. viride.*

Surilirajan and Kandhari (2005) studied to access the disease severity, Percentage Disease Incidence (PDI) and yield parameters. Out of 16 treatments, *T. viride* (TV-3235) + Carbendazim 50WP (0.1%) spray along with soil amendments (FYM 1% + saw dust 1%) showed that maximum reduction in sheath blight severity, percent disease incidence and higher grain yield over the control. Singh (2006) found that single application of Carbendazim @ 0.1% was best in reducing the sheath blight severity and increasing the rice grain yield as compared to application of combination of *T. harzianum*+ *Pseudomonas fluorescens* or also with single application of validamycin at any stage of crop seed, seedling tillering and symptoms initiation. Khan and Sinha (2007) reported *T. harzianum* and its volatile compounds inhibited *R. solani* followed by *T. viridae* in dual culture techniques.

Screening of Botanicals against test Pathogen

Antifungal activity of *Allium sativum* leaf extract against 11 fungal pathogens observed by Misra and Dixit (1977b). Naidu and John (1981) observed that the leaf extract of *Parthenium hysterophorus* inhibited growth of *R. solani.* Dubey and Dwivedi (1991) found fungicidal properties of Allicin a constituent found in *A. cepa,* against vegetative growth and sclerotial viability of *Macrophomina phoseolina* at 0.1% concentration.

Tiwari and Nayak (1991) found leaf extract of *Ocimum sanctum* quite effective in reducing the growth of *R. solani in vitro* and *in vivo.* Narasimhan *et al.* (1998) carried out laboratory evaluation of botanical formulation against sheath blight diseases of rice. Meena *et al.* (1998) evaluated a plant extracts in which bulb extract of garlic at 5% concentration (W/V) completely inhibited the mycelial growth of R. solani causing sheath blight of rice.

Coden : IJABPT Copyrights@2013 ISSN : 0976-4550

Upmanyu and Gupta (2002) evaluated 16 plant species against *R. solani* and found that extracts of *Ocimum sanctum, Allium cepa* and *Phyllanthus emblica* completely inhibited the growth of *R. solani* on 25, 50 and 75% concentration at 24, 48 and 72 hours of inhibition. Gautham *et al.* (2003) evaluated 24 botanicals belonging to family compositae (Asteraceae) *in vitro* for their fungitoxicity against *R. solani*, the caused agent of sheath blight of paddy. Mishra *et al.* (2005) evaluated 7 aqueous plant extracts (*Calotropis gigantea, Vinca rosea, Ocimum sanctum, Azadirachata indica, Eucalyptus citriodora, Allium cepa* and *Zingiber officinale*) against *R. solani* in green gram *in vitro* and found that highest inhibitory action (86.11%) was recorded in ginger. Somani (2009) evaluated fresh leaf extract of 20 botanicals against *R. solani* causing black scurf of potato and found tulsi was effective and neem and onion gave good control when used as seed dip treatment of potato.

REFERENCES

Ahuja, S.C. and M.M. Payak (1988). Relationship of relative humidity and temperature levels with the development of leaf and sheath blight of maize. Z. Pfekrankh. Pfeschutz. 88: 265-268.

Akter, S., M.S. Mian and M.A.T. Mia (2001). Chemical control of sheath blight disease (*R. solani)* of rice. Bangladesh J. of Pl. Path., Gazipur, Bangladesh. 17: 35-38.

Ali, A., A. Anwar, G.N. Bhatt, and G.S. Singhara (2002). Management of sheath blight and blast in rice through seed treatment. Annals of Plant Protection Sciences. 10: 285-287.

Allison, J.L. (1951). Rhizoctonia blight of forage legumes and grasses. Pl. Dis. Reptr. 35: 372-373.

Arun Yanart, P., A. Susin, W. Rajanainasadin, R. Dhitokiattipong and S. Disthaporn (1986). Chemical control of sheath blight I.R.R.N.11 (2): 90.

Baby, U.I and M.K. Rao (1993). Control of rice sheath blight through the integration of fungal antagonists and organic amendments. Tropical Agriculture. 70 (3): 240-244.

Baker, K.F. (1947). Seed transmission of *Rhizoctonia solani* in relation to control of seedling damping off. Phytopathology. 37:912-924.

Bracker, C.K. and E.E. Butler (1963). The ultra structure and development of septa in hyphae of *Rhizoctonia solani* associated with the plant debris. Phytopathology. 49:192-198.

Carpenter, J.B. (1949). Production and discharge of basidiospores by *Pellicularia filamentosa* (Pat.) Rogers on Hevea rubber. Phytopathology. 39: 980-985.

Carpenter, J.B. (1957). Target leaf spot of the Hevea rubber tree in relation to host development, infection, defoliation and control. *U. S.* Dept. of Agr. Tech.Bull. 1028: pp 34.

Chahal, K.K.S., S.S. Sokhi and G. S. Rattan (2003). Investigation on sheath blight of rice in Punjab. Indian Phytopath. 56(1): 22-26.

Chaubey, R.D. (1976). Studies on sheath and leaf blight of paddy caused by *Rhizoctonia sp. Ph.D. Thesis, Kanpur Uni., Kanpur.* 108-161.

Dahl, A.S. (1953). Effect of temperature on brown patch of turf (Abstr.). Phytopathology. 23:8.

Das, B.C and D.K. Hazarika (2000). Biological management of sheath blight of rice. Indian Phytopathology. 53 (4): 433-435.

Das, B.C., A.S.M. Khairuzzaman and L.C. Bora (1998). Biological seed treatment for management of sheath blight. J. of Mycology and Pl. pathology. 28(1): 45-47.

Das, S.R. and B. Mishra (1990). Field evaluation of fungicides for control of sheath blight of rice. Indian phytopath. 43:94-96.

Dasgupta, M.K. (1992). In (U.S. Sing Eds) Plant Diseases of International importance: Diseases of cereals and pulses vol.1 Prentice Hall Englewood cliffs, New Jersey. pp 130-150.

Dash, S. N. (1985). Studies on epidemiology of leaf and sheath blight of maize. *Indian J. Mycol. Res.* 23:53-56.

Deniels, J. (1963). Saprophytic and parasitic activities of some isolates of *Corticium solani*. Trans. Br. Mycol. Soc. 46:485-502.

Dennis and J. Webster (1971). Antagonistic property of species groups of *Trichoderma* III hyphal interaction. Iran Brit. Mycol. Soc. 57:363-369.

Dodge, B.O. and N.E. Stevens (1924). The *Rhizoctonia* brown rot and other rots of strawberry. J. Agric. Res. 28:643-648.

Dubey, R.C. and R.C. Dwivedi (1991). Fungitoxic properties of some plant extracts against vegetative growth and sclerotial viability of *Macrophomina phaseolina.* Indian Phytopath. 44: 411-413.

Duggar, B.M. (1915). *Rhizoctonia crocorrum* (Pers.) Dc and *R. solani* Kühn (*Corticium vagum* B. & C.) with notes on other species. Ann. Missouri Botan. Garden. 2:403-458.

Coden : IJABPT Copyrights@2013 ISSN : 0976-4550

Dwivedi, R.P. and H.K. Saksena (1974). Occurrence of web blight disease caused by *Thanatephorus cucumeris* on mung bean. Indian J. Farm Sci. *2*:100.

Dwivedi, R.P. and H.K. Saksena (1975). Web blight disease of Arhar *(Cajanus cajan* (L.) Mill sp.) caused by *Thanetephorus cucumeris.* Indian J. Farm Sci. 3:113-114.

Echandi, E. (1965). Basidiospore infection by *Pellicularia filamentosa (Corticium microsclerotia)* the incidence of web blight of common bean. Phytopathology. 55:698-699.

Elad, Y., I. Chet and J. Katan (1980). *Trichoderma harzianum:* A biocontrol agent effective against *Sclerotium rolfsii* and *R. solani.* Phytopathology. 70:119-121.

Exner, B. and S.J.B. Chilton (1943). Cultural differences among single basidiospore isolates of *Rhizoctonia solani*.. Phytopathology. 33: 171-174.

Galindo, J., G.S. Abawi, H.D. Thruston and G. Galvez (1983). Source of inoculum and development of bean web blight in Costa rice. Plant Dis. 67:1016-1021.

Gangopadhyay, S. and N. Chakrabarti (1982). Sheath blight of rice. Rev. Pl. Path. 61: 451-460.

Gautham Kaushal, P.B. Rao and S.V.S. Chauhan (2003). Efficacy of some botanicals of family compositae against *R. solani.* J. Mycol. Pl. Pathol. 33:230-235.

Gokulapalam, C. and M.C. Nair (1989). Antagonism of a few fungi and bacteria against *Rhizoctonia solani.* Indian J. Micrb. 24: 57-58.

Goswami, B.K., K.A. Bhuiyan and I.H. Mian (2010). Morphological and Pathogenic variations in the isolates of *Rhizoctonia solani* in Bangladesh. Bangladesh J. Agril. Res. 35:375-380.

Herzog, W. (1961). Dar uberdauern and der saprophytismus des Wurzeltoters, *Rhizoctonia solani* Kuhn in Boder. Phytopth. J. 40: 379-415.

Hyakumachi, M. and T. Ui (1982). The role of the over wintered plant debris and sclerotia as inoculums in the field occurred with sugar beet root rot. Ann. Phytopath.Soc., Japan.48: 628-633.

Itaka, S. and T. Hitomi (1930). On the mode of primary infection through sclerotia as inoculums in the field occurred with sugar beet root rot. Ann. Phytopath. Soc. Japan. 48: 628-633.

Kannaiyan. S. and N.N. Prasad (1980). Dicot weed hosts of *Rhizoctonia solani* Kuhn. Agri. Res. J. Kerala. 18:125-127.

Kanniyan, S. and N.N. Prasad (1978). Studies on the viability of sclerotia of *Rhizoctonia solani* Kuhn in soil and water. Madras Agricultural J.65:741-742.

Khan, A.A. and A.P. Sinha (2007).Screening of *Trichoderma spp.* against *Rhizoctonia solani* the causal agent of rice sheath blight. Indian Phytopathology. 60(4):450-456.

Kohli, C.K. (1966). Pathogenicity and host range studies on paddy sheath blight pathogen *Rhizoctonia solani* Kuhn. Journal and Research , *P.A.U.* 3:7-40.

Kotila, J.E. (1945b). Cotton leaf spot *Rhizoctonia* and its perfect stage on sugar beets. *Phytopathology.* 35:741-743.

Kozaka, T. (1961). Ecological studies on sheath blight of rice of rice caused *Pellicularia sasakii (*Shirai) and its chemical control. Chugoko agric. Res. 20*:*1-133

Kozaka, T. (1965). Ecology of Pellicularia sheath blight of rice plants and its chemical control. Ann. Phytopath. Soc. Japan. 31:179-185.

Kulkarni, U.K. (1967). Viability of sclerotia of *claviceps microcephala* in relation to their weight and size. Indian Phytopathology. 20:139-141.

Li Shi Dong (2004). Population dynamics and survival of *Rhizoctonia solani AG-1* in the field soil under rice-wheat rotation. Agricultural sciences of China. 3:448-455.

Lixili, Li Jian Quang, Zhang Long, Luo Jun and Li Xianolin (2001) Effect of fungicides and its mixture on toxicity and morphology of the pathogen, *Rhizoctonia solani, of rice.* Acta. Phytophylacica sinica. 28(4): pp 352-356.

Lorentz, R.C. (1948). A new leaf disease of *Hevea* in Pery. J. Forestry. 46:27-30.

Luttrell, E.S. (1962). *Rhizoctonia* blight of tall fescus grass. Plant Dis. Reptr. 6: 661-664.

Mahendra, P., C.A. Ramanath, K. Menon, I. Rama Devi and C.K. Rama krishnan (1974). studies on the viability of sclerotia of *Corticium sasakii* (Shirai) Mastsumoto. Agricultural Research J. of Kerala, 12:96-98.

Maiti, S. (1978). Two new ear rots of maize from India. *Plant Dis. Reptr.* 62:1074-1076.

Matsumoto, T. (1921). Studies on the physiology of the fungi XII. Physiological specialization in *Rhizoctonia solani* Kuhn. Ann. Missouri Botan. Garden. 8:1-62.

Matsumoto, T. and W. Yamoto (1935). *Hypochnus sasakii* Shirai in comparison with *Corticium stevensii* Burt. and *Corticium coleroga* (Cook) V. Hohn. Trans.Nat. Hist. Soc., (Formosa). 25:161-175.

Meena, B. and M. Muthusamy (1998). Control of Sheath blight of rice by plant extracts. Indian J. Pl. Protec. 26:155-156.

Mishra, B.D., K.C. Sahoo, G. Sugata, M.K. Rout (2005). *In vitro* evaluation of plant extracts, oil cakes and agrochemicals against web blight of green gram caused by *Rhizoctonia solani.* J. of Mycopathological Research. 43:255-257.

Misra, S.B. and S.N. Dixit (1977b). Screening of some medicinal plants for antifungal activity. *Gaebios.* 4:129-132.

Miyake, I. (1910). Studies uber die pilze der Reispflanze in Japan, J. coll. Agric. Tokyo. 2:237-276.

Muller, K.O. (1924). Unterruchugen Zur Enteickel ungsgeschichte and Biologie Von *Hypochnus solani* P.U.D. (*Rhizoctonia solani* K.*).* Arbeit Biol. Reichsanst Lnad –U_Forstw. 13:198-262.

Naidu, V.D. and V.T. John (1981). Invitro inhibition of rice fungal pathogens by extracts from higher plants. Int. Rice Res. News L. 6:12.

Naito, S. (1984). Studies on foliage blight of sugar beet. *Research Bull* of the Hokkaido. Nat. Agri. Exp. Sta.139:145-188.

Narasimhan, S., S. Masilamani, and B. Muralidharan (1998). Laboratory evaluation of botanical formulation against blast, brown spot and sheath blight disease of rice. Pestology. 22(11):19.

Neergaard, P. (1958). Infection of Danish seeds by *Rhizoctonia solani* Kühn. Plant Dis. Reptr. 42:1276-1278.

Onesirosan, P.T. and S.O. Sagay (1975). Survival of two pathogens of cowpea over dry season. Plant Dis. Reptr. 59:1018-1020.

Oshima, N., C. H. Livingston and M.D. Harrison (1963). Weeds as a carrier of two potato pathogens in *Colarado.* Plant Dis. Reptr. 47:466-469.

Ou, S.H. (1972). Rice diseases. First edition. The common wealth Mycological Institute, Kew Survey, England. 368pp.

Palo, M.A. (1926). Rhizoctonia diseases of rice I. A. study of the disease and of the influence of certain conditions upon viability of the sclerotial bodies of the causal fungus. Philippine Agric. 15:361-376.

Paracer, C.S. and Chahal, D.S. (1963). Sheath blight of rice caused by *Rhizoctonia solani* Kuhn- A new record in India. Curr. Sci. 32:328-329.

Park, D. and L.S. Bertus (1932). Sclerotial disease of rice in Ceylon by *Rhizoctonia solani* Kühn. Ann. Rov. Botan. Garden (Pradeniya).11: 319-331.

Parmeter, J.R.Jr., H.S. Whitney and W.D. Platt (1970). Affinities of some *Rhizoctonia* species that resemble mycelium of *Thanetephorus cucumeris.* Phytopathology. 57:218-223.

Rangaswami, G and A. Mahadevan (2005). Diseases of Crop Plants in India. Fouth edition, Prentice Hall of India Private Limited, New Delhi. pp536.

Ritcher, R. and R. Schneider (1953). Unterruchungen Zear Morphologische and Biologischen Differen-ziercing Von *Rhizoctonia solani.* Phytopath. Z. 20:167-226.

Rush, M.C. and F.N. Lee (1992). Sheath blight In: compendium of rice diseases (Webster, R.K. and Gunnel, P.S. eds) American Phytopathological Society, St. Paul, M.N. pp 22-23.

Ryker, T.C. (1939). The *Rhizoctonia* disease of Bermuda grass, Sugarcane, rice, and other grass in Louisiana. Cong Intern. Soc. Sugarcane Teebnol Proc. 6:198-201.

Saksena, H.K. (1961). Nuclear structure and divison in the mycelium and basidiospores of *Ceratobasidium praticoloum.* Can. J. Botany. 39:749-756.

Saksena, H.K. and O. Vaartaja (1960). Description of new species of *Rhizoctonia.* Can. J. Bot. 38:931-943.

Saksena, H.K. and O. Vaartaja (1961). Taxonomy, morphology and pathogenicity of *Rhizoctonia* species from forest nurseries. Con. J. Bot. 39:627-647.

Saksena, H.K. and R.D. Chaubey (1973). Banded blight disease of paddy in North India. Int. Rice Res. Conf., Manila, Philippines. April, 1973.

Singh, A., R. Rashmi, S. Savary, L. Willocquet and U.S. Singh (2003). Infection process in sheath bligt of rice caused by *Rhizoctonia solani*. Indian Phytopathology. 56 (4): 434-438.

Singh, B.P. (2006). Effect of carbon and nitrogen sources on *Rhizoctonia solani* and its integrated management. M.Sc. (Ag.) thesis. Deptt. Of Plant Pathology, N.D.U.A.T., Kumarganj, Faizabad, U.P. -224 229. pp72.

Singh, P.K. and A.K. Singh (2008). Effect of temperature and soil texture on the survival ability of rice sheath blight pathogen (*Rhizoctonia solani).* Flora and Fauna (Jhansi). 14:55-56.

Singh, S.B. and H.K. Saksena (1980). A new sheath and leaf blight of bajra.*Indian Phytopath.*33:127-129.

Somani, A.K. (2009). Management of black scruf (*Rhizoctonia solani)* of potato through seed treatment with botanicals. Potato J. 36:155-159.

Sudhakar,R., K.C. Rao and C.S. Reddy (1998). Survival of sclerotia of *Rhizoctonia solani* under puddled and upland conditions. Indian J. of Pl. protection, 26(2):157-158.

Coden : IJABPT Copyrights@2013 ISSN : 0976-4550

Surilirajan, M. and J. Kandhari (2005). Integrated management of rice sheath blight under field condition. Indian Phytopath. 58(4):431-436.

Talbot, P.H.B. (1965). Studies on *pellicularia* and associated genera of Hymenomycetes. *Persoonia.* 3: 371-406.

Talbot, P.H.B. (1970). Taxonomy and nomenclature of perfect state 20-31pp. In :J.R. Parameter (Jr.) (ed.) *Rhizoctonia solani. Biology and Pathology,* 255 pp. University of California Press, Berkely.

Tan Genjia, Chen Liu Daoping and YangYong (2000). Studies on viability and under ground infectivity of *Rhizoctonia solani* sclerotia. Mycosystema. 19:142-145.

Thind, T.S. and Rohit Aggarwal (2008). Characterization and pathogenic relationships of *Rhizoctonia solani* isolates in a potato-rice system and their sensitivity to fungicides. Journal of Phytopathology.156(10) 615-621.

Thomas, K.S. (1925). Onderzockinger over *Rhizoctonia* Electr. Drukkerij "De Industries J. Van Drutten Utrecht. pp 98.

Tiwari, R.K.S., S.S. Chandravanshi, B.M. Ojha and B.S. Thakur (2002). *In vitro* and *In vivo* efficacy of new fungicides against *R. solani* causing sheath blight disease of rice. J. Mycol. Pl. Patho. 32:418.

Tiwari, S.N. and Nayak (1991). Activity of four plant leaf extracts against 3 fungal pathogen in rice. Trop. Agri. 68:373-375.

Tsai, W.H. (1974). Assessment of yield losses due to rice sheath blight at different inoculation stages. Journal of Taiwan Agricultural Research. 23: 188-194.

Tu, C.C., Y.C. Chang and C.W. Wang (1979). Studies on ecology of *Rhizoctonia solani,* the causal agent of sheath blight of rice. National Science Council Monthly.7:1208-1219.

Upamanyu, S., S.K. Gupta and K.R. Shyam (2002). Innovative approaches for the management of root rot and web blight (*Rhizoctonia solani)* of French bean. J. Mycol. Plant Pathol. 32(3):317-331.

Venkatasubbiah, P. and K.M. Safeeulla (1983). Studies on the viability of sclerotia of *Rhizoctonia solani* in the soil. J. Coffee Res. 13:30-32.

Vishwanathan, V. and V. Mariappan (1980). On the chemical control of sheath blight. *I.R.R.N.* 5:8-9.

Weber, G.F. and L. Abrego (1958). Damping off and thread blight of coffee in El Salvador. Plant Dis. Reptr. 43: 1378-1381.

Webster, R.W. and P.S. Gunnel (1992). Compendium of Rice Diseases. American Phytopathological Society, Minnesota, U. S. A. pp: 22-23.

Whiteny, H.S. and J.R.Jr. Parameter (1964). The perfect stage of *Rhizoctonia heimalis.* Mycologia. 56:114-118.