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Production of sclerotia by *Sclerotium oryzae* and incidence and susceptibility of rice cultivars under field conditions

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Sclerotium oryzae. Catt. the causal fungus of rice stem rot disease produced sclerotia inside infected rice stems. Mycelial growth and production of sclerotia were initiated radially inside the stem at harvesting stage around the court of infection near the water line and progressed downwards inside culms of left over infected stubbles after harvest. All twelve rice varieties studied were infected by the disease. Production of sclerotia was closely related with susceptibility of rice varieties against the fungus in individual plants. Highly susceptible varieties produced 3905.5, while moderately susceptible varieties produced 2742 ; susceptible varieties 3156.5 and moderately resistant varieties produced an average of 2328.0 sclerotia per tiller respectively, within seven months after harvest inside their left over stubbles in the field. Number of tillers bearing sclerotia and number of sclerotia produced inside individual tillers increased simultaneously with age of the stubbles in the field. Quantity of sclerotia produced in the field was basically determined by the magnitude of disease incidence in the field, rather than the susceptibility of the variety grown.

Key Words : *Sclerotium oryzae*, production of sclerotium, rice cultivars, susceplibility, resistance

INTRODUCTION

Rice is mono-cropped in the Manipur valley exclusively in *kharif* under rain fed condition. Stem rot of rice caused by *Sclerotium oryzae* Catt. occurs worldwide (Ou, 1985) and is widespread in Manipur (Konthoujam, 1998). Resistance among rice cultivars against the disease is rare (Raina *et al.* 1980; Chand *et al.* 1985). All cultivated rice cultivars are infected by the disease (Ali & Singh, 1994, a.; Kumar *et al.*, 2003). Further, there is no variety which is highly resistant to the disease (Singh and Doodan, 1997). Eventually, the disease is one of the most important constraint for rice production in the country (Singh *et al.*, 2002). It is well documented that sclerotia are produced inside infected rice stems at the time of harvesting (Ou, 1985) and overwinter inside infected rice stubbles and soil for long time (Mishra *et al.*, 1966). However, there is no concrete information on the determining factors and scenario on the production of sclerotia with regards to disease status among different varieties.

The current investigation has been carried out to determine the quantity of sclerotia produced inside infected left over stubbles of different varieties, during the off-seasons (November-June) of 2002/03 and 2003/04 respectively, in relation to the disease incidences and severity of the disease under natural field conditions.

MATERIALS AND METHODS

Field screening of stem rot was conducted at harvesting stage of the crop during October-November by extensive roving surveys in the major low land rice areas in the valley, as prescribed in the

Standard Evaluation System for Rice stem rot (IRRI 1988). The disease incidence per cent was calculated by the formula ;

$$\% \text{ Disease incidence} = \frac{A \times 100}{N};$$

where, A = number of plants having stem rot symptoms ; N = total number of plants observed.

Performance of different rice varieties affected by the disease was recorded at the Agronomy Farm. Agriculture Department, Mantripukhri, Central Agriculture University, Iroisemba and progressive farmer's fields at Imphal. Samples for the current studies were collected from such marked fields having identical agronomic field inputs.

The type of reaction exhibited by different rice varieties against the disease was scored and designated by following the Coefficient of infection per cent (CI%) which takes both disease incidence percentages and disease severity into account formulated by Singh and Doodan (1997) given below ;

$$CI\ \% = \frac{0\ (H)+0.25\ (L) + 0.50\ (M) + 0.75\ (Y) + 1.0\ (S)\times 100;}{N}$$

where, N = total number of tillers ; H = no. of healthy tillers ; L = lightly infected tillers with lesions only on the outer leaf sheath ; M = mildly infected tillers with lesions through leaf sheath to culm ; Y = moderately infected tillers with lesions penetrating culm ; S = tillers with mycelium and sclerotia inside culm.

Score	%CI Rating	Reaction type
0	0	Highly Resistant
1	less than 5	Resistant
2	5-10	Moderately Resistant
3	10-20	Moderately Susceptible
4	20-40	Susceptible
5	Above 40	Highly Susceptible

One hundred (100) plants of different cultivars were collected at random from infected plots at different locations, having not less than 25% disease incidences at the time of harvesting. One (1) tiller from each plant was sampled randomly. The outer leaf sheaths of the selected tiller of the stubbles were carefully removed, leaving only the main stem and split opened longitudinally by a scalpel on a white paper sheath. Sclerotia present inside the stems were then dislocated from the tissue by gently rubbing with the thumb and finger. The total number of sclerotia collected was counted under a simple microscope. The root system of the infected plants were also similarly cut separately and examined for presence of sclerotia.

The process was continued at 30 days interval consecutively from the date of harvesting until May last week. Only ten (10) inches long stubbles of each variety were accounted for observations as the standard length during the current studies.

RESULTS AND DISCUSSION

During the current investigations, the disease occurred in all 12 varieties studied which included both local indigenous, local inbred HYV's and exotic HYV cultivars at different magnitudes of disease incidences and severity. Not a single cultivated cultivar was highly resistant against the disease (Table 1). Dark grayish mycelium and black sclerotia occurred within the culms of the infected internodes, while some were dotted between the

Table 1 : Production of *S.oryzae* sclerotia in different rice varieties and level of incidence and severity in the field*

Varities	DI%	CI%	Reaction category	No. of sclerotia
Huikap	27.27	7.90	Mod. resistant	2083
Chakhao amuba	28.27	7.95	Mod. resistant	2512
Ching Chakhao	39.65	12.17	Mod. resistant	2573
CAU-R-2	27.65	13.29	Mod. susceptible	2698
Phouoibi	33.92	17.85	Mod. susceptible	2882
RCM-11	45.45	19.49	Mod. susceptible	2648
Sana phou	42.85	21.42	Susceptible	2754
Sanayanbi	48.27	24.13	Susceptible	3611
Leima phou	60.00	26.56	Susceptible	3568
Champra phou	63.63	40.90	Highly susceptible	4027
Tampha phou	60.25	41.07	Highly Susceptible	4525
Drum phou	73.33	46.66	Highly susceptible	4279

*Mean of two years (2002/03-2003/04)

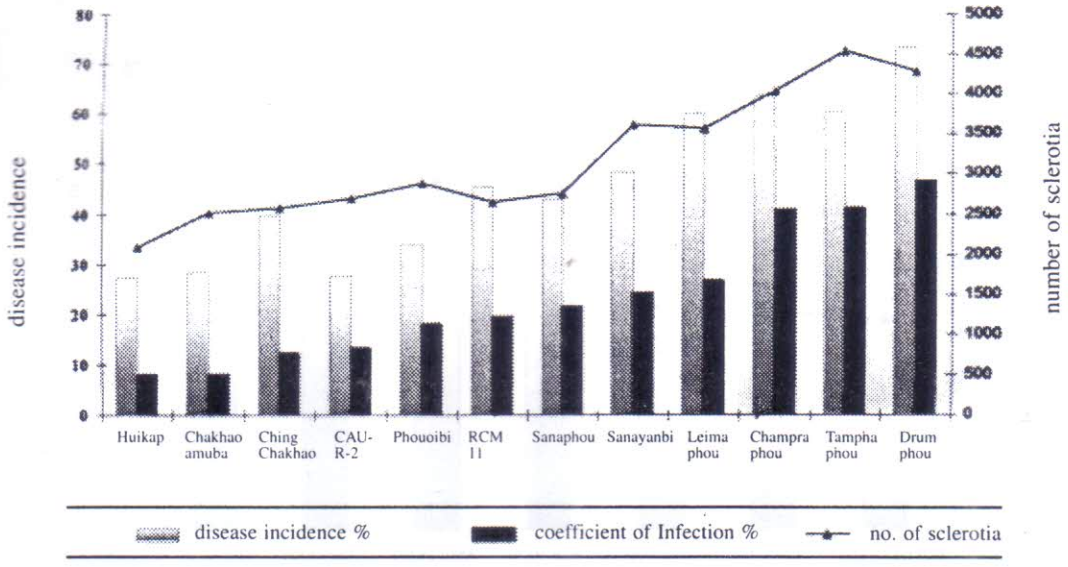
Correlation

DI% and CI%-Significant at 1% level of significance

DI% and number of sclerotia production-Significant at 1% level of significance

CI% and number of sclerotia production-Significant at 1% level of significance

leaf sheath and the stem around the court of infection. Production of sclerotia progressed quantitatively with age of the stubble from an average quantity of 625.00 numbers at harvesting in November to 3037.66 in May, seven months after harvest in individual plants. At the same time, number of stems bearing sclerotia also increased simultaneously from 31.62% to 65.72% during the same period in the field. The number of stems bearing sclerotia initially increased steadily from November to January. Later, it increased abruptly in February and remained passive for a short time up to March. The number further increased considerably in April and May (Fig 1). Ou (1985) maintained that in the tropics where there is sufficient moisture after harvest, the fungus grows further and produce more sclerotia. Formation of sclerotia was often but not always correlated with growth of mycelium. Mycelial growth of the stem rot fungus occurred best at pH 4.05-6.1. and at temperatures of 11-15^{0}C minimal, 27.5-30.0^0 C moderate and maximum of 35^{0}C. Soil pH in the four valley districts (Imphal East, Imphal West, Thoubal and Bishenpur) ranged from 5.1-5.5 (Anonymous, 2004). Besides, the prevailing meteorological parameters in the Manipur valley conforms to the congenial conditions listed for growth and development of sclerotia (Fig 1) as described above by Ou (1985). Kraus and Webster, (1973) observed that once infected, the tissue eventually died, when they are rotted numerous sclerotia are produced in them. Production of sclerotia differed with susceptibility of the cultivars. Moderately resistant cultivars (Huikap, Chakhao amuba and Ching Chakhao) produced 2083 to 2573 number of sclerotia, within seven months after harvest. Moderately susceptibile cultivars (CAU-R-2, Phouoibi and RCM-11) produced 2698 to 2648 numbers, while susceptible cultivars (Sanaphou, Sanayanbi and Leimaphou) produced 2754 to 3568 and highly susceptible cultivars (Champraphou, Tampha phou and Drum phou) produced 4027 to 4279 sclerotia per tiller respectively (Fig 2). It was noted that, in individual plants the production of sclerotia was determined by the type of varietal reaction (susceptibility) against



* Sclerotia count of 10 inches long 7 months old stubbles after harvest

\# Mean of two years (2002\03 – 2003\04)

Correlation

DI% and CI%-Significant at 1% level of significance

DI% and number of sclerotia production-Significant at 1% level of significance

CI% and number of sclerotia production-Significant at 1% level of significance

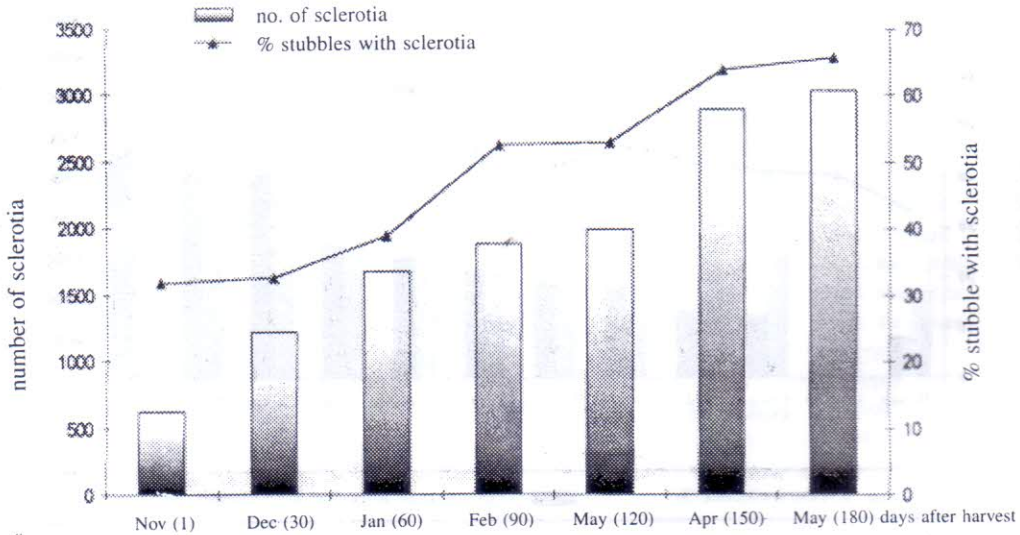
Fig. 1 : Production of *S. oryzae* sclerotia* in different rice cultivars with corresponding level of diseases incidences and coefficient of infection percentages.

the disease. However, by and large the extent of disease incidence in the individual fields significantly decided the quantity of sclerotia produced and the inoculum density produced and made available in the respective fields. Kraus and Webster, (1973) found that at stem elongation stage of the crop, 500 viable sclerotia per plant can sufficiently infect the plants causing a yield reduction of 12%. He maintained that rice stem rot disease incidence increased with the inoculum density of the fungus sclerotia. Further sclerotia of *S. oryzae* over wintered in stubbles and soil for a long time from 1-9 years (Bockus and Webster, 1979) and served as the primary inoculum of the disease (Ali and Singh, 1994, b).

Rice plants parasitically infected by *S. oryzae* were the principle source of sclerotia. Bockus *et al.*, (1978) also concluded that colonization of healthy rice residue by mycelium from sclerotia of the fungus was not an important avenue for production of new sclerotia, but rice tissue parasitically infected by the fungus was an important one. It was found that once infected, production of sclerotia continued inside the left over stubbles at uneven rates under the influence of weather (Table 1, Fig 2). Thereafter, large quantity of sclerotia were deposited in the soil in the diseased fields when the plant tissues bearing sclerotia were completely degraded and disintegrated with age of the rice stubbles. Luthra and Sattar (1936) reported that rice stem rot disease developed on healthy seedling when transplanted into soil in which there were stem rot diseased stubbles.

At the backdrop of monocropping of rice and with abundance of inoculum density of the disease available in the fields, there is very little scope for the succeeding rice crop to avoid from the disease. In addition, farmers habitually change cultivars very frequently, which can have both beneficial and detrimental effects with regards to the scenatio of rice stem rot in Manipur.

Hence, it is concluded that choice of variety shall have a profound role on the spread and severity of



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Av. Max°C	28.53	5.47	23.05	26.52	28.02	27.39	30.13
Av. Min°C	11.31	7.89	4.02	6.02	10.18	16.7	20.03
Av. RH	63.9	62.5	55 35	46.12	51.93	63.14	68.6
Av. Rf	1.48	2.44	0.25	0.71	3.41	19.29	13.38

* Mean of 12 varieties during 2002–2004

 # Meteorological data

Mean of 2 years Nov-Dec (2002-2003) / Jan - May (2003-2004)
(Plant Protection Unit, Dept. of Agric. Govt. of Manipur, Imphal)

Fig. 2 : Per cent stubbles with sclerotia and quantity of sclerotia produced with corresponding age of stubble after harvest*

the disease in the field. Selection of more reisitant varieties shall be inevitable in reducing the primary inoculum and the disease incidence and provide means of preventing the disease from becoming endemic and subject to yield loss in the region.

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REFERENCES

Ali, Z. and Singh, R. A. 1994,a. Studies on the Saprophytic Survival of *Sclerotium oryzae* under different conditions. *Indian J. Mycol. Pl. Pathol.* **24** (1) : 55-57

Ali, Z. and Singh, R. A. 1994,b. Reaction of rice varieties to stem rot (*Sclerotium oryzae*) in Uttar Pradesh. *Indian J. Mycology Pl. Pathology* **24** (1) : 58-59

Anonymous, 1980. Standard evaluation System for Rice. Second Edition, July 1980. International Rice Testing Programme, *International Rice Research Institute, Los Banos, Phillipines.* pp 10-12 ; 31

Anonymous, 2004. Annual Soil survey Report for the year 2003-2004. *Soil Analyst, Department of Agriculture, Government of Manipur, Mantripukhri* p. 4-12

Bockus, W. W., Webster, R. K. and Kosuge, T. 1978 The competitive saprophytic ability of *Sclerotium* oryzae derived from sclerotia *Ibid.* **68** : 417-421

Bockus, W. W. and Webster, R. K. 1979. Decline in numbers and inoculum potential of *Sclerotium oryzae* in field soil. *Phytopathology* **69** : 389-392

Chand, H., Singh, R. and Panwar, D.V.S. 1985. Search for multiple resistance in rice. *Indian Phytopath.* **38** : 452-455

Singh, R. and Dodan, D. S. 1997. Comparison of two scoring systems for evaluating stem rot resistance in rice, and a new proposed rating scale. *International Rice Research News letter.* **22** (1) : 48-50

Singh, R., Kumar, A. and Jalali, B.L. 2002. Variability, predisposing factors and management of stem rot of rice caused by *Sclerotium oryzae* Catt. : An overview. *Annu. Rec. Pl. Pathol.* **1** : 275-289

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