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Incidence and pathogenicity of fungi associated with seedling disease of rain-fed wheat (*Triticum aestivum* L.) in Nigeria

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ABSTRACT

A post- emergence disease of rain-fed wheat (*Triticum aestivum* L.) encountered in Ibadan, South-Western Nigeria was investigated. The incidence of disease was 13.07% in 1993, 20.81% in 1994 and 11.95% in 1995 on six wheat cultivars. Cultivar 'Sonalika' was most susceptible. Of the two fungal species isolated from infected tissues, only *Sclerotium rolfsii* Sacc. produced the disease in pathogenicity tests. Disease developed within 6-10 days after planting and infected seedlings died by the twelfth day. Twelve to fourteen- day old seedlings were not infected by *S. rolfsii*. Seedling infection by *S. rolfsii* induced a reduction in the rate of seedling emergence, root length and seedling vigour. *Fusarium graminearum* Schwab., isolated from infected tissues alongside *S. rolfsii* is a secondary invader of *S. rolfsii* infected tissues. It exhibited antagonistic potentials against *S. rolfsii*.

Key words: Post-emergence disease, rain-fed wheat, *Sclerotium rolfsii*, *Triticum aestivum* L.

INTRODUCTION

One of the efforts made to increase wheat production in Nigeria was the introduction of the crop to areas other than the traditional growing areas. The cultivation of wheat under rain-fed conditions in south-western Nigeria is one of such attempts. Rain-fed wheat gives lower yields than irrigated wheat. However, it still serves to add to the total production (Tyagi and Olugbemi 1980). The diseases associated with irrigated wheat differ from those of rain-fed wheat as indicated by the few reports from field trials (Anaso *et al.*1980; Tyagi and Olugbemi *et al.* 1980). Thus, the pathogenic potentials of fungi associated with diseases of rain-fed wheat need to be ascertained with a view to understanding their overall impact on rain-fed wheat cultivation.

Post-emergence seedling diseases caused by *Sclerotium rolfsii* Sacc. have not been reported on rain-fed wheat in Nigeria. However, it has been reported in other warm non-traditional growing areas such as Brazil (Igarashi *et al.* 1983), Ecuador, Peru, Bolivia and in many South-East Asian Countries (Dubin 1985). The disease is capable of causing up to 30% yield losses (Hobbs *et al.* 1988) and it is often severe under conditions of high temperature and moisture (Punja 1988). This disease was recently encountered in rain-fed wheat trials in Ibadan, South-Western Nigeria and this paper summarize studies on the disease and the causal pathogen.

MATERIALS AND METHODS

Field sampling for diseases

Sampling of infected seedlings was made between 1993 and 1995 from wheat plots in the experimental farm of the Department of Crop Protection and Environmental Biology, University of Ibadan, during the rainy season (June to September). The plot size was 8m x 8m for each of the cultivars, namely Sonalika, Siette ceros, Pavon 76, Indus 66 and heat tolerant lines KAL/BB/TOB2/7C and BUC`S' /NAC`S'. In each plot, permanent quadrats of 24 cm x 24 cm were constructed randomly at different locations. There were eight quadrats within each plot. Each quadrat was labelled and the number of seedlings within each quadrat was counted. The incidence of disease was taken at the onset of disease and expressed in percentage using the formula:

$$P_i = \frac{n \times 100}{N}$$

Where Pi= Percentage incidence of disease.
n= Number of seedlings expressing each disease symptom per quadrat.
N=Total number of seedlings within the quadrat.

Isolation of fungi

Fungi associated with diseased tissues were isolated from basal plant parts (crown and lower culms) through surface-sterilization (1%NaOCl for 5 min), washing in five changes of sterile distilled water and plating (2 - 3 mm tissues) on Potato dextrose agar (PDA) modified with 60mg ml^{-1} chloramphenicol. Plates were incubated at 28±2°C and resultant fungi were sub-cultured for identification and use in pathogenicity tests.

Pathogenicity test

Two fungal species, namely *Sclerotium rolfsii* Sacc. and *Fusarium graminearum* Schwab. were isolated from infected plant parts. These were tested for pathogenicity on wheat cultivar Sonalika. The inoculum of *S. rolfsii* was prepared by inoculation of 100 g of moist autoclaved wheat seeds with sclerotia of *S. rolfsii* in a 1 L Erlenmeyer flask. This was incubated for two weeks at 28±2°C. Soil infestation by *S. rolfsii* was ensured by keeping soil (mixed with inoculum at 1 % W/W) in moist condition for one week before use. The infested soil was then packed into 21cm diameter pots. Conidial suspension of *F. graminearum* was adjusted to 6.0×10^5 ml^{-1} using a haemocytometer. Steam-sterilized soil contained in 21cm-diameter pots were infested with 15 ml conidial suspension of *F. graminearum*. For the mixed inoculation by both fungi, steam sterilized soil contained in pots were infested by both inocula as described above. Fifty surface-sterilized seeds were sown in each pot while steam-sterilized soil moistened with sterile distilled water and sown with surface-sterilized seeds served as control. There were four replicates (pots) of each treatment and control. The course of disease development was observed and data were obtained for daily seedling emergence until day 7 and shoot and root length and vigour index after day 21. Vigour index was calculated according to Randhawa *et al.* (1985);

$$VI = (RL + SL)\,GP$$

Where VI = Vigour index, RL = Root length, SL = Shoot length, GP = Germination percentage.

Infected parts were surface sterilized and incubated to isolate associated fungi.

RESULTS

Field sampling for disease

Table 1 shows that cultivar Sonalika was the most susceptible to seedling infection. Incidence of disease was significantly higher (range 39.6% - 43.6%) over the years than on other cultivars. The heat tolerant lines were more tolerant to seedling infection (Table 1). Incidence of disease on tolerant lines was significantly lower than on others in 1993 and 1994. With a mean of 20.81%, incidence of seedling disease was highest in 1994 (Table 1).

Table 1. Incidence of seedling disease of rain-fed wheat between 1993 and 1995 (± S.E. Standard Error)

Cultivar/Line	Disease incidence, %		
	1993	1994	1995
Sonalika	39.6±7.40 f	43.6±2.16 e	42.5±6.24 e
Siette ceros	7.2±1.20 cd	22.7±2.50 c	11.2±1.42 c
Pavon 76	15.5±2.36 e	28.9±6.41 d	15.06±2.92 d
Indus 66	6.9±4.38 c	18.6±11.36 b	10.2±1.80 bc
KAL/BB/TOB2/TC	3.4±1.32 b	7.5±10.30 a	6.2±4.51 ab
BUS'S'/NAC'S'	5.5±1.32 b	6.4±3.82 a	4.5±5.26 a
Mean	13.87	20.81	14.91

Values within a column followed by the same letters are not significantly different at P= 0.05 (Duncan's Multiple Range Test).

Field symptoms of disease and associated fungi

The disease first appeared on 6 to 8-day-old seedlings as whitish sclerotia and fluffy mycelia of a fungus on the crown and foot of seedlings. Initial symptoms of infection included severe crown tissue invasion with light brown foliar discolouration. White sclerotia soon turned brown to dark brown with increase in sclerotia aggregation while the aerial (foliar) plant parts became straw-coloured and dry. Diseased seedlings died twelve days after the onset of disease. Dead seedlings had thin, dark-brown and collapsed crown tissues with no root rot. Seedlings that had not shown initial symptoms of infection by the 8th day after sowing often escaped death although they had reduced height and vigour. The base of such seedlings turned brown while lower leaves bear light-brown to straw coloured lesions bordered by a dark-brown irregular ring. Two fungal species were isolated from diseased tissues. They were *Sclerotium rolfsii* Sacc. and *Fusarium graminearum* Schwab.

Pathogenicity test

By the day 21 after sowing, no seedlings death occurred in the control (uninfested soil) as well as in soils infested with *F. graminearum* alone or in the soil containing *F. graminearum* + *S. rolfsii*. Seedling infection however occurred in soil infested with S. rolfsii. In such soils, the white sclerotia premordials and fluffy mycelia of *S. rolfsii* appeared on the soil surface and on crown of seedlings by the sixth day, a time at which seedlings had not shown initial symptoms of infection. Symptoms appeared on the tenth day and by the twelfth day, up to 28.5% of seedlings were dead. In soil infested with *F. graminearum* + *S. rolfsii*, sclerotia of *S. rolfsii* were not present on soil surface until the twelfth day, a stage at which most seedlings had fully established. Similarly in *S. rolfsii* infested soil, seedlings that were twelve days old before *S. rolfsii* establishment were not infected.

Effect of fungi associated with seedling disease on seedling emergence, length and vigour of wheat

The rate of seedling emergence in *S. rolfsii* infested soil was significantly reduced in relation to other treatments (Fig. 1). Rate of seedling emergence was also significantly lower (P = 0.05) in *F. graminearum* infested soil than in soil infested with *F. graminearum* + *S. rolfsii* or in the uninfested soil (control) (Fig. 1). When the soil was infested with *S. rolfsii* alone, the wheat seedlings recorded significantly lower root length and vigour than in other treatments. However, it's pathogenic potential was reduced when in combination with *F. graminearum* (Table 2).

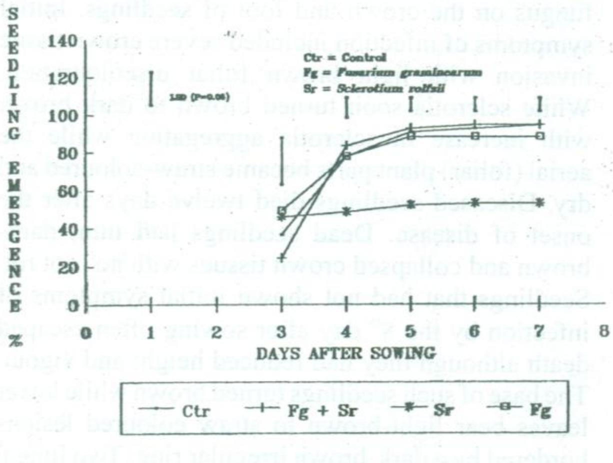

Fig. 1: Effect of fungi associated with seedling disease on the rate of seedling emergence of wheat.

Table 2. Effect of fungi associated with seedling disease of wheat on root length, shoot length and vigour of seedling.

Fungal treatment	Root length*	Shoot length*	Vigour index* ($X10^3$)
Fusarium graminearum	11.82b	26.58a	1.83d
Sclerotium rolfsii	8.42d	26.85a	1.49c
F. graminearum *S. rolfsii*	9.64c	29.65a	1.85b
Control	14.19a	30.16a	2.09a

†Values are means of 10 (surviving) plants per treatment per replicate. Means on the column followed by the same letters are not significant different at P = 0.05 (Duncan's Multiple Range Test).

DISCUSSION

S. rolfsii is the causal pathogen of the post-emergence seedling disease of rain-fed wheat. The disease, also called Sclerotium foot rot (Dubin *et al.* 1990) or Sclerotium root rot (Mehta and Gaudemicio 1990) has a potential to reduce rain-fed wheat cultivation. This is because *S. rolfsii*, a highly facultative soil-borne parasite is more pernoicious under conditions of high temperature and moisture (Punja 1988) and these readily subsist in south west Nigeria during the rainy season. According to Dubin *et al.* (1990), *S. rolfsii* is one of the most damaging soil-borne pathogens of warm temperate areas of the world. Other workers had associated *S. rolfsii* with foot rot and seedling blight of wheat (CIMMYT 1983; Rassaque and Hossain 1990).

The higher incidence of disease in 1994 may be due to inoculum build-up on crop residues of the preceding year. Although the plots were ploughed it may only have reduced the inoculum level as ploughing is most effective in controlling *S. rolfsii* when used in combination with other control measures (Punja 1988). The adverse effect of the pathogen on the rate of seedling growth as well as vigour have been reported earlier by CIMMYT (1983) and Prescott *et al.* (1986). Unlike the earlier reports however, plants older than 12-14 days were not infected by the pathogen. Similarly, the roots of infected plants were weaker. This may be due to variations in the different isolates of the pathogen. Osai (1992) reported variations in the virulence of Cassava (*Manihot esculenta*) and Yam (*Dioscorea* spp) isolates of *S. rolfsii*. The incidence of disease was significantly low in the heat tolerant lines. This makes them more suited to cultivation in warm tropical climate of south- western Nigeria. Their heat tolerant nature may be an important factor in their tolerance to *S. rolfssi*.

F. graminearum, the fungus isolated alongside *S. rolfsii* from infected seedlings on the field did not induce seedling infection in pathogenicity tests. This suggests that *F. graminearum* is a secondary invader of *S. rolfsii* infected tissues. This is because *F. graminearum* delayed the establishment of *S. rolfsii* in the soil and totally prevented seedling infection when both organisms were introduced into the soil at the same time. Hence, antagonism between *F. graminearum* and *S. rolfsii* can be suspected such that the potential of *S. rolfsii* as a crown and lower culm pathogen of wheat is reduced by *F. graminearum*. However, the suitability of *F. graminearum* for the practical control of *S. rolfsii* on wheat is limited. This is because of the potential of *F. graminearum* to cause head blight of wheat (Strange and Smith 1971, CIMMYT 1983). Soil borne inoculum will readily serve as a source for subsequent head infection. Moreover, the isolate encountered in this study has the characteristics of the head blight isolate of *F. graminearum* as reported by Purss (1970).

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