EFFECTS OF HOST VARIETY, PLANT MATURITY, SOIL TEMPERATURE, AND SOIL MOISTURE ON THE SEVERITY OF *Macrophomina* STEM ROT OF JUTE[1]

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Introduction

Stem rot, caused by *Macrophomina phaseoli* (Maubl.) Ashby (*Sclerotium bataticola* Maubl.), is one of the most important diseases of jute (*Corchorus capsularis*) and kenaf (*Hibiscus cannabinus*) in Taiwan (7). the organism is also known to cause root and stem diseases of many economic crops, notably charcoal rot of soybean (*Glycine mix*), corn (*Zea mays*), and sorghum (*Sorghum Vulgare*) (9), and root rot of cotton (*Gossypium hirsutum*) (4). The epidemics of *Macrophomina* diseases in relation to environmental factors has been discussed in some crops. Edmunds (2) reported that no infection in soils occurred when the available soil moisture was above 80%, but the infection, as evidenced by abundant sclerotial production, was so severe as up to 25%. Cotton plants subjected to water stress were more susceptible to the disease than plants watered normally (3). In sugar pine (*Pinus lambertiana*), infection occurs early and results in death of a large number of seedlings at 35°C (5).

According to field investigations, the incidence of *Macrophomina* stem rot of jute is especially severe when the plants are mature and almost ready for harvest. However, the significance of the environment in relation to the severity of the disease on jute is not clear. The purpose of this study was to determine the effects of jute variety, plant maturity, and some environmental factors on the severity of the disease.

Materials and Methods

M. phaseoli was originally isolated from diseased jute in 1969. A stock culture of the fungus was maintained in the laboratory by frequent transfers to fresh potato-sucrose agar (PSA) slants. To infest soil and plant with *M. phaseoli*, the inocula were prepared with the following methods : (1) Mycelial suspension—a mycelial mat of the organism grown on PSA was transfered to an Erlemeyer flask containing 100 ml of Czapeck's solution. After 5 days of incubation at 28°C, the colony was filterd and macerated in a Waring blender with 100 ml of distilled water for 30 seconds. The mycelial suspension prepared in this manner was used for direct soil inoculation. (2) Toothpick inoculum- toothpicks (diameter 0.1 cm) were autoclaved and placed on the surface of PSA in a Petri dish. A 5-mm-

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diameter mycelial mat was transfered to the central part of the Petri dish. After 5 days of incubation at 28°C, toothpicks were completely covered with mycelia and ready for the use as inocula to infest plants by inserting a toothpick into the plant.

For the comparison of the susceptibility of different ages of jute varieties, Tainoun No. 1, Tainoun No. 2, Tainoun No. 3, and Tainoun Selected No. 1 were planted in 24-cm pots filled with autoclaved soil. After seed germination, young seedlings were thinned to grow 10 plants in each pot. Different ages of jute plants were infected with mycelial suspension or toothpick inoculum. Each pot was considered as a replicate and each treatment was consisted of 4 replications. All pots were kept in the greenhouse where the temperature fluctuated around 26±2°C.

For determining the optimum soil temperature for disease development, jute seeds of the variety Tainoun No. 1 were sowed in a 18-cm metal pot containing autoclaved soil. The soil moisture was maintained at the level of about 25% moisture holding capacity. Elimination of young seedlings was made immediately after the appearance of first true leaves to allow the growth of 25 plants in each pot. These pots were then kept in the specially designed water baths to maintain constant soil temperatures of 23, 27, 31, and 35°C in the greenhouse. Inoculation was made by adding 50 ml of mycelial suspension on the soil surface of each pot, then sufficient amount of water was applied to assure even distribution of the inoculum. Noninoculated pots were served as control. Each pot was considered as a replicate and 4 replications were made for each treatment.

Effect of soil moistures on the disease development was tested with 24-cm-diameter plastic pot containing autoclaved soil. Four moisture levels, 15, 25, 35 and 45% MHC were maintained and the soil surface was covered with polyethylene sheet to prevent water evaporation. Twenty plants were planted in each pot and 4 pots were used for each treatment. Inoculation was made 30 days after planting by inserting a toothpick inoculum into stem at the part of 10 cm above the soil level. Noninoculated plants were served as control. 15 days after inoculation, disease reading were made by measuring lesions with a planimeter.

Disease index reading was made 15 days after inoculation for the investigation of root-rot type of infection. The disease groupings used were : 0=healthy ; 1=slight rotting at root tip ; 2=lateral roots heavily affected, but slight infection on main root ; 3=heavy infection and rotting on all parts of root ; 4=death of plants. The calculation method of disease index was made after Tu (6).

Results

Variety and plant maturity : Of the four jute varieties tested, none was found to be immune to the infection of *M. phaseoli*. However, to the stem-rot type of infection, Tainoun No. 3 variety showed moderate resistance, the average spot sizes on 30-, 60-, 90-, and 120-day-old plants only reached 12.67, 22.25, 22. 11, and 22.50mm^2, respectively. The most susceptible variety was Tainoun No.2, the average spot sizes on the 4 different ages of plants were 31.90, 38.25, 43. 25, and 50. 91mm^2, respectively. The disease severity also increased with the age of plants regardless of the varieties tested(Fig. 1). Detailed results are shown in Table 1.

A similar result of varietal susceptibility was observed in the root-rot type of infection. Root-rot indexes of varieties Tainoun No. 1, Tainoun No. 2, Tainoun No. 3, and Tainoun Selected No. 1 15 days after inoculation were 20.14, 32.18, 6.53, and 8. 78, respectively. No appreciable root-rot was found from the plants older than 30 days (Table 2).

Table 1. Effects of jute variety and maturity on stem-rot severity*

Variety	Plant age (days)				
	14	30	60	90	120
	Size of spot (mm²)**				
Tainoun No. 1	0	21.67	31.38	32.63	34.69
Tainoun No. 2	0	31.90	38.25	43.16	50.96
Tainoun No. 3	0	12.67	22.25	22.11	22.50
Tainoun Selected No. 1	0	15.71	26.32	30.31	27.16

*Inoculation was performed with toothpick method.

**Size of spot was measured 15 days after inoculation.

Table 2. Effects of jute variety and maturity on root-rot severity*

Variety	Plant age (days)				
	14	30	60	90	120
	Disease index**				
Tainoun No. 1	20.14	0	0	0	0
Tainoun No. 2	32.81	0	0	0	0
Tainoun No. 3	6.53	0	0	0	0
Tainoun Selected No. 1	8.75	0	0	0	0

*Inoculation was performed with mycelial suspension.

**Disease index was calculated 15 days after inoculation.

Soil temperature : Soil temperature is an important environmental factor affecting the severity of *Macrophomina*-root rot of jute. At the lowest soil temperature (23°C), *M. phaseoli* was quite destructive and the disease index read 15 days after inoculation was 7.58. Disease severity increased with the increase of soil temperature, and the disease index read a maximum of 19.26 at 35°C (Fig. 2). All uninoculated plants were healthy throughout the period of experiment.

A test on the influence of soil temperatures on the growth of jute was also made with check plants (uninoculated). Growth of the top and root was depressed at 23°C and 35°C. The optimum growth temperature was 27°C (Fig. 3).

Soil moisture : In a preliminary study, top growth of jute was retarded at soil moisture below 25% or above 45% MHC, but it was little affected at soil moisture between these two levels. Plant height was measured at the end of the experiment. 20 check plants grown at each of 4 moisture levels, 15, 25, 35, and 45% MHC, measured 86.3, 124.7, 148.6, and 128.6 cm in height, respectively (Fig. 4).

On the other hand, soil moisture markedly influenced the development of *Macropho-*

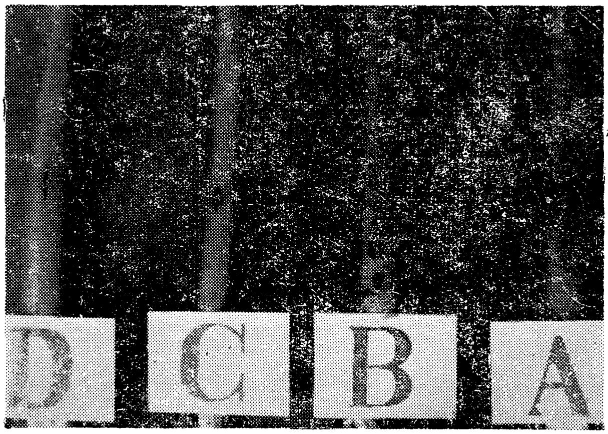

Figure 1. Successful infection with toothpick inoculum on 120-day-old jute plants of different varieties. A. Tainoun No. 1. B. Tainoun No. 2. C. Tainoun No. 3. D. Tainoun Selected No. 1.

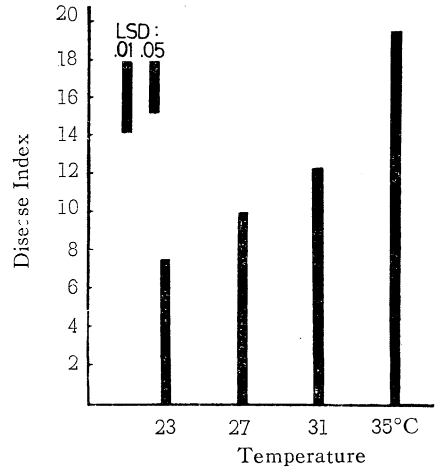

Figure 2. Influence of soil temperature on jute *Macrophomia*-root rot occurrence

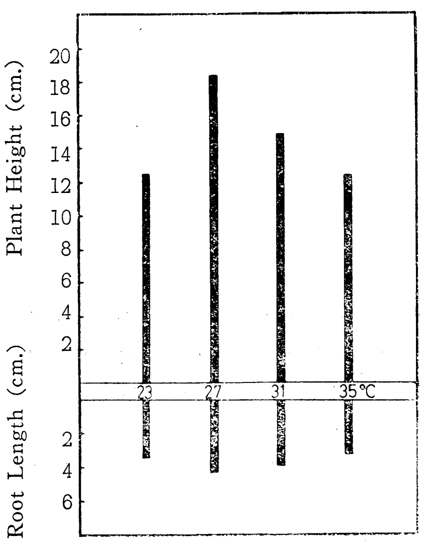

Figure. 3. Influence of soil temperature on jute growth

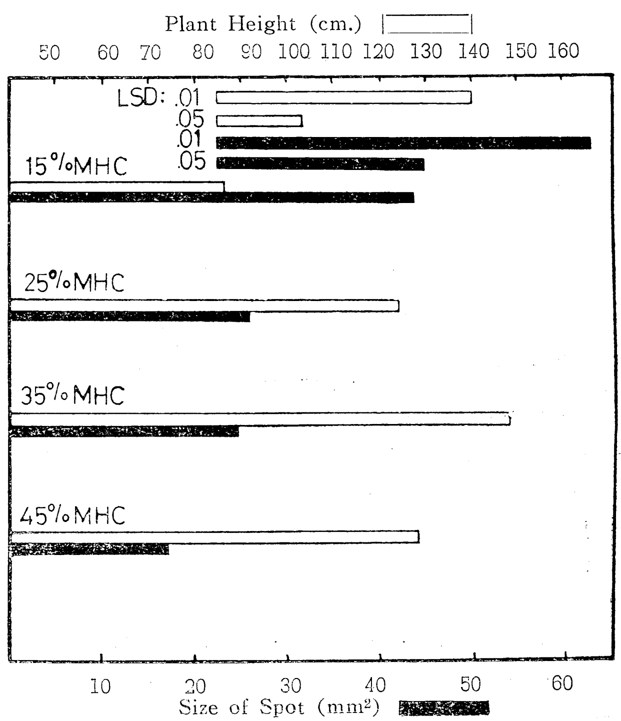

Figure. 4. Influence of soil moisture on jute growth and *Macrophomina*-stem rot development

mina-stem rot 15 days after inoculation. The average sizes of disease spots on the plants at 15, 25, 35, and 45% MHC were 44, 26, 25, and 17mm^2, respectively (Fig. 4). The uninoculated plants remained healthy in all cases. The soil temperature was also kept at 28–33°C.

At the lowest moisture level tested, the expansion of disease spot was very quick. However, the spot expansion was significantly slowed down by increasing soil moisture from 15% MHC to 45% MHC. There appeared to be an inverse relationship between disease development and soil moisture content.

Discussion and Conclusion

The results obtained in this study demonstrate that there are no commercial jute varieties completely resistant to the infection of *M. phaseoli* in Taiwan today. Of the four most widely accepted varieties tested, Tainoun No. 3 was moderately resistant, and Tainoun No. 2 was a very susceptible one. The other two varieties, Tainoun No. 1 and Tainoun Selected No. 1, were intermediate, but they were still susceptible to the disease.

Concerning the relationship between disease incidence and plant maturity, the results showed that disease susceptibility was closely related to plant age. The older the plant was, the more severe disease incidence occured. This results agreed to our field experience that jute plants after 4 months of fully growth were more susceptible to the organism, and the entire jute plants in the field destroyed by the disease was found to be not unusual. Further study on the reason of this late susceptibility is needed.

Vasudeva (8) reported that cotton *Macrophomina*-root rot was reduced at lower soil temperature. Our results revealed that the infection of *M. phaseoli* on jute was favorated by higher soil temperature (Fig. 2). The root rot index was only 7.58 at soil temperature of 23°C, then gradually increased with increase in soil temperature. At 31°C an abrupt increase in disease severity was detected. Our results also indicated that optimum temperatures for growth of jute and for infection of *M. phaseoli* were not similar; the former was 27°C, and the latter was at 35°C. However, the average temperature during the jute harvesting period in Taiwan is about 30°C or higher. This temperature condition is unfavorable to the host but suitable to the infection of pathogen, and may explain why *M. phaseoli* causes damage mostly during the harvesting period.

Soil moisture plays an important role in the disease development of jute *Macrophomina*-stem rot. Our results strongly indicate that soil moisture has significant effect on the development of jute stem rot and that damage caused by *M. phaseoli* can be reduced by manipulation of soil moisture (Fig. 4). Crall (9) reported that infection occured more readily on mature soybean plant when soil moisture was deficient. Hence, it is almost certain that lower soil moisture is more favorable to the development of the disease.

Wyllie and Calvert (9) emphasized that infection of *M. phaseoli* on soybean was not directly related to the influence of temperature or moisture on the fungus, but rather affected by these environmental stresses on maturation of the plant. We believe that their conclusion may also be true on jute *Macrophomina*-stem rot. An effort to determine more precisely on the disease development influenced by the combination of environmental factors and plant ages should be made further.

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黃麻品種，植株成熟度，土壤温度及土壤濕度對立枯病發生之影響[1]

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中 文 摘 要

本省目前推廣之黃麻4品種中並無完全抗立枯病品種。臺農3號具中等抗病性，其次爲臺農選1號，再次爲臺農1號，而以臺農2號最爲感病。黃麻自發芽後14日內可因(*Macrophomina phaseoli* (Maubl) Ashby 之侵染產生嚴重幼苗根腐型立枯病，但自30日後黃麻根部對立枯病病原菌之侵染具有抵抗性，即使極感病性品種（臺農2號）亦未見有根腐型病徵。黃麻愈成熟愈容易發生莖腐型立枯病，經以牙籤接種法將病原菌接種在不同生育日數之黃麻莖部，15日後檢查罹病病斑結果，以臺農1號爲例、生長日數30日者爲 21.69mm^2，60日者爲 31.38mm^2，90 日者爲 32.63 mm^2，120日者爲 34.69 mm^2 。土壤溫度與黃麻根腐型立枯病之發生成正相關關係。在 35°C 土溫下黃麻根腐型立枯病發生指數爲19.26，31°C爲12.3，27°C爲9.90，而以23°C最少爲7.58。土壤濕度與黃麻莖枯型立枯病之發生成負相關關係。低土壤濕度環境下較容易感染；病斑擴大快速，而在高土壤濕度環境者較有抵抗性；病斑擴大緩慢。黃麻（臺農1號）生長在不同含水量土壤1個月後接種病原菌，經15日後調查病斑大小結果，45%MHC者平均爲 17mm^2，35%MHC者爲 25mm^2，25%MHC者爲 26mm^2，而以15% MHC者病斑最大爲 44mm^2。

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