FACTORS AFFECTING THE RATE OF *FUSARIUM* ROT DEVELOPMENT IN HARVESTED TOMATO FRUITS

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ABSTRACT

The effects of storage temperature, moisture, packaging material and duration of exposure to inoculum on the development and severity of *Fusarium* rot on tomato fruits were investigated. Apparent infection rate and disease severity values were significantly higher at room temperature (27.5°C). However, disease development was completely inhibited at 10°C but most favored by moist condition. Severity and spread of disease increased with longer exposure to inoculum. Sealed polypropylene bags gave the utmost protection of tomato fruits against *F. moniliforme* infection.

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KEY WORDS: Tomato. *Fusarium moniliforme* Sheldon. Apparent infection rate. Disease severity. Inoculum.

INTRODUCTION

Tomato (*Lycopersicon lycopersicum* Karsten) is one of the world's important vegetable crops. It is popular among many consumers because of its nutritional value and diversity in use. In the Philippines, the area planted to tomato is about 18,640 hectares, contributing almost ₱200 million annually to the national economy (BAEcon, 1978). In many instances, however, tomatoes sold in the markets are of poor quality due to microbial attack. Higher demands for this commodity

by consumers have emphasized the need for quality improvement.

Fungi are among the economically important pathogens that infect harvested tomatoes. Walker (1952) reviewed the principal diseases of tomato in different countries and associated them with microorganisms such as *Fusarium* spp., *Gloeosporium phomoides* and *Rhizopus nigricans*. However, the epidemiological aspect of these diseases has not been thoroughly investigated. This study was thus undertaken to identify the organism causing the rot disease of tomato observed in the markets and the conditions that affect its rate of development.

MATERIALS AND METHODS

Isolation and Identification of the Causal Organism

Samples of diseased tomatoes were collected from the public market of Los Baños, Laguna, brought to the laboratory, and washed to remove soil and debris. Samples from the margin of the diseased tissue were plated using potato dextrose agar (PDA) and the recovered microorganisms were preserved on PDA slants.

To test the pathogenicity of the microorganisms, medium ripe tomatoes which were free from blemishes and defects were selected. These were thoroughly washed and surface disinfected with 10% sodium hypochlorite solution for 5 minutes. The tomatoes were then rinsed several times with sterile water, dried, and inoculated with *Fusarium moniliforme* Sheldon. After inoculation, the set-up was placed in plastic bags and maintained at ambient temperature. Appearance of symptoms and signs was observed daily. Reisolation of the microorganisms and comparison with the original inoculum were then made. Identification of the pathogen isolated from naturally diseased tomato fruits was based on the taxonomic system of Booth (1971).

Determination of Factors Affecting the Rate of Disease Development

Factors that could possibly affect the rate of disease development in tomato such as temperature, moisture, packaging material and duration of exposure to inoculum were tested. The method of selection, disinfection and inoculation of samples previously described was followed in the succeeding experiments.

Temperature. Tomato samples inoculated with *F. moniliforme* were sorted into four lots (six tomato fruits per lot) and placed in plastic bags. Individual lots were maintained at varying temperatures (10, 15, 20 and 27.5°C). Disease severity was determined daily using the formula:

$$\text{Disease severity} = \frac{\text{\% tomato surface infected}}{\text{\% total surface area of tomato}}$$

Moisture. Tomato samples inoculated with *F. moniliforme* were sorted into two lots (four tomato fruits per lot). One lot was placed in a moist chamber while the other was devoid of moisture. Disease severity was also observed daily using the rating scale earlier described.

Packaging Material. To determine the effect of packaging material on the rate of disease development, six tomatoes were placed in each of the following retail packaging materials:

A - Polyethylene bag, thin, sealed
B - Polyethylene bag, thin with 16 pinpricked perforations
C - Polypropylene bag, opaque, with 16 pinpricked perforations
D - Polypropylene bag, opaque, sealed
E - Control (exposed)

The different treatments were stored at ambient conditions. Disease development was evaluated daily using the rating scale previously described.

Duration of Exposure to Inoculum. Tomato samples were exposed to *F. moniliforme* inoculum at varying time durations (2, 4, 6 and 8 days). These infected specimens were used as source of inoculum by mixing them with healthy tomatoes. Rate of disease development was determined by counting the number of infected tomatoes after each duration of exposure.

RESULTS AND DISCUSSION

Description of the Disease

The disease first appears as small water-soaked lesions which are either circular or irregular in outline. The lesions are generally brown and somewhat sunken. Under moist condition, the lesions usually become covered all over with whitish or colored mycelia and the entire fruit becomes infected and reduced to a watery decay after 4 to 6 days.

Morphological and Cultural Characters

Growth is initially rather filmy, colorless and rapid. Cultures appear to be violet in color from below. The aerial mycelium is generally dense, delicately floccose to felted, vinaceous white, and often with a powdery appearance due to the formation of microconidia. Microconidiophores are simple, lateral, subulate phialides formed on the aerial hyphae.

Microconidia are formed in chains measuring 5-12 x 1.5-2.5 µm. They are fusiform to clavate with slightly flattened base, and occasionally become one septate. Macroconidial formation is rare. Chlamydospores are absent in both mycelia and conidia.

Causal Organism

The causal organism was identified as *Fusarium moniliforme* Sheldon. Penetration of the said

pathogen is possible only if wounds or injuries are present on host surfaces. This agrees with the findings of Walker (1952) that *F. moniliforme* is a wound parasite.

Effect of Storage Temperature on Disease Development and Severity

Fusarium rot development in tomato was significantly affected by different storage temperatures. Table 1 shows that the mean apparent infection rates and disease severity values at 10 and 15°C were significantly reduced. At room temperature (27.5°C), the values obtained were maximum. However, apparent infection rate at room temperature was not statistically different from that at 20°C. Disease development was completely inhibited at 10°C even 6 days after inoculation. In addition to the obvious differences in apparent infection rates, marked variation in lesion size was observed among tomato samples stored at different temperatures.

Effect of Moisture on Disease Development and Severity

Mean apparent infection rate and disease severity values under dry and moist conditions are presented in Table 2. Disease development was significantly enhanced by moist condition as reflected in the significantly higher apparent infection

Table 1. Average apparent infection rates and percent disease severities of *Fusarium moniliforme* isolate at varying storage temperatures.

Storage Temperature	Apparent Infection Rate[1]	Disease Severity (%)[2]	
		Initial	Final[3]
10°C	0.00b	0	0
15°C	0.02b	0	0.07
20°C	0.14ab	0	0.41
27.5°C (room temperature)	0.42a	0.01	0.62

[1]Determined as linear regression coefficient of logit values of disease proportion against time. Means within a column followed by a common letter are not significantly different at 5% level, DMRT.

[2]Average of six replications.

[3]Taken 6 days after inoculation.

Table 2. Average apparent infection rates and percent disease severities of *Fusarium moniliforme* on tomatoes as affected by moisture condition.

Treatment	Apparent Infection Rate[1]	Disease Severity (%)[2] Initial	Final[3]
With moisture	1.08a	0.010	0.990
Without moisture	0.30b	0.002	0.350

[1]Determined as linear regression coefficient of logit values of disease proportion against time. Means within a column followed by a common letter are not significantly different at 5% level, DMRT.

[2]Average of four replications.

[3]Taken 6 days after inoculation.

rate and the markedly higher final disease severity obtained. The lesions generally became covered with whitish or pinkish mycelia after 4 days, and the entire fruit became infected and reduced to a watery decay.

Under relatively drier condition, infection was less and significantly reduced although lesions were present. Diseased tissues remained firm. Final disease severity estimate was also low.

Disease severity as affected by moisture increased with time as reflected by the disease progress curve in Figure 1.

Effect of Packaging Material on Disease Development and Severity

Table 3 indicates that development of *Fusarium* rot in tomato is greatly affected by packaging material used. Significant differences in the mean apparent infection rates were noted among treatments. Generally, sealing the bags (whether polyethylene or polypropylene) significantly reduced the rate of disease development. This could be attributed to lowered oxygen and increased carbon dioxide content of the modified atmosphere which is

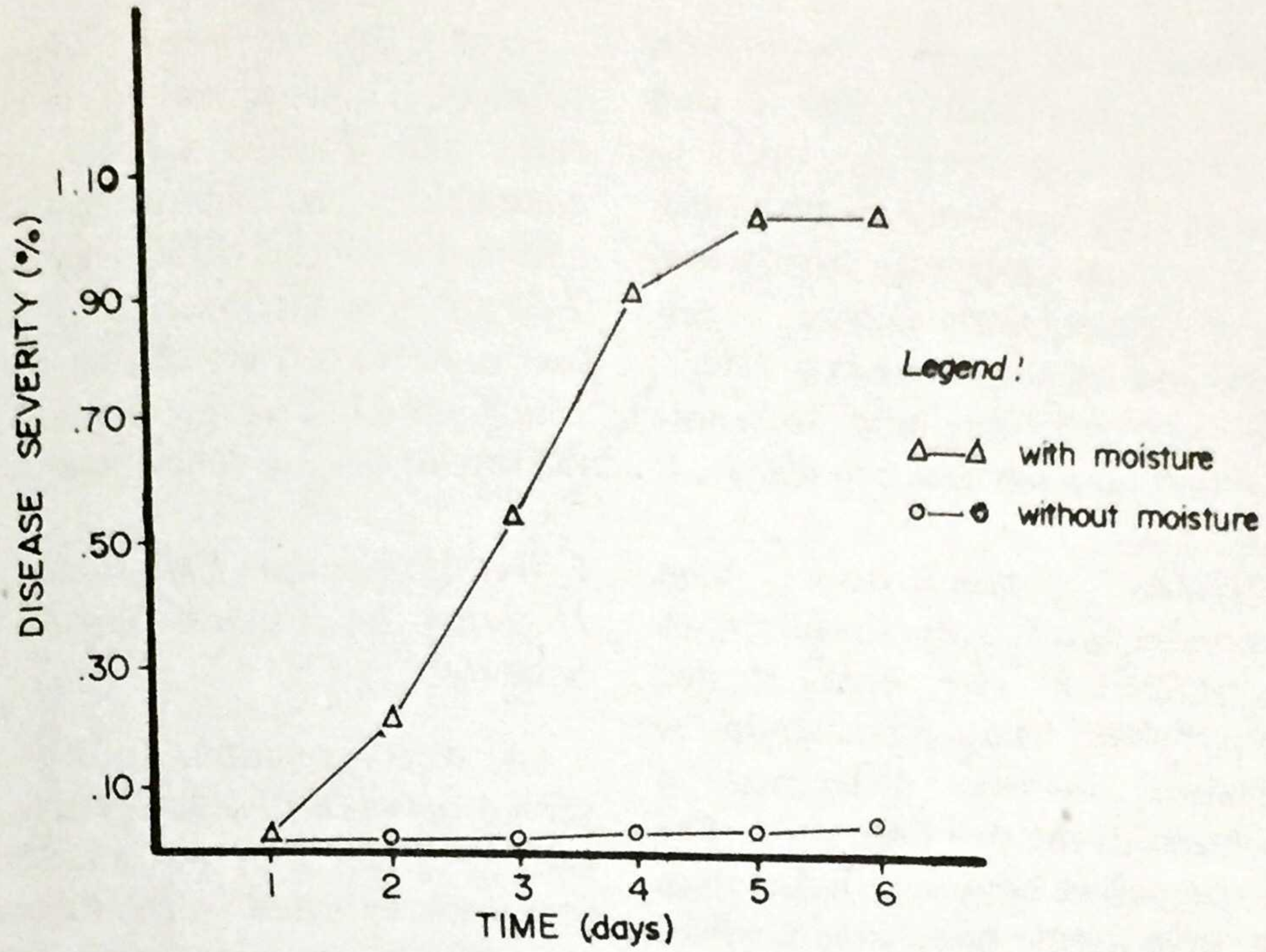

Figure 1. Effect of moisture and time on severity of *Fusarium* rot in tomatoes.

Table 3. Average apparent infection rates and percent disease severities of *Fusarium moniliforme* on tomatoes stored using different packaging materials.

Packaging Material[1]	Apparent Infection Rate[2]	Disease Severity (%)[3]	
		Initial	Final[4]
A	0.09d	0.005	0.262
B	0.68a	0.020	0.752
C	0.60b	0.035	0.753
D	0.01e	0.003	0.057
E	0.12c	0.030	0.317

[1] A - polyethylene bag, thin, sealed; B - polyethylene bag, thin with 16 pinpricked perforations; C - polypropylene bag, opaque, with 16 pinpricked perforations; D - polypropylene bag, opaque, sealed; E - control (exposed).

[2] Determined as linear regression coefficient of logit values of disease proportion against time. Means within a column followed by a common letter are not significantly different at 5% level, DMRT.

[3] Average of six replications.

[4] Taken 6 days after inoculation.

inhibitory to most pathogens. Young et al. (1962) explained that lower O_2 concentration and increased CO_2 levels reduce respiratory rate and substrate oxidation. These consequently retard senescence and its accompanying effects like fruit yellowing and softening such that host resistance to disease is prolonged.

Sealed polypropylene bags effected a significantly lower apparent infection rate than sealed polyethylene bags. This could be explained by the difference in thickness of the two bags used. The polypropylene bags are thicker than the polyethylene bags, thus possible diffusion of CO_2 to the atmosphere was relatively slower. Consequently, the slower diffusion of CO_2 into the atmosphere reduced the respiratory rate, retarded the senescence and prolonged the resistance of tomato fruits to infection by *F. moniliforme*.

Apparent infection rates and disease severity values were maximum in perforated bags. Moreover, apparent infection rates were significantly higher in polyethylene than in polypropylene bags. This suggests that packaging in perforated bags provides more favorable condition for *Fusarium* rot development in tomato, possibly due to optimum amount of gases which enhances rot development.

For the exposed treatment (control), the apparent infection rates and disease severity values were neither too high nor too low as compared to the other treatments. This might be attributed to moisture loss in tomato fruits during storage which could have greatly affected the rate of disease development.

Effect of Inoculum Exposure Duration on Disease Spread and Severity

A direct relationship was observed between disease severity and time (Fig. 2), i.e., the number of tomatoes infected with *Fusarium moniliforme* increases with longer exposure to the inoculum. This observation is supported by the high positive correlation coefficient (r) of 0.93. Such relationship could be attributed to the fact that longer exposure of uninfected fruits to infected ones increases the chance of rot-causing organism to multiply and produce subsequent inoculum to initiate further disease development. During the rotting process, the infected ones also supply considerable amount of moisture that aggravates disease severity. Moreover, longer exposure to the disease increases the chances of actual contact in storage hence, naturally increases the possibility of spreading the disease.

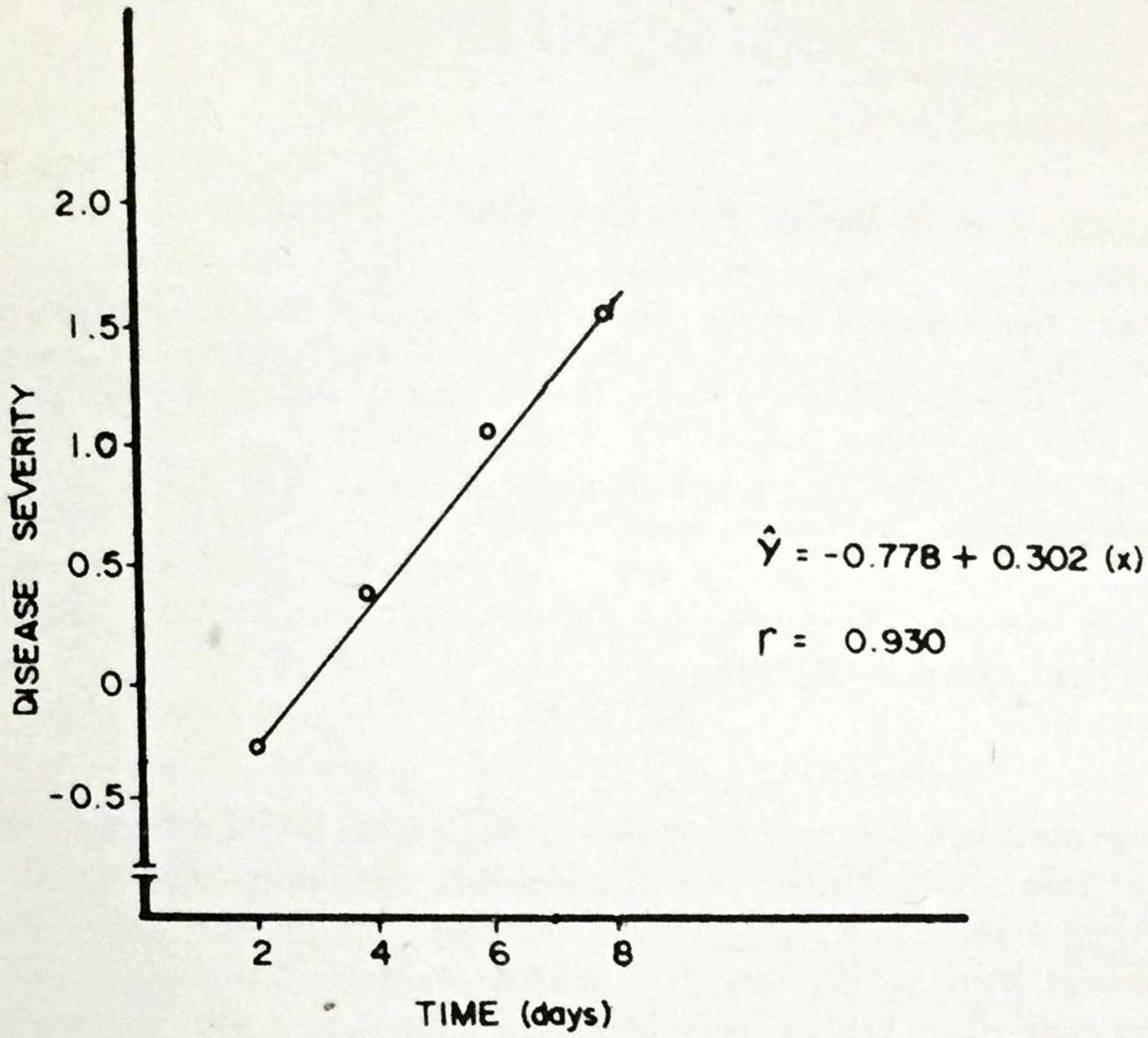

Figure 2. The relationship between inoculum exposure time (days) and severity $Y = \ln \frac{(x)}{(1-x)}$ where x = disease severity (%) of *Fusarium* rot in tomatoes.

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