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Role of Soil Moisture and Temperature on Development of Fusarium Wilt in Cucumber

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Abstract

The research experiment was conducted during the June to August of 2018 under green-house condition at the Experimental farm, Department of Plant Pathology, Dr YS Parmar University of Horticulture and Forestry, Nauni Solan, Himachal Pradesh, India. Mass culture of the pathogenic fungus, *Fusarium oxysporum* prepared on the corn sand meal medium were inoculated into the sterilized soil (7 cm diameter) in controlled conditions. Sterilized distilled water was sprinkled onto the inoculated soil followed by covering them pots with polythene sheet for about one week for build-up of inoculum. Different moisture and temperature regimes were tested for disease development. Results obtained from the experiments revealed that maximum disease incidence was observed at a soil moisture level of 45% however, no disease was observed at 15% soil moisture regime. Disease development was observed at all the temperature regimes tested except at 15°C where no disease progression was observed even after 21 days of inoculation. Maximum disease incidence (%) was recorded at 25°C temperature. Thus, the present studies indicated that extreme temperature and moisture levels were not found to be favourable for the development of the Fusarium wilt disease in cucumber as disease was observed at optimum environmental conditions of the Fusarium wilt disease in cucumber as disease was observed at optimum environmental conditions.

Keywords: Cucumber wilt, *Fusarium oxysporum*, soil moisture, soil temperature, edaphic factors

1. Introduction

Cucumber is one of the oldest cultivated vegetable crops which dates to 5000 years and belongs to the family cucurbitaceae (Wehner and Guner, 2004). Fusarium wilt caused by the fungal pathogen *Fusarium oxysporum* is one of the destructive diseases specially under protected conditions thereby, reducing the potential yields of cucumber crop. The disease was firstly reported from Florida as economic losses were reported from commercial field grown cucumber crops (Owen, 1955). Under protected cultivation, the disease was reported for the first time from North Carolina in 1979 (Jenkins and Wehner, 1983). Fusarium wilt causes significant yield losses ranging from 50 to 70% along with complete failure of cucumber crop (Martinez et al., 2003, Ye et al., 2004; Shen et al., 2008; Hu et al., 2010; Chen et al., 2011; Fareed et al., 2016). Cucumber wilt due to fungal pathogen has been reported for the first time from Jammu and Kashmir in India. Later the disease was reported from Lucknow and Punjab (Singh, 2018). In India, cucumber occupies an area of 96 thousand hectares with a production of 1696 thousand tonnes (Anonymous, 2020) and is cultivated mainly in the states of Haryana, Karnataka, Madhya Pradesh and Tamil Nadu. In mid hills of Himachal Pradesh, it is grown as an off-season vegetable crop during summer and rainy season both under open and protected cultivation conditions. Being an off-season crop, fruits are transported to the Northern plains where they fetch remunerative prices. Typical symptoms of infected plants appear as wilting and early infection of plants that prevent fruit set, while late infection results in small, abnormal fruits (Shukla and Sharma, 2017, Sharma and Shukla, 2021; Singh, 2018). The wilting symptoms are accompanied with chlorosis and finally necrosis of interveinal areas of leaves. Wilted plants later collapsed rapidly with vascular discoloration of roots and stem extending upto 8-10 nodes of common occurrence (Meena and Thakur, 2014; Manhong et al., 2014). Early infection of plants prevented fruit set, while later infection resulted in small, abnormal fruits. Cracks often appear on diseased vines. Temperature is the most important environmental factor strongly affecting wilt diseases since it has an influence on each of the three biotic components involved in the development of wilt diseases, *i.e*. the pathogen, the host plant and soil microorganisms. Wilt induced by *Fusarium* spp. is markedly affected by soil temperature. Temperature and moisture play important role on the growth and development of *Fusarium* species. Mina and Dubey (2010) reported that temperature and moisture are two parameters which greatly influence development of Fusarium wilt in different crops.

Soil moisture plays an important role in initiation and development of infectious diseases. A positive co-relation between high soil moisture and high wilt incidence was reported with a saturation level of 40–80%. Fusarium wilts are reported to be generally more severe in warm soil and at high soil moisture (Chen et al., 2013; Sekhon and Singh 2007; Attri et al., 2016). Scarce reports have been there in literature with respect to influence of temperature and soil moisture on development of Fusarium wilt of cucumber. Also, the interaction of disease development with that of soil temperature and moisture has not been studied, Therefore, the present study was envisaged to evaluate the influence of different soil moisture and temperature level regimes on development of disease.

2. Materials and Methods

The research experiment was conducted during the June to August of 2018 under green-house conditions at the Experimental farm, Department of Plant Pathology, Dr YS Parmar University of Horticulture and Forestry, Nauni Solan, Himachal Pradesh, India. Cucumber hybrid "KH-1" which was procured from Department of Vegetable Science, UHF, Nauni, Solan (HP) was used as a susceptible host for checking the effect of soil moisture and temperature on disease development. For carrying out the research experiment, mass culture of fungus was prepared which was then artificially inoculated into pots containing soil and different soil moisture and temperature regimes were maintained to test the development of the disease.

2.1. Preparation of mass culture

Fusarium oxysporum which is the causal agent of Fusarium wilt in cucumber was mass multiplied on corn: sand meal medium (Dohroo, 1988). These polypropylene bags containing corn-sand meal were then autoclaved at 20 p.s.i for 30 minutes. Bags were later inoculated with actively growing culture of *Fusarium oxysporum* and incubated at 25±2°C in BOD incubator for 15 days. The bags were shaken regularly after 2-3 days for uniform fungal growth. The mass culture of fungus was thus used for carrying out the experiments.

2.2. Effect of soil moisture regimes on disease development

In order to study the effect of different soil moisture regimes i.e. 15, 30, 45, 60 and 75% on development of disease, an experiment was conducted under controlled conditions. Mass culture (4 g) of *Fusarium oxysporum* was mixed with sterilized soil in the paper cups (7 cm diameter) and sprinkled with sterilized distilled water followed by covering them with polythene sheet for about one week. After seven days, young healthy cucumber seedlings of hybrid "KH-1" were transplanted in paper cups at 2-true leaves stage. Desired soil moisture levels were measured by using moisture meter. Weight of the dry soil present in each cup was measured using moisture meter and to achieve the required moisture levels, required amount of water was added to each cup to achieve the required moisture regime. Once the soil of the cups reached to required levels, seedlings were transplanted in each cup after 7 days of inoculation. They were then kept in plant growth chamber for further observations. The experiment was conducted in completely randomized design with four replications for each treatment. Data on disease incidence in each treatment was then recorded.

2.3. Effect of soil temperature regimes on disease development

In order to study the effect of different temperature regimes *i.e.* 15, 20, 25, 30 and 35°C on development of disease, an experiment was conducted in which paper cups were filled with sterilized soil and inoculum of the pathogen was then mixed in them @ 4 g cup^{-1}. The paper cups containing corn meal medium and soil were sprayed with sterilized distilled water and covered with polythene sheet for a week. After the establishment of the pathogen, a healthy seedling of hybrid "KH-1" was transplanted in each paper cups. The experiment was conducted in completely randomized design with four replications for each treatment. Cups were transferred to plant growth chamber where desired temperature was maintained. Data on disease incidence in each treatment was recorded.

3. Results and Discussion

3.1. Effect of different soil moisture regimes on disease development

An increment in per cent disease incidence was recorded with the increase in soil moisture level up to 45% and thereafter; decline in per cent disease incidence was recorded as depicted (Table 1). Maximum disease incidence was recorded at 45% moisture level followed by 60% soil moisture. In general, it was observed that low moisture levels check the vegetative vigour of the host which reduced the disease proportionally. Moreover, plants growing in saturated soil were also less susceptible to attack. These results were in agreement with Fahmy and Tewfik (1928), they reported a positive co-relation between high soil moisture and high wilt incidence.

Table 1: Effect of different soil moisture regimes on development of Fusarium wilt of cucumber

Moisture level (%)	Disease incidence (%)
15	0.00 (0.00)^{e}
30	53.58 (47.04)^{c}
45	74.99 (60.13)^{a}
60	64.58 (53.55)^{b}
75	22.91 (28.34)^{d}
CD (p=0.05)	6.01

Figures in the parenthesis are arc sine transformed values

Moisture level of 30–40% was found optimum for disease development as reported by other workers also (Mustafee and Chatopadhyay, 1971).

Contrary to the findings of present studies, Prasad and Saifulla (2012) observed that 75% water holding capacity was favourable for the growth and multiplication of *Fusarium udum* causing pigeon pea wilt. Yan and Nelson (2022) studied the requirement of optimum soil moisture regimes for two isolates of Fusarium species causing root rot in soybean. They reported that reduction in emergence of disease was observed at 80% WHC in silt loam and 40% in sandy loam soil in comparison to non-infested ones.

3.2. Effect of different soil temperature regimes on disease development

It was observed that with the increment in soil temperature regimes, there was a corresponding increase in the disease incidence (Table 2). Maximum disease incidence was observed at 25°C which was significantly superior to other treatments followed by 30°C while, minimum incidence was recorded at 20°C. This shows that extremely low and high soil temperatures are not favourable for disease development. The effect of soil temperature on pathogen colonization and wilt occurrence will vary in different pathosystems (Marios and Mitchell, 1981). Sequential increase in soil temperature resulted in an increase in root rot severity and foliar symptom expression. Huang et al. (1988) studied the effect of different temperature regimes on spore germination and hyphal growth of *Fusarium* sp. and found that optimum growth of the pathogen is at 24–27 °C and no growth occurred above 37°C. Kumar et al. (2011) reported that most suitable temperature range for growth and sporulation of *Fusarium oxysporum* f. sp. *lycopersici* is between 25 to 30 °C.

High temperatures (30 and 35°C) enhanced symptom expression of cabbage yellows, watermelon and chrysanthemum wilt of Fusarium as reported by Vakalounakis (1996). (Sekhon and Singh, 2007) observed that Fusarium wilt in muskmelon was severe at 25°C as compared to other temperature regimes. The results obtained in present studies are in conformity with (Scarlett, 2013) who reported 25°C temperature best for the development of Fusarium wilt of cucumber. Further, (Attri et al., 2018) also reported maximum incidence of Fusarium wilt of bell pepper at soil temperature of 25°C followed by 30°C. Mina and Dubey (2010) carried out study on environmental variables on development of Fusarium wilt in chickpea. They reported that the pathogen was able to grow at all temperature ranges tested (20–37°C), however maximum infection and sporulation was observed at temperature range of 28–30 °C. Zhang et al. (2021) reported that cotton seedlings manifested more severe symptoms with higher mortality at temperature of 23°C followed by 26 to 29°C. Landa et al. (2007) studied the influence of temperature and inoculum density of *Fusarium oxysporum* f. sp. *ciceris* on suppression of Fusarium wilt of chickpea by rhizosphere bacteria and reported that disease development was greater at 25 °C in comparison to 20 and 30 °C.

Table 2: Effect of different soil moisture regimes on development of Fusarium wilt of cucumber

Temperature (°C)	Disease incidence (%)
15	0.00 (0.00)[e]
20	16.66 (23.72)[d]
25	100.00 (90.00)[a]
30	70.16 (62.92)[b]
35	64.57 (53.47)[c]
CD (p=0.05)	4.66

Figures in the parenthesis are arc sine transformed values

4. Conclusion

The optimum soil temperature of 25°C and soil moisture level of 45% had been found most congenial for disease development. Hence, these conditions must be avoided to check the development and spread of the disease.

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