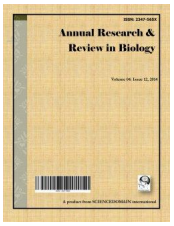

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Influence of Soil Properties on Wilt Incidence of Water Melon, Tomato and Marigold

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Authors' contributions

This work was carried out in collaboration between all authors. All authors read and approved the final manuscript.

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ABSTRACT

The fungal pathogen *Fusarium oxysporum* affects a wide variety of hosts of any age by causing wilt disease. The aim of this present work was to evaluate the role of soil texture, moisture, pH, and temperature against the wilt incidence of watermelon, tomato and marigold. Observations revealed that sandy soil with supported highest wilt incidence of water melon, tomato and marigold compared to silt clay soil. It should be significantly highest infection was noticed at soil pH6 while pH9. Furthermore, to evaluate the effect of soil moisture on occurrence of disease incidence, the pots containing water melon, tomato and marigold plants were irrigated after 2, 4, 6, 8 and 10 days interval. It was reported that the plants which were irrigated after the interval of two days showed less disease incidence. It means that if we increase the interval of irrigation then the disease incidence will ultimately increased *i.e*., as same as shown by the interval of ten days.

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1. INTRODUCTION

Throughout human history, our relationship with the soil has affected ability to cultivate crops and influenced the success of civilizations. This relationship between humans, the earth, and food sources affirms soil as the foundation of agriculture [1].

Water melon, tomato and marigold crops are grown on a variety of soils from sandy loam to heavy clay, but it grows best on well drained sandy loam soil. It was noticed that *Fusarium* wilt is generally associated with acid soils whereas alkaline clay soils are least favourable [2-3]. The effect of soil types on the saprophytic activity of soil borne pathogens has been reported [4]. It has been also reported that in five types of soils viz., black, red, sandy, sandy loam and clay, the *Fusarium solani* causing root-rot and wilt in chickpea was significantly highest in sandy loam soil followed by black soil and lowest sandy loam soil [5]. The minimum disease incidence was found in clay soil followed by red soil [6]. Decreasing levels of sand and increasing levels of clay lead to decreased fruit rot incidence in chickpea caused by *Rhizoctonia bataticola* [7-8]. It was reported that wilt of muskmelon consistently more severe in fox sandy loam soil than claywood loam [9-10]. Some scientists reported that the wilt caused by *Fusarium oxysporum* f.sp. *lycopersici* mostly developed in sandy loam soil and least in clay soil [11-12]. *Fusarium* in general is strong aerobes and activities are favoured by light soils.

The objective of the present study was to evaluate the important environmental and physiological factors (edaphic factors) that influence the disease development *viz*. soil texture, moisture, pH and temperature.

2. MATERIALS AND METHODS

To study the effect of soil types on the incidence of water melon, tomato and marigold wilt, five types of soil viz., sandy, sandy loam, sandy clay loam, clay loam and silt loam were collected. Before using, these soils were sterilized (autoclaved for two consecutive days at 1.1 kg/cm^3 pressure for two hours) and mixed with the inoculum of *Fusarium* spp. @ 5% weight of soil in pot. These inoculated soils were put in pots and moisten with water. For all the treatments moisture holding capacity was maintained at 35 per cent by adding required quantity of distilled water.

In the study on effect of *p*H, sandy loam, soil with 7.6pH was adjusted by using calcium hydroxide or commercial sulphuric acid. After adjustment of the soil pH, was allowed to weather for seven days and readjusted to the level 5,6,7 and 9 before sowing, for each *p*H level four replicates were maintained.

During moisture bioassay sterilized sandy loam soil was filled and inoculated with *Fusarium* spp. 5 per cent of weight of soil in pot. These pots were irrigated at the intervals of 2, 4, 6, 8 and 10 days to maintain different moisture regimes. Four replications in each set were maintained. Soil moisture was recorded by drying 100 g soil of each set interval regimes within flask in oven at 160^oC for 4 hours.

During each experiment seed samples of watermelon, tomato and marigold were purchased from the markets of Allahabad city, UP, India. In each pot 25 seeds (surface sterilized) of each crop were sown in four replicates. A control set without inoculums of the pathogens was also maintained. After germination, 10 plants of each crop were selected for the observation of disease incidence in each pot. These pots were regularly observed for the appearance of the wilt and finally per cent wilt disease incidence in each treatment as well as in control set was calculated. Diseases incidence was scored with a 9 points hedonic scale index of 0-9 where, 0 = no disease incidence; 1 = disease incidence 10-20%; 2 = 21-30% of disease incidence, 3 = 31-40% disease incidence, 4 = 41-50% disease incidence; 5 = disease incidence 51-60%; 6 = 61-70% DI; 7 = 71-80%; 8 = 81-90%; 9 = 91-100. Percent diseases incidence was calculated by the following formula:

> Disease incidence = [(Sum of diseases plants in the index × Disease index) / (Total number of plants investigated × the highest disease index)] × 100%.

3. RESULTS

Data presented in the Table 1 clearly indicates that sandy soil supported highest wilt incidence of water melon (75%), tomato (72%) and marigold (52%). The least incidence was found in

silt clay soil were 21.0%, 16.0% and 15% in water melon and tomato and marigold, respectively.

The results of the effect of soil *p*H on wilt of water melon, tomato and marigold crops revealed that infection in water melon, tomato and marigold was significantly highest at *p*H 6 followed by pH 5 and 7. Least infection was recorded at pH 9 (Table 2).

Sterilized sandy loam soil was filled and inoculated with *Fusarium* spp. 5 per cent of weight of soil in pot. These pots were irrigated at the intervals of 2, 4, 6, 8 and 10 days to maintain different moisture regimes. Four replications in each set were maintained. Soil moisture was recorded by drying 100 g soil of each set interval regimes within flask in oven at 160^{o}C for 4 hours.

Table 3 shows that in pots having irrigation every 2 days, the per cent incidence was 33, 31, and 27 in water melon, tomato and marigold, respectively. However, when intervals of irrigation were increased to 6, 8 and 10 days, disease incidence was also found to be increased to 53, 58, 61 per cent in water melon, 47, 54, and 58 per cent in tomato and 44, 54, 58 per cent in marigold. Increase in interval period of irrigation reduced moisture regime in pots.

It was noticed from the Table 4 that disease incidence varies under different soils temperature conditions. A range of 21 – 26°C temperature was most favourable for the disease development. Maximum incidence was recorded at 23^{o}C in all the selected crops. The disease incidence started to decrease above and below the 24^{o}C temperature. The minimum disease incidence was found at 30 and 16.2^{o}C (Table 4).

Table 1. Influence of soil types on wilt incidence of Water melon, tomato and marigold

Sl. no.	Soil types	% wilt incidence		
		Water melon	Tomato	Marigold
1.	Sandy	75	72	52
		(60)	(58.1)	(46.2)
2.	Sandy Loam	64	60	48
		(53.2)	(50.8)	(43.9)
3.	Sandy Clay Loam	46	42	32
		(42.7)	(40.4)	(34.5)
4.	Clary Loam	29	20	20
		(32.6)	(26.6)	(26.6)
5.	Silt Clay	21	16	15
		(27.3)	(23.6)	(22.8)

Figure in Parentheses are transformed 'Arc' values

Table 2. Influence of soil pH on wilt incidence of Water melon, tomato and marigold

S. no.	pH	% wilt incidence		
		Water melon	Tomato	Marigold
1.	5	70	64	61
		(56.8)	(53.2)	(51.4)
2.	6	91	89	86
		(72.6)	(70.7)	(68.1)
3.	7	46	42	43
		(42.7)	(40.4)	(41.0)
4.	8	33	32	32
		(35.1)	(34.5)	(34.5)
5.	9	25	29	23
		(30.0)	(32.6)	(28.7)

Figure in Parentheses are transformed 'Arc' values

Table 3. Influence of soil moisture on wilt incidence of Water melon, tomato and marigold

S. no.	Interval of irrigation (Days)	% wilt incidence		
		Water melon	Tomato	Marigold
1.	2	33 (35.1)	31 (33.9)	27 (31.3)
2.	4	34 (35.7)	34 (35.7)	29 (32.4)
3.	6	53 (46.7)	47 (43.3)	44 (41.6)
4.	8	58 (49.6)	54 (47.3)	52 (46.2)
5.	10	61 (51.4)	58 (49.6)	56 (48.5)

Figure in Parentheses are transformed 'Arc' values

Table 4. Influence of soil temperature on wilt incidence of water melon, tomato and marigold

Sl. no.	Temperature	% wilt incidence		
		Water melon	Tomato	Marigold
1.	16.2(Jan,15)	37 (37.5)	39 (38.7)	38 (38.1)
2.	18.2(Jan,28)	41 (39.8)	46 (42.7)	39 (38.7)
3.	19.6(Feb,8)	47 (43.3)	49 (44.4)	44 (41.6)
4.	20.4(Feb,18)	50 (45.0)	51 (45.6)	46 (42.7)
5.	21.7(March,3)	63 (45.6)	62 (48.5)	54 (47.3)
6.	23.0(March,24)	77 (52.6)	73 (52.0)	70 (56.8)
7.	25.0(April,2)	72 (61.4)	69 (58.7)	61 (51.4)
8.	26.3(April,13)	66 (58.1)	61 (56.2)	60 (50.8)
9.	27.0(April,22)	58 (54.4)	56 (51.4)	51 (45.6)
10.	29.04(April,26)	51 (45.6)	42 (40.4)	41 (39.8)
11.	30.0(April,30)	31 (33.9)	26 (30.7)	24 (29.3)

Figure in Parentheses are angular transformed "Arc" values

4. DISCUSSION

Soil texture and *p*H are inseparable parameters as both of them are interdependent. *Fusarium* has the ability to survive in most soil-arctic, tropical, desert, cultivated and non-cultivated that's why the sandy soil show highest wilt incidence of water melon, tomato and marigold [13]. The proportion of soil particles which decides texture would also be a deciding factor for pH, but addition of lime to acid soils decrease disease symptoms [14]. Similarly, the wilt disease was more severe in low *p*H soils of South Africa [15]. The first critical work on the relation of soil pH to development of wilts was that the percentage of wilted results were obtained by Chand and Thakur (1969) who found that *Fusarium* of tomato wilt was more in acidic soils [10,16]. Whereas, the percentage of wilted tomato plants declined from 50.7 percent at pH 3.4 to minimum of 6.2 per cent at pH 6.1 and rose to another maximum of 68.6 per cent at pH 8.5 [17].

Soil moisture is an important regulator of temperature because more heat is needed to

raise the temperature of wet soil. It would be difficult to define the effect of soil moisture without accounting for other factors, as it is an extremely complex interaction in which a change in one factor leads to change in other factor [18]. The optimum growth and survival of *Fusarium* spp. was better at 15 per cent saturation and decreases sharply at 25 per cent saturation indicating the strong aerobic nature of the fungus [19].

Incidence of wilt and root-rot was related to higher moisture content and due to the presence of under decomposed organic matter near the soil surface [20]. The root-rot and wilt disease of chickpea increases by 2 to 3 fold as the number of irrigation of crop increase [21]. The effect of soil moisture on wilt and root-rot of chickpea caused by *Fusarium oxysporum* f. sp. *ciceri, Fusarium solani* f. sp. *pisi, and Phythium ultimum* increase with decreasing soil matrix potential [22]. The less moisture favours the luxuriant growth of *Rhizoctonia bataticola* and hence, it caused more damage to crops moisture stress condition. Soil having more sand content has less water retention capacity and consequently ideal for the luxuriant growth of this pathogen [23-25]. It is also proved that increased irrigation level will increases the biomass content but reduces the water use efficiency in producing economic yield of crops [26].

Soil temperature was observed important factor for disease incidence by several investigators. *Fusarium* wilt is a warm weather disease. The disease developed severely and rapidly during the period of highest average temperature of 29°C in case of *Fusarium* wilts of tomato [10]. An optimum of 28°C for disease development, but no disease was seen in infested soil above 34°C or below 20°C [27]. However, the fungus caused abundant injuries at all temperature down at 18°C and no wilt occurred at temperature above 30°C. Contrary to most of the *Fusarium* wilts, tomato wilt is a disease that occurs in warm soils, that most severe symptoms being found at temperatures between 18 and 20°C. At higher temperatures (30°C) the plant is infected without showing symptoms. More susceptibility of plants at 25-30°C was found in the glasshouse study with cucumber wilt by *Fusarium oxysporum* f. sp. *cucumerinum* [28]. Soil temperature was recorded daily at 5 cm depth both in the morning at 10:00 am and afternoon at 4:00 pm throughout the crop period.

Soil moisture is indispensable for the germination of fungal spores and penetration of the host by the germ tube. It is also indispensable for the activation of bacterial, fungal and nematode pathogens before they can infect the plant.

Moisture, in such forms as splashing rain and running water, also plays an important role in the distribution and spread of many of these pathogens on the same plant and on their spread from one plant to another. Finally, moisture increases the succulence of host plants and thus their susceptibility to certain pathogens, which affects the extent and severity of diseases.

5. CONCLUSION

From the above results it is concluded that sandy soil supported highest wilt incidence of water melon, tomato and marigold and the least incidence was found in silt clay soil. The results also revealed that the plants which were irrigated after the interval of two days showed less disease incidence. The interval of ten days showed highest disease incidence. This is the area where research is required to improve use efficiency of inputs such as moisture in the form of irrigation, pH, soil temperature, etc by various agricultural techniques use to minimize the disease incidence thereafter increases the economic yield rather biological yield or it can also say that higher harvest index.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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