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Ontogenic Predisposition of Tomato Foliage to Early Blight Caused by *Alternaria solani* under Mountainous Conditions of Kashmir

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Authors' contributions

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

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ABSTRACT

This study explores the susceptibility of tomato plants to early blight caused by *Alternaria solani* concerning their chronological and physiological ages. While previous research has noted higher resistance in younger potato plants and an acropetal increase in resistance within plant leaves, such investigations are limited in tomatoes. Our study aimed to address this gap by investigating the influence of chronological and physiological ages on early blight resistance in tomato plants.

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Using the Keck Ruth Ageti cultivar, we conducted experiments at various plant growth stages. Chronological age variations were achieved by sowing seeds at 10-day intervals, with inoculation occurring when the youngest seedlings reached 20 days. Leaf sampling from different sections facilitated the evaluation of physiological age effects. Results showed a direct relationship between plant age and disease susceptibility, with older plants exhibiting higher incidence rates. Moreover, resistance increased from lower to upper leaves, with top leaves demonstrating the highest resistance.

Keywords: Tomato; early blight; Alternaria solani; ontogenic; plant growth.

1. INTRODUCTION

The young plants of potato show high resistance to early blight due to *A. solani* as compared to the older ones [1]. According to Dowley *et al*., [2] lower leaves within a plant, physiologically distinct from middle and top leaves, exhibit higher susceptibility to specific pathogens, with resistance increasing towards the upper parts. While similar research is lacking for tomato plants, some evidence suggests that plants generally decrease in resistance as they undergo senescence [3]. The present work was conducted to determine if resistance to *A. solani* in tomato was influenced by its chronological and physiological ages.

2. MATERIALS AND METHODS

The experiment was conducted on tomato cultivar Keck Ruth Ageti. The soil used in the experiments had 11.5, 2.8 and 85.7 per cent of clay, silt and respectively as determined by International Pipette Method [4].

To have the plants of different chronological ages, the tomato seeds were sown regularly at 10-day intervals. When the seedlings from the last sown seeds reached 20 days of age, seedlings from all sowing dates, each with different chronological ages, were inoculated simultaneously. The inoculation involved using a standard mycelial spore suspension prepared by blending a 7-day old culture of *A. solani* grown on Czapek's Dox Agar medium. The standard inoculum had approximately 15-20 propagules (mycelial-spore-bits) per microscopic field. The nutrient-amended vermiculite inoculated plants were covered with water-sprayed perforated polythene bags for 24 hours to ensure high humidity. The ages of the seedlings at the time of inoculation were 20, 30,40,50,60,70,80, 90,100, 110 and 120 days. The flowering occurred at an age of 80 days and the initial fruit setting took place after 100 days. The data were recorded at the end of 7 days. The degree of infection was based on the lesion size and the leaf area infected. There were three replications for each treatment and the experiment was conducted in double set.

Three plants per sowing date were transplanted into 18 cm diameter clay pots. To study the effect of physiological maturity of the leaves on their reaction to early blight, leaf sampling was done from the potted plants. At each sampling, three leaflets were taken from top, middle and bottom sections of the plant. The standardized inoculum was applied to the upper surface of detached leaves with an atomizer. In another set of the experiment, the same inoculum was also applied on the lower surface of detached leaves. The leaves were incubated for 3-5 days in a humid atmosphere at 22+ _2 ^{0} C. The degree of infection was based on lesion size and leaf area infected. The incidence of the disease was recorded according to 0-5 scale (0= no disease, 5=total leaflet area infected). The disease rating in each treatment was then converted to per cent infection [5] and analyzed statistically for comparison.

3. RESULTS

The measurements of susceptibility by leaf area infected and lesion size showed very close agreement. Consequently, all results are expressed only in terms of mean class of area of the leaf infected. Effect of age of tomato plants on their reaction to early blight.

(a) Effect of chronological age

The age of the plant had a significant influence on its response to early response to early blight infection. The incidence of disease was in direct relation to the chronological age of the plants at the time inoculation. The incubation period for the appearance of initial symptoms was also found to have a broad relationship with the host age.

Table 1. Effect of chronological age on the incidence of early blight of tomato

Age of the plant (Days)	Disease Incidence (per cent)	Incubation period (hours)
20	17.70 (24.87)	78
30	28.30 (32.13)	78
40	37.30 (37.64)	78
50	48.10 (43.91)	72
60	51.00 (45.57)	72
70	66.00 (54.34)	60
80	51.30 (45.74)	60
90	57.20 (49.14)	60
100	71.50 (57.76)	60
110	72.00 (58.05)	54
120	73.10 (58.76)	54

Average of 3 replication.
The figures within brackets are angular transformations.
S.E. M.= 0.72
C.D. at 5% = 1.50
C.D. at 1% = 2.04

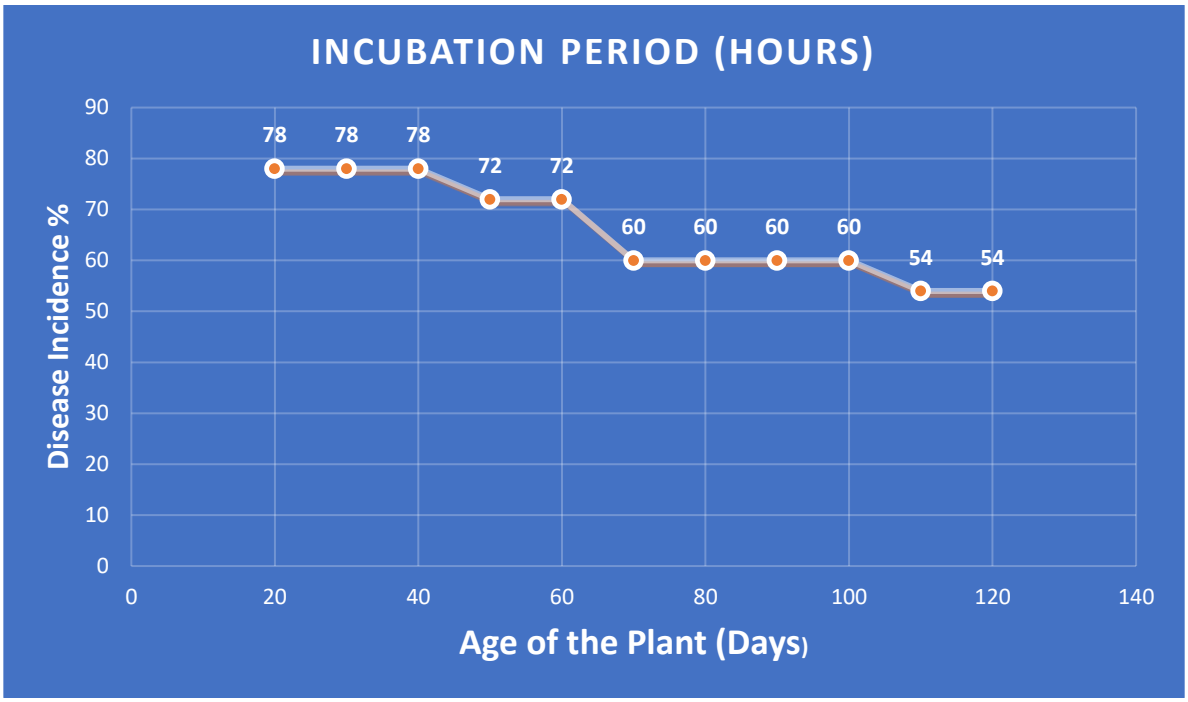

Fig. 1. Graphical representation of the impact of tomato plant age on early blight incidence (%) and incubation period (hours)

(b) Effect of physiological age

Irrespective of the chronological age of the plants, the resistance to the disease increased from lower to upper leaves of the same plant with the top leaves showing the greatest resistance. The necrosis of lower leaves was significantly more as compared to the leaves located at the middle and the top portions of the plant. The disease incidence on lower leaves was approximately four times more than that on the leaves located at the top of the plant.

The lower surface of the leaf irrespective of its chronological and physiological age was more susceptible to infection by *A. solani* than the upper surface. The average incidence of disease, where inoculation was done on the upper surface of the leaf was 51 per cent as compared to 61.3 per cent where inoculation was done on the lower surface. However, the

incubation period invariably remained 72 hours in both the cases.

4. DISCUSSION AND CONCLUSION

Ontogenic host resistance is an important epidemiological variable since the epidemics are not static and because different plant growth stages may be exposed to different conditions of the ecosystem [6]. The disease incidence of tomato plants increased with the increase in their chronological age Table 1). As the incubation period determines the duration of infection cycles or infection cycles completed during a given time, it is thus an important factor in the ecological succession of the pathogen on the host surface [7]. It was found that there was a reduction in the incubation period with an advancement in the chronological age of the plants.

Differences in resistance among leaves located at different parts of the plant were observed at all stages of its growth. The lower and older leaves which are physiologically mature were more susceptible to infection by *A.solani* than the upper leaves which are not as mature physiologically. Similar results were reported by Sohi and Sokhi [8]) on defoliation disease of tomato caused by *Septoria lycopersici*. The pathogen destroys the leaf tissue, resulting in the reduction of foliage yield and total photosynthetic area, thus decreasing the total carbohydrate level of the host [9]. This makes the substrate favorable for the attack of a low sugar pathogen like *Alternaria solani* [10].

The same thing might be happening in the plants of different chronological ages where the sugar level of the mature foliage is reduced because of its translocation towards the developing fruits and the less attack of *A.solani* on younger plants might also be due to their high phytoalexin activity [3].

The more susceptibility of lower surfaces of tomato leaves may be attributed to their morphological and physiological feature such as a greater number of stomata per unit leaf area, thickness of cuticle, thin waxy coating and probably the nature of exudates [11]. Due to interplay of different epidemiological and ecological factors, the plants may still show larger susceptibility to the disease under natural conditions of growth in the field than those we have obtained in the present study.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declare that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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