Does size matter? Observational Study on How the Length of Tree Branches Correlate with Fungal Pathogen Susceptibility in Tecoma Stans

Abstract

Tecoma Stans are a shrub native to southwestern regions of the United States and Mexico. It is known for its bright yellow flowers and has potential resistance to pathogens. This study investigated the relationship between branch length and susceptibility to fungal pathogen damage in T. Stans samples collected from the University of Arizona campus. There is previous research that suggests anti-fungal properties in invasive weed species like the *T. Stans*. This study focused on understanding how branch morphology may be an influence on the vulnerability of herbivory damage from the antagonistic interactions with fungal pathogens. Specifically, I looked at brown curling damage. Fifteen branch samples were randomly selected and analyzed using regression analysis to examine the correlation between the branch length and the percentage of leaves displaying fungal pathogen damage. The results revealed a moderate and negative correlation ($r = -0.7$ and $R^2 = 0.5$) indicating that shorter branches tend to experience more fungal pathogen damage and vice versa. These findings suggest that branch size may be a possible significant factor in the plant's defense mechanisms against damage from microbial pathogenic attack. Further research could expand on this study and explore the diverse ways that these microorganisms interact, discovering additional factors that influence plant’s susceptibility to pathogenic herbivory.

Keywords: *Tecoma Stans*, fungal pathogens, herbivory, ecology, species interactions.

Introduction

Tacoma Stans (T. Stans) are shrubs characterized by their bright yellow flowers that have thin to wide tubular structures with petals expanding outwards. They have short

branches with green compound leaves that cover most of the area of the plant. Their flowers bloom in the seasons of summer into early fall. *T. Stans* prefer inhibiting dry and warmer climates and are native to the southwest bordering states including the state of Arizona in America and the state of Chihuahua in Mexico. Like many plants, *Tecoma Stans* have antagonistic interactions with herbivores. This study focuses the herbivore damage inflicted on the *T. Stans* known as brown curling caused by fungal or bacterial pathogens. This damage occurs on the edges of the leaves as brown or dark orange curls. Research shows that *Tecoma Stans* possess anti fungal qualities and resistance to pests and pathogens (Gilman et al. 2019). However, when the strength of such anti fungal pathogen activity was measured in multiple invasive weed species, the *T. Stans* presented the lowest activity.(Meela et al. 2019) Many plant characteristics are linked to plant defenses against and susceptibility to herbivore damage such as morphological, physiological, and ecological, influencing how plants fight herbivore damage.(Schuldt et al. 2017)

In this study, I explored if there is a relationship between size of *Tacoma Stans* branches and the susceptibility to damage caused by fungal pathogens on samples of *T. Stans* on campus at the University of Arizona. The length size of the branches was measured and the abundance of damaged leaves on those branches that displayed brown curling to determine if the size of the branches related to susceptibility to damage. I hypothesized that *T. Stans* with smaller branches are more prone to being a target damaged by fungal pathogens due to weaker defenses and structure. I predict that if the branches are shorter in length, then there will be a higher abundance of brown curling damage present on the leaves compared to the longer branches. If the results support the prediction, then the expected outcome should present a negative relationship between the length of the branch size and percent cover of damaged leaves (fig. 1). Regression analysis was used because of the variation of data recorded in the length(cm) of the branches and the abundance of damage on the branch's leaves (%) making both variables continuous.

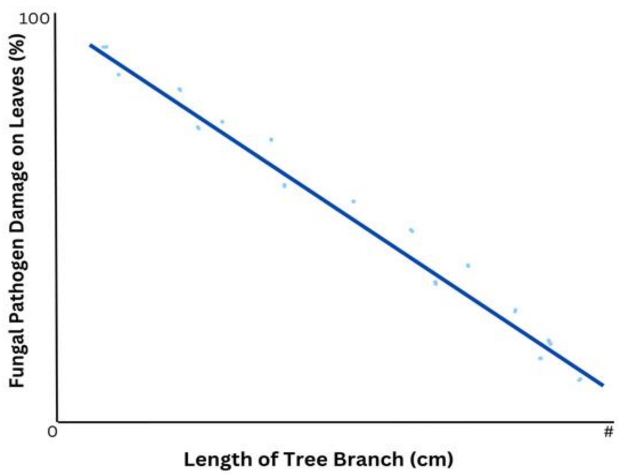

Figure 1. Graph of predicted results if hypothesis is supported. Dots represent a single sample.

Methods and materials

Sample description and collection

The Tacoma Stans observed were a species with small orange tubular flowers. It was small compared to near yellow flowered species in the area. The *T. Stans* visually displayed noticeable damage by herbivory throughout the lower and mid regions but overall appeared to be of good health. This plant was located near the south area of the education building on campus at the University of Arizona. The data collected was on fifteen samples of branches chosen randomly from the *T. Stans* (Table 1.). The length of the branches was measured in centimeters using an open reel measuring tape. The total count of leaves on each branch and of damaged leaves were recorded to calculate the percent cover for the abundance of fungal pathogen damage on each sample.

Regression analysis

Regression analysis was the statistical method used to understand the relationship between the varying length of the tree branches and the abundance of fungal pathogen damage on each of the individual branch's leaves. This method was also a suitable choice since both variables are continuous. Regression analysis finds a line that best suits the relationship between the length of the tree branches and the abundance of fungal pathogen damage on an x-axis and y-axis coordinate plane to produce the model. R is the correlation coefficient that can determine the direction of the linear relationship between the length of the tree branches and the amount of fungal pathogen damage occurring on the leaves of each branch. A -1 is a strong negative relationship between the variables and a +1 is a strong positive relationship between the two variables. 0 indicates no linear relationship between the two variables. The coefficient of determination for this analysis is known as R squared which provides a value by standard unless otherwise adjusted between 0 and 1 with 1 indicating a great fit from the data that provides significant explanation, and 0 indicating no explanation between the varying data. The level of significance was set a 0.5 for the study. To conduct the linear regression analysis a web application (Stats.Blue.) was utilized.

Table 1. Sample length measurements and leaf data collected for damage abundance.

Branch	Length(cm)	d leaves by browi	Total leaves	Abundance(%)
1	12	3	10	30
2	20	2	61	3.3
3	15	6	21	28.6
4	11	3	3	100
5	8	4	5	80
6	19	4	32	12.5
7	4	4	4	100
8	13	2	19	10.5
9	17	2	42	4.8
10	23	0	50	0
11	7	2	21	9.5
12	14	2	7	28.6
13	15	4	26	15.4
14	13	7	17	41.2
15	13	1	9	11.1

Results

Branch size dependency of susceptibility to fungal pathogen damage

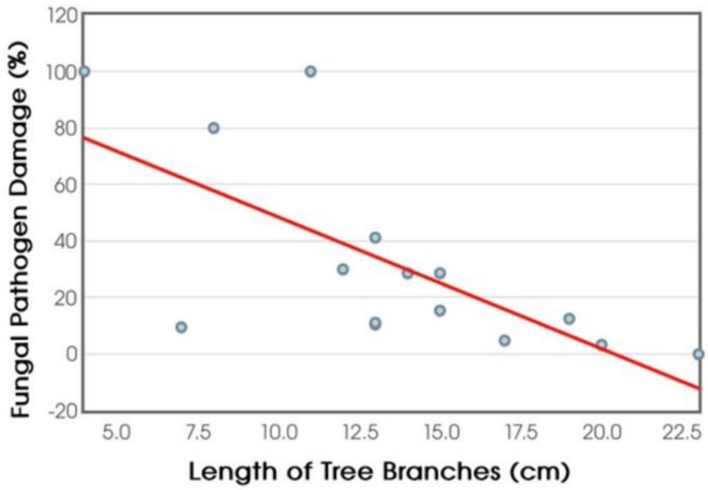

Figure 2. Results of linear regression analysis displaying the relationship between the length of tree branches and the percent cover of damage caused by fungal pathogens.

15 samples were analyzed from the observed *Tecoma stans* to understand the relationship between the length of the branches and the abundance of fungal pathogen damage to investigate how the factor of size impacts susceptibility to such damage (Table 1.). The branches varied from four to twenty-three centimeters in length. The percent coverage for the total amount of leaves per branch range from zero to one hundred percent.

Overall, there was a negative trend between the tree branch lengths and the percent cover of brown curling. The regression analysis results (Fig 2.) found moderate significance for explanation of the relationship between the branch length and the abundance of fungal pathogen damage with an r^2 value of 0.5 explaining exactly 50% of the variation. This half of the samples that could be explained presented a negative correlation ($r = -0.7$) between the length of the branches and the abundance of fungal pathogen damage. This negative r value indicates that as the length of tree branches of the *Tecoma Stans* increase, the abundance of fungal pathogen damage on the leaves of each branch decrease.

Discussion

In this study, I initially predicted that the branches shorter in length would have a higher abundance of brown curling damage present on their leaves compared to the branches with longer lengths. The model standing for this prediction can be seen in the introduction (Fig. 1). If the results support the prediction, then the expected outcome should present a negative relationship between the branch lengths, small to large, and the percent cover of damaged leaves per branch decreasing, respectively.

The results of this study found a negative relationship between these two variables, supporting this prediction. I concluded from the r squared value of 0.5 that there is moderate support that explains that the length of the plants branches is a factor of the *Tecoma Stans* susceptibility to fungal pathogen damage. Though most of the data followed the direction of the prediction, there was still data from the study that did not align with the predicted relationship and could not be explained by the statistical analysis.

Looking towards the future and how I would expand on the completed study to further understand the antagonistic relationship between Pathogenic herbivores and plants would be a broader look on the different ways that microbial species attack the *Tecoma Stans.* Fungi can directly attack or indirectly damage plant tissues through an insect vector. This damage can present not just in brown leaf curling, but in patches or blotches of white or brown spots on leaves.

Literature Cited

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