To What Extent is the Severity of Oak Tatters Affected by the Trees' Proximity to an Agricultural Field?

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Research Article

Received: 01-Apr-2021, Manuscript No.JEAES-22-001-PreQc-20;**Editor assigned**:03-Apr-2021,PreQCNo. JEAES-22-001-PreQc-20(PQ); **Reviewed:** 17-Apr-2021, QCNo.JEAES-22-001-PreQc-20; **Revised**: 01-Apr-2022,Manuscript No. JEAES-22-001-PreQc-21 (R); **Published**: 17-Jul-2022, DOI:OI:10.4172/23477830.10.05.004

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Keywords: Oaks; Agricultural field; Photosynthesis; Leaves; Herbicides

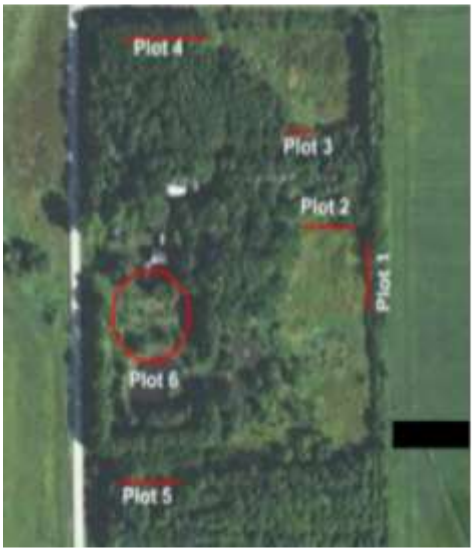
ABSTRACT

Oak tatters affect trees across the Midwest, but especially so in Iowa, because oak forests are the more predominant type in the region. The exact cause of the tatters is unknown, but one possibility is the use of herbicides on agricultural fields. While the tatters themselves do not cause tree death, the resulting energy loss has the potential to render the tree more susceptible to things like diseases or other pests, which can lead to death. Oak trees are relied upon by many animals, like squirrels, birds, raccoons, and many more. Without a strong presence of oak trees, those animals face a depleted food supply, and the ecosystem as a whole suffers. Over the course of approximately a year, three separate studies were done concerning oak tatters. The first study compared the average severity of oak trees in six plots at one site, and the second study looked at how tatters vary when kept at multiple sites. In the second study, an extension of the first, the trees were observed from the planting of the acorns, allowing for observation of the tatters' effect on the oaks from the beginning of the trees' life. Results from three field studies and a personal experiment showed a positive correlation between distance and severity: the closer the oak trees were to an agricultural field, the more severe the tatters were likely to be.

INTRODUCTION

Imagine a world without oak trees. Although that example may be drastic, today's oak trees are facing a real threat: tatters. In this condition, the leaf buds normally, but leaf tissue dies and falls off. Due to the reduced surface area of the leaves, photosynthesis cannot happen at an optimal rate, so the trees grow new ones to compensate for the damage[1]. Doing so depletes their energy storage, inhibiting the tree's ability to fight off other pests or diseases. The trees are then more susceptible to other pests and diseases that may kill the tree, so while the oak tatters specifically do not cause tree death, the resulting energy depletion makes the trees more susceptible to things that do. Right now, one of the leading candidates for the cause of oak tatters is herbicide use, but more research is required in order to reach a definite conclusion. The null hypothesis of this study states that there is no significant link between the distance of the oak trees from an agricultural field and the average severity of oak tatters. The first study, a field study, looked at six individual plots at one large site, and compared the average severity of the tatters in each plot; in total, 112 red, black, or bur oaks were examined[2]. The same plots, as well as one additional one, were examined during the second field study. A personal experiment allowed for the observation of tatters from the very start of the oaks' lives, as well as an ability to see how the trees were affected by tatters depending on how far away they were from the field: similar to the first study, but on a larger scale[3]. I was able to widen the scale because not only were the six original plots used, but more were introduced, increasing the sample size. When I began this research, I did not know very much about what oak tatters were, because this issue is not widely discussed outside those researching it. I did a lot of background reading in order to gain a better understanding of the topic, so I could identify areas I wanted to emphasize in my own work. After learning more about what tatters are, I was then able to set up my studies and experiment in ways that would allow me the best access to the information I needed. I was able to extend the work done by prior researchers because while a lot of the background research I did focused on examining the relationship between the presences of herbicides on the presence of oak taters, my work took it one step further Figure 1[4,5].

Figure 1. The map shows where each plot was there as well as the approximate size and coordinates were covered when measuring distance from a field, the field closest to each plot was the one used.



MATERIALS AND METHODS

The materials used in both studies are quite similar. In the first study, a rating system from 1-5 was used to asses tatter severity. While a rating system from 1-3 was considered, the 1-5 range was chosen because of the more specific and precise observations and calculations it would yield. A 1 indicated minimal damage: most of the leaves were unaffected. A 3 meant approximately 50% of the leaves were affected, andA 5 was maximum damage: almost all of the leaves were affected, giving the tree a shriveled, "tattered" appearance. Six plots were chosen throughout the 22 acres that make up the Black Hawk Wildlife Rehabilitation Center (BHWRC), due to the oak population in each plot and their proximity from a nearby agricultural field. During field observation, there was no way to manipulate variables because the oaks had already been growing there for years, and the tatters had already "taken hold" at that point. Thus, observation was the only way to collect data. While observing oaks at the BHWRC, the severity of tatters in each tree was noted, as well as the approximate height of the tree, and the distance of the whole plot from the nearest agricultural field.

Figure 2. This is how data was collected in each study, as well as what the location of each piece of information means.

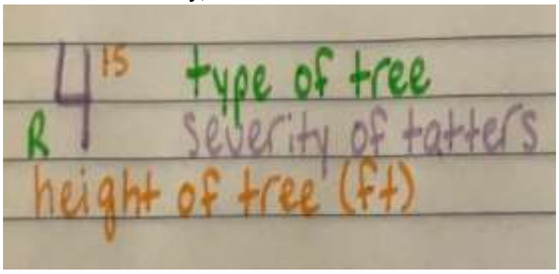


Figure 2 shows three of the four pieces of information that were recorded about each tree during the first study. The fourth piece of information is the plot each tree belongs to, but this was not recorded for each individual tree: when recording data, the information about each plot was kept separate from the others. After all of the data was collected and sorted by plot, an ANOVA test was run, to compare the mean severity of all six plots. Next, t-tests were used to compare only two plots at a time. During this study, the calculations were done with the help of an online statistical calculator; first by number (1 and 2, 2 and 3, etc.), and then by characteristics specific to each plot. For example, tests were done to compare the plots with the highest and lowest severity and the plots closest and farthest from a field. The first study, conducted in 2017, was based on field observation. I collected data and made observations concerning the severity of the oak tatters, and conducted statistical calculations based on my data. Study 1 was somewhat limited due to the fact that I was unable to manipulate any variables, because I was observing changes that had already taken place and had no way to alter or stop them. However, in Study 2, conducted in 2018, I was able to do both field observation and a personal experiment. Running my own experiment provided me with the opportunity to manipulate variables. Initially in the second study, 65 acorns were planted in 4 different planters, with the goal of keeping each planter at a different site. Planter 1 was to stay in the classroom as the control group: it was the most isolated from the outdoors because it would be kept inside all day every day. Planter 2 was move to my house, which is in a relatively urban area and kept the oaks far away from any herbicides. Planter 3 was to be sent to the BHWRC, which from the first study is known to be heavily impacted by tatters. Plot 4 was going to go to a friend's house, which is closer to agricultural fields than my house, but not as close as the BHWRC. However, in early May, two planters were knocked over and the sprouting trees destroyed. The ramifications will be discussed later on, but to adjust I replanted any remaining acorns into planter 4 and made tha- t my new control group. Planters 1 and 2 were kept at my grandma's place , which is in the same urban area as my own, and planter 3 was sent to the BHWRC. Approximately a week after the planters were readjusted and the oaks were replanted, the new control group died. At this point, approximately 3/4 of the oaks had died, extremely limiting my sample size. I was able to collect data from the two planters at my grandma's house , as well as the BHWRC, so not all was lost, but making comparisons was difficult. At the BHWRC, in both studies, the same six plots were observed, as well as one additional one in Study 2. month difference in start time was beneficial, because in the second study, there was not yet any discoloration or leaf loss due to the start of fall, so identifying the causes of damage (tatters, insects, or something else) was much easier. Following the data collection, an ANOVA test was run, again followed by t-tests for more specific comparisons.

RESULTS AND DISCUSSION

In year 1 after collecting and organizing my data, I did an ANOVA test in order to compare the mean severity of all plots at once. For year 1, this yielded an F value of 22.7058 at a p value of 0.0000 (Figure 3,Table 1).

Figure 3. The graphs serve as a visual representation of the information in the table from experiment done in year 1.

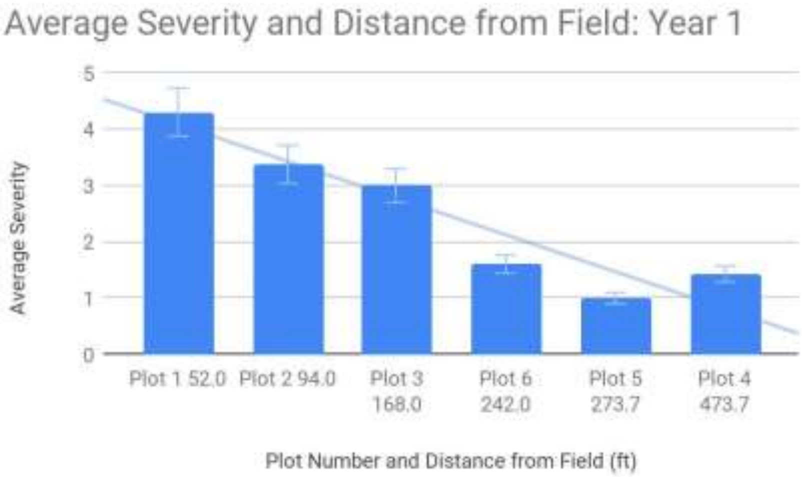


Table 1. The table shows the distance of each plot from the nearest agricultural field as well as the average severity.

Plot Number	N (Sample Size)	Distance from Field (feet)	Average Severity
1	16	52	4.31
2	26	94	3.38
3	14	168	3
4	16	473.67	1.43
5	7	273.67	1
6	15	242	1.6

The F value is the significance of the results: in other words, how much of a statistical difference is there between the means. The p value is the degree of certainty, or how sure one can be of the results of the calculation[7]. In this case, having such a high F value of 22.7058 at a p value of 0.0000, I concluded that there is a highly statistically significant difference. I rejected my null hypothesis, because the difference led me to conclude that there is a difference in severity when the plot's distance from a field varies. In year 2, I did the same thing. First, I did an ANOVA test without the additional pond plot. This test yielded an F value of 13.1578 at a p value of 0.0000. The F value is not as high as last year, because overall, the means were much closer together than in Year 1. The oaks were not as badly affected by tatters in 2018 as they were in 2017. When I included data from the additional plot, the F value decreased again to 11.0411, while the p value remained 0.0000. In both years, despite the addition of a new plot, my F value remained very high with a very low p value, so I was able to reject my null hypothesis; both years, I concluded that there is a relationship between the severity of tatters and the distance from an agricultural field. My rejection was further reinforced by the trendline on Figures 4 Table 2 (from the first and second year, respectively) because as the plots became farther and farther away from the fields, the average severity of the tatters decreased overall.

Figure 4. This data was collected during field observations collected in year 2.

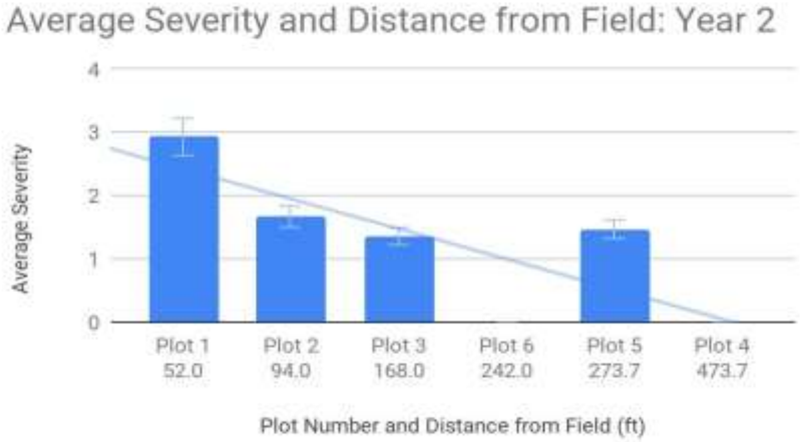


Table 2. Year 2: It is worth noting that this year,the average severity wasmuch lower in every plot except plot 5.

Plot Number	N (Sample Size)	Distance from Field (feet)	Average Severity
1	16	100	2.93
2	26	105	1.6
3	14	168	1.364
4	16	473.67	0
5	7	273.67	1.476
6	16	242	0
Pond	2	473.67	1.5

The trendline further emphasized that there is a relationship between distance and severity: the closer the oaks were to a field (and subsequently the herbicides applied there) they were to be affected by tatters. This relationship holds true for both studies, even though across all six plots, the tatters were less severe in year 2 than in year 1. An ANOVA test for year 3 yielded an F value of 20.9993 at a p value of 0.0000. This is a higher level of statistically significant difference than the second year, but not as much so as the first year. The means are farther apart than the second year; that is to say, there was a wider range in mean severity across the site. This test enabled me, for the third year in Figure 5 Table 3 a row, to reject my null hypothesis. The trendline again shows that as the plots become farther and farther from a field, the mean severity decreases, allowing me to reject my null hypothesis. After the ANOVA test was run and the null hypothesis rejected, t-tests were done to compare more specific aspects of each plot[8].

Figure 5. Plot Info for Year 3. This year, the pond plot was not observed. This year, the average severity was higher than the previous year, but not as high as the first year.

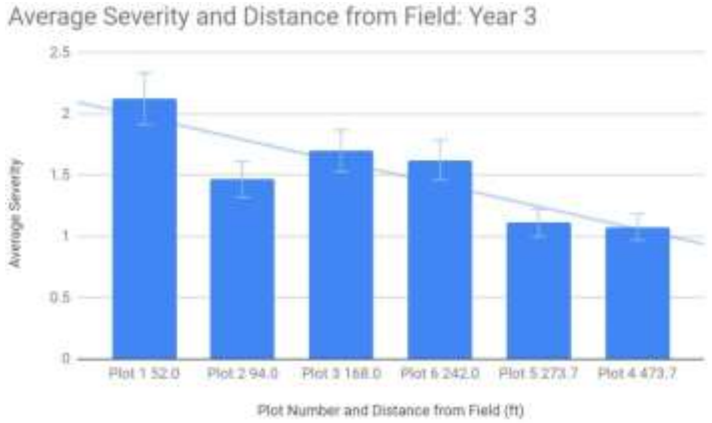
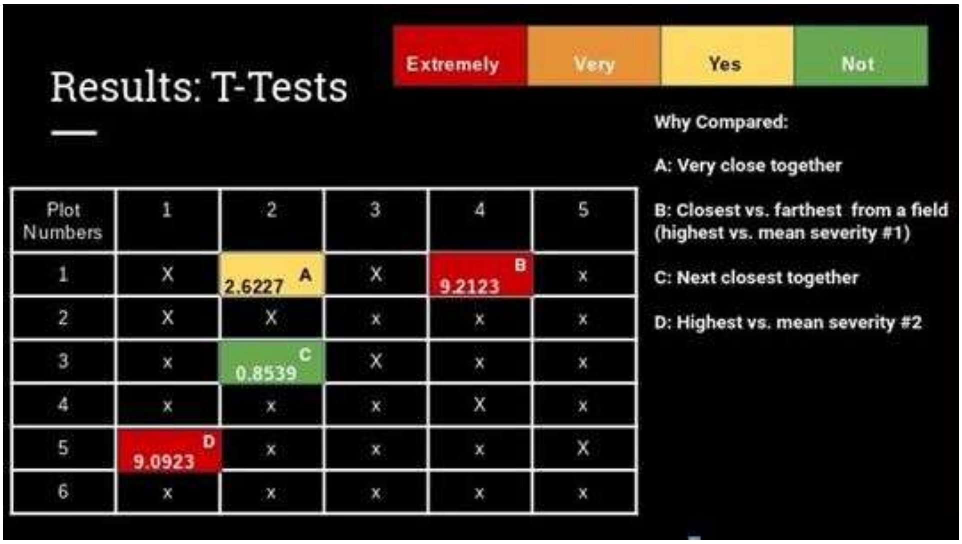


Table 3. Plot Info for Year 3. This year, the pond plot was not observed.

Plot Number	N (Sample Size)	Distance from Field (feet)	Average Severity
1	16	100	2.125
2	26	105	1.467
3	14	168	1.7
4	16	473.67	1.077
5	7	273.67	1.111
6	16	242	1.625

The ANOVA revealed that there was a statistically significant difference among the means, but was unable to show which mean was causing the difference. The t-tests allow for a closer comparison of specific plots, resulting in a more in-depth analysis of the data. In Figure 9, the t-tests revealed varying levels of statistical significance between the means. Despite the small difference in the distance between Plots 1 and 2 and the closest field, there was a significant difference in the mean severity of both plots. The most statistically significant value was test B: plots 4 and 1 were equidistant from a field, but had the t value for that test had the highest level of statistical significance. The number in each test's box is the p value, or the significance of the difference between the two means. A higher p value indicated a higher level of significance: in other words, the higher the p value, and the larger the difference between the means. Test B, which compared the plots closest and farthest from a field, was the most statistically significant. This test supports the conclusion I came to in my ANOVA test, further rejecting my null hypothesis. From year 1 to year 2, the most obvious change is the increase in statistical significance [9]. This year, plot 5 no longer had the lowest mean severity- both plots 4 and 6 were unaffected by tatters and there had a mean severity of 0. Last year, plot 6 was not included in any specific calculations, but was included this year due to its change in severity. The test comparing the plot closest to an agricultural field to the one farthest from one was again extremely statistically significant, supporting the conclusions from my ANOVA test two years in a row. In my experiment, which was conducted during Year 2, the oaks I planted were affected by oak tatters. As mentioned before, my sample size was extremely reduced by external factors, but I was still able to cultivate a small portion of the total number of oak trees I planted.(Figure 6)

Figure 6. T-test Results. The box color shows the level of statistical significance and the letter indicates the plots



CONCLUSION

The oaks I observed were kept in an urban area far away from any agricultural fields, yet were still affected. There was damage to some leaves that was unrelated to tatters: something else was affecting them, but I was unable to determine exactly what it was. The tatters I observed on these oaks were somewhat severe; they received a rating of 3 on the 1-5 scale. In all of my calculations this year, I did not include data from the pond plot; it was added in the second year and therefore could not have been included in any calculations I did in Year 1, because I did not examine that plot during my first year. It was not observed in Year 3 and therefore not included in any calculations in that year either. In Year 3, the most statistically significant tests compared plots 1 and4 , 1 and 5. Plot 1 is the closest to a field and has consistently been the most severely affected by tatters. Plots 4 and 5 are the two farthest from a field, and are the two least severely affected. In Year 3, plot 5 was no longer the least severe and was replaced by plot 6, leading to an additional test. The tests comparing the plots closest to and farthest from an agricultural field were the most statistically significant for the third year in a row, so I was again able to use t-tests as another way of rejecting my null hypothesis.

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