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Initial Report

September 2017

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Oak testing:

Two year old Shumard oaks (*Quercus shumardii*) were transplanted in February 2017 from 30 gallon pots to 50 gallon pots. The soil that was used was a standard potting soil mixed with vermiculite at a 4:1 ratio. Ten trees (the control group) were transplanted into this unaltered soil. The next ten trees were transplanted into a soil that had a common fertilizer (NPK: 13-13-13 [T-13]) mixed into the soil at a rate of 5.5g/gallon (comparable to the rate of NPK in the final treatment). This T-13 treatment also served as a positive control. Finally, the MitoGrow Pellet 3-IA product was mixed with a fertilizer that had an NPK of 8-8-8 such that the Pellet 3-IA was 2.50%, by weight, of the fertilizer blended into the soil for these final ten trees. The rate of the Pellet 3-IA/fertilizer blend was 9 g/gallon. Thus the Pellet 3-IA/fertilizer treatment and the T-13 treatment had the same effective fertilizer weight by soil volume thus the only difference in products was the Pellet 3-IA product.

Half (five trees) of each of the three treatments were placed in a controlled greenhouse environment and the other half were placed outside in ambient conditions. Trees in both locations were watered/irrigated daily. After transplanting in February 2017, Louisiana Tech measured the diameter one inch above the soil line and the height to the tallest shoot and these measurements were repeated on July 26, 2017. Furthermore, very quickly after transplanting and with the emergence of new foliage in the spring, there was a color difference among the leaves. Because of this, Louisiana Tech also measured the leaf reflectance to quantify the pigment change.

Overall, both the Pellet 3-IA/fertilizer blend and the T-13 treatments produced healthier looking, dark green foliage. Though the occurrences were low (two trees), only the T-13 treatment produced dieback which may have been caused by over availability of fertilizer even though the application rate was not outside of generally accepted application rates for these trees. When no fertilizer was added, leaves generally had a light yellow tint (Figure 1). While it was difficult to visually see a color difference between the two fertilizer treatments, Louisiana Tech measured a specific reflectance wavelength at

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510nm (green) which is specifically associated with the color dark green and the reciprocal of this reflectance wavelength in leaves is associated with total pigment content. Louisiana Tech found that when analyzing this specific wavelength, the Pellet 3-IA/fertilizer blend treatment statistically different and greater than the other two treatments, so, as such, the Pellet 3-IA/fertilizer blend would be expected to have a higher pigment content which was also visibly observable by the Louisiana Tech researchers. .

Another apparent difference between the two fertilizer treatments was an increase in foliage throughout the stem, which allows for the potential of greater photosynthetic capture which should result in accelerated future growth. Both visual, observable differences and measured wavelength differences occurred with the Pellet 3-IA/fertilizer blend in both growing conditions, the greenhouse as well as ambient conditions, thereby indicating that the Pellet 3-IA/fertilizer blend has the same overall impact on trees across these two very different growing conditions.

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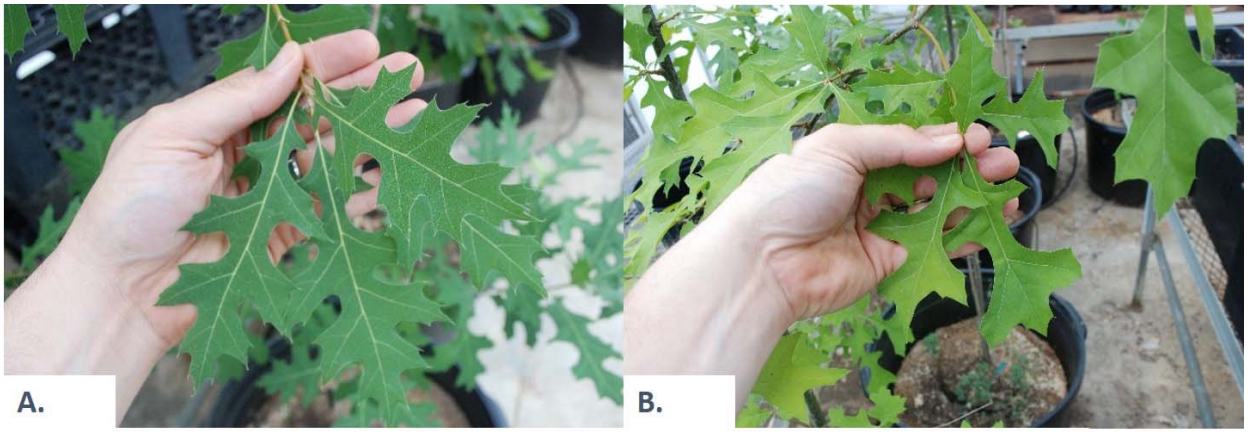

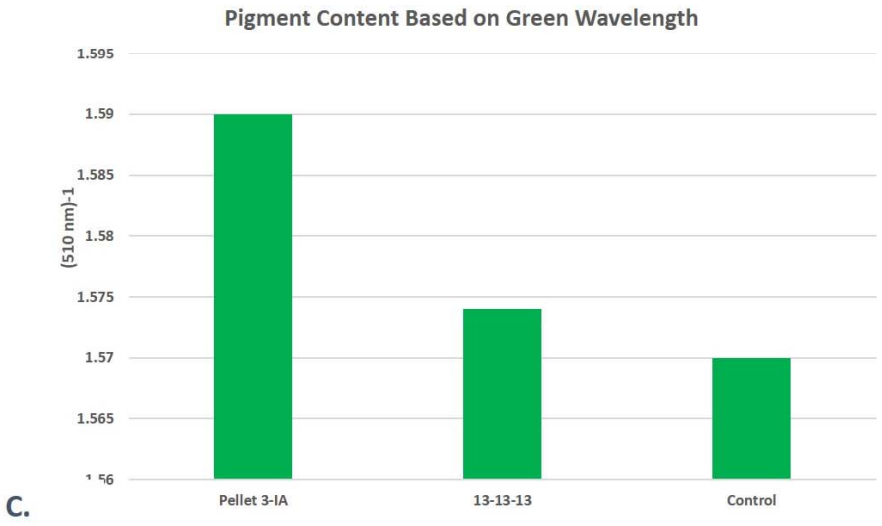

Figure 1. A typical leaf of either fertilizer treatment (A) or the no fertilizer control (B) had visibly different colors and, with a spectrometer, Louisiana Tech was able to detect the green wavelength differences (C).

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Increases in photosynthetic capacity are not always indicative of a current year's growth in the oak species. Many times, these trees will use the increased capacity for rapid growth during the following year's growth. However, Louisiana Tech did detect growth differences after the first five months of treatments. The diameter growth was higher for both fertilizer treatments than the control group. There is not a large statistical difference between the two treatments, though the Pellet 3-IA/fertilizer blend treatment did generate the largest average diameter growth overall at 0.21 inches. Additionally, Louisiana Tech detected a difference in overall height growth for the Pellet 3-IA/fertilizer blend treated trees which grew over 2.5 ft taller than the T-13 treatment on average. This is attributed to seedlings in the T-13 treated soil exhibiting dieback in several cases that we attribute to possible fertilizer scotch (Figure 2).

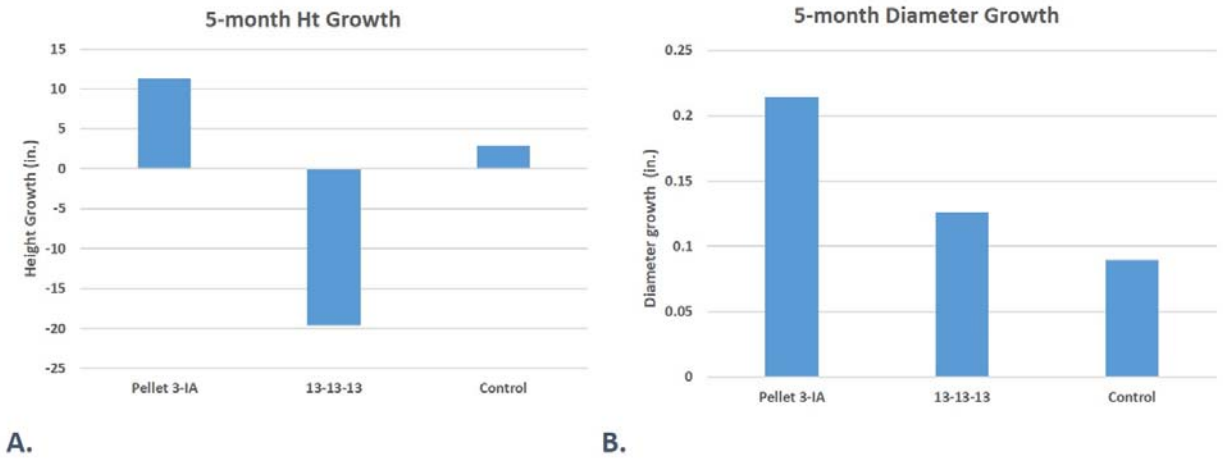

Figure 2. Growth after 5 months of (A) height across soil treatment and (B) height across soil treatment. Decrease in height are attributed to dieback in the 13-13-13 treatment grown outside had two trees with substantial dieback.

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Louisiana Tech also took acorns that were collected around the campus from the same oak species and sowed them into the same three soil treatments. Louisiana Tech planted acorns in February 2017, with 70% germination. After observing no further germination for several weeks and with the seedlings more than an inch tall, with fully formed leaves, Louisiana Tech began a water stress test.

The soil for all seedlings was kept moist until this point but then Louisiana Tech halted watering in early May 2017 to stress the new seedlings for approximately three days, at which point the water volume approached 0% in the control group pots (the lowest measured value was 0.8%), at which point one would expect plants to approach the permanent wilting point.

Louisiana Tech then began watering daily again to observe recovery results. A research assistant visually graded the seedlings on a four-point scale in late March, late June, and early August 2017. Seedlings were given a “1” if there was no apparent damage, “2” for slight damage, “3” for severe damage, and “4” for death. Thus, the closer the overall score was to “1” the better the treatment performed in maintaining seedling health.

Across all four sampling times, approximately 4 months after the removal of water, both fertilizer treatments had seedlings that recovered favorably after reintroducing water. While not statistically different, the Pellet 3-IA/fertilizer blend seedlings recovered slightly better in May and maintained a slight superiority into September over the control and T-13 seedlings (Figure 3a).

More differences in response were evident when looking exclusively at mortality during each monitoring period. The two fertilizer treatments were far superior with respect to seedling survival, with over an approximate 60% reduction in mortality (Figure 3B). During the first observation, the two treatments had both relatively low mortality rates, with the T-13 slightly superior. However, in the succeeding months, the Pellet 3-IA/fertilizer blend treated seedlings maintained survival at a better rate. Furthermore, seedlings grown in the Pellet 3-IA/fertilizer blend amended soil had healthier seedlings that maintained dark green foliage (Figure 3c).

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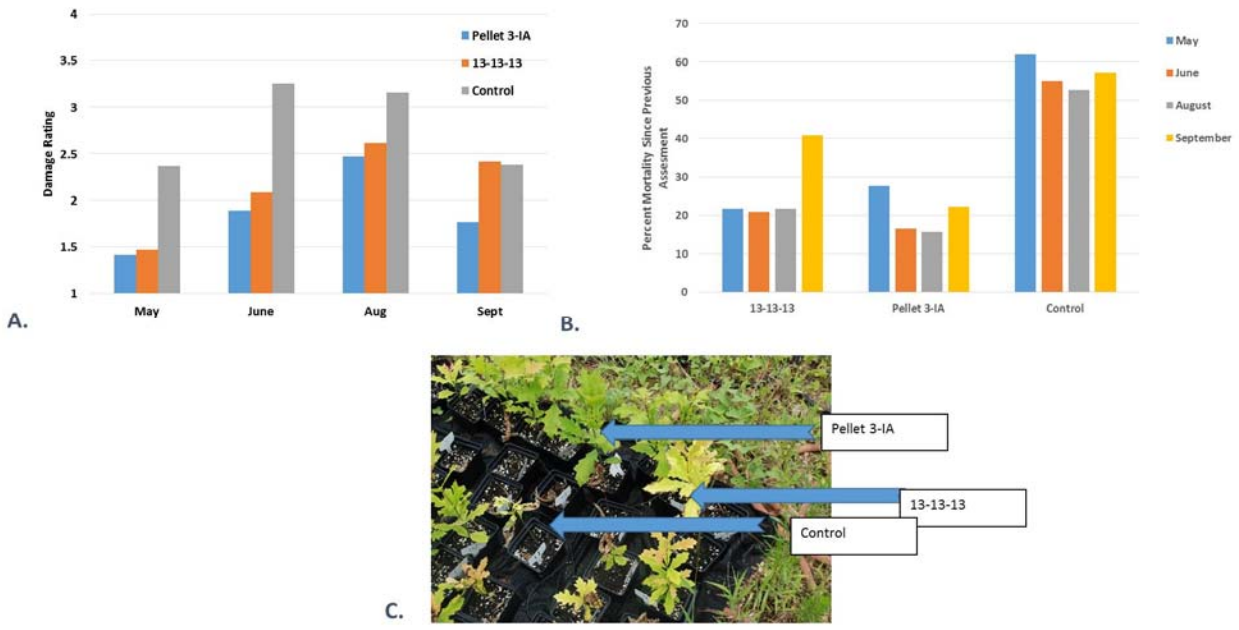

Figure 3. Seedlings were monitored for three months, post water deprivation. (A) Damage scores were monitored each month ranging from 1=no damage to 4=death. (B) Percentages of dead seedlings were also calculated since the previous period. (C) Seedlings also had visible foliage differences after water deprivation.

Louisiana Tech also harvested the seedlings after the September observations. Root collar diameter was measured with a caliper and variables of the root system were measured using a WinRizo scanner and software. Variables including average root diameter, average root length, surface area, and number of forks were calculated based on these root scans.

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In every variable, oaks that were grown in the Pellet 3-IA/fertilizer blend produced averages that were between the T-13 and control group seedlings. For instance, the T-13 had the largest surface area root diameter, and root collar diameter but the lowest number of forks. This indicates that the T-13 treatment causes the oaks to invest resources in the tap root, while having little forking to the lateral roots. On the other hand, the control group had the smallest root systems with respect to the same variables, but exhibited the most forking. The Pellet 3-IA/fertilizer blend seemed to keep the seedlings in the middle for all of these variables. By generating this ratio of root growth in the Pellet 3-IA-fertilizer blend seedlings, both the tap and lateral roots may have aided in the recovery performance of the seedlings using the Pellet 3-IA/fertilizer blend.

In summary, for the use of the Pellet 3-IA/fertilizer blend as a soil amendment, there is early evidence that the product is much better than no fertilizer, but it is also better overall than simply using a standard 13-13-13 fertilizer. This conclusion was most pronounced in the two-year old sapling study, in which the Pellet 3-IA/fertilizer blend trees grew larger but also did not exhibit any die-back that one associates with fertilizer "burn" that was observed for two trees in the T-13 trees. Indeed, the diameter of the two treatments appeared close, but the growth was measured on the re-shoots on the "burned" trees. As well, among both saplings and seedlings, the trees growing in the Pellet 3-IA/fertilizer blend soil had more lush foliage, so based on all of these empirical results, Louisiana Tech would expect the differences among the treatments to be even more profound during next year's growth season.

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