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# Individual and Interactive Effects of Polyester Microplastics and Naproxen-Sodium on Lactuca Sativa Growth and Development and Soil Abiotic Conditions

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# Individual & Interactive Effects of Polyester Microplastics and Naproxen-sodium on *Lactuca sativa* Growth and Development and Soil Abiotic Conditions


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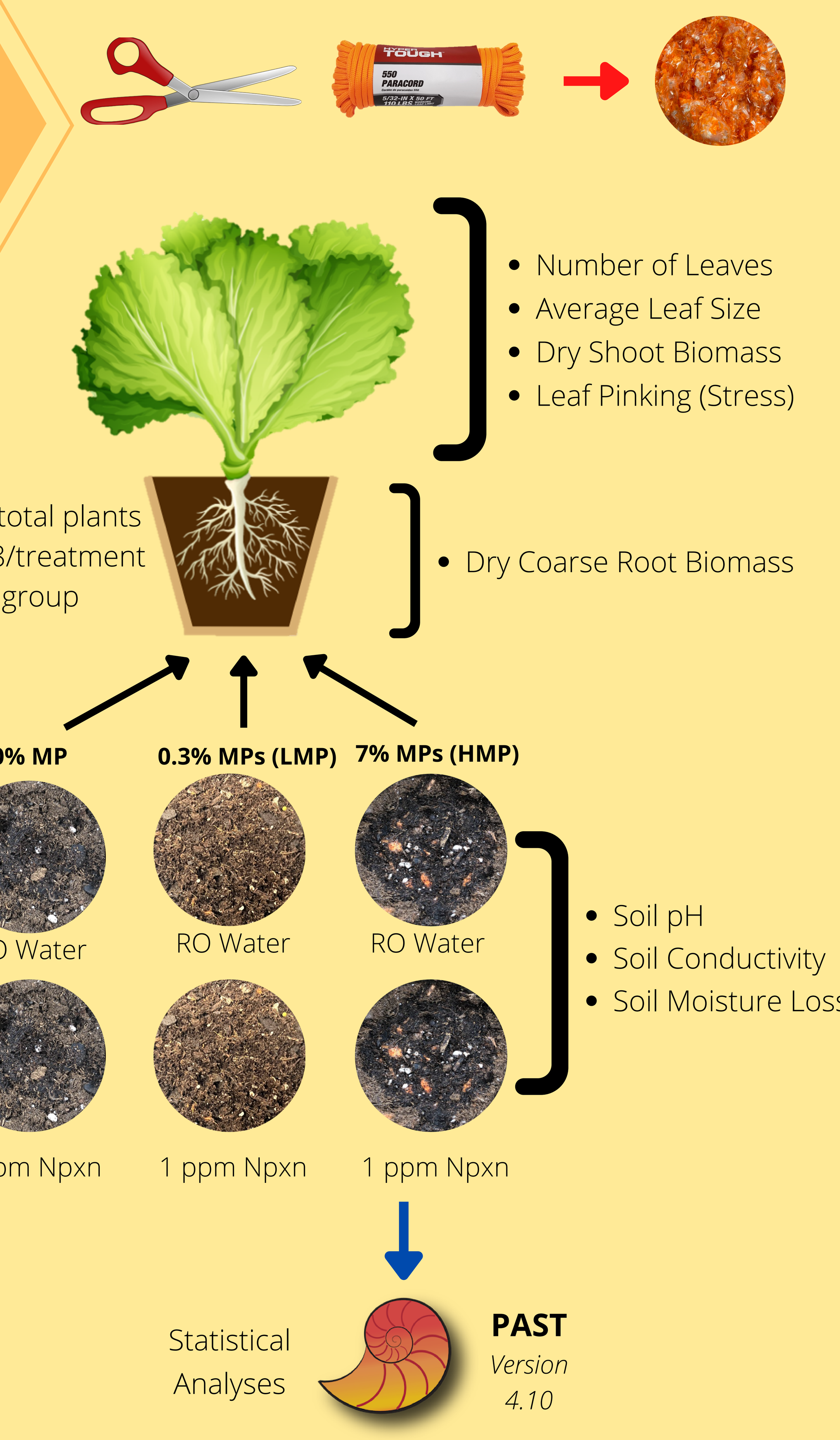
## What We Asked

Do **microplastics** (MPs) and **naproxen-sodium** (Npxn) contamination individually & interactively affect ***Lactuca sativa* growth** and **development** and **soil abiotic conditions**?

## Why We Asked

Formed from the degradation of larger plastics, **MPs** (<5mm) **contaminate soil**, especially in **agricultural settings. Npxn** contamination is common in municipal & natural water supplies from lack of filtration. Few literature shows the **individual + combined** effects of MPs and Npxn on **terrestrial ecosystems**.[1-3]

## How We Did It




## What We Found

Control (Ctrl) Naproxen (Npxn) Low MP 0.3% (LMP) LMP/Npxn High MP 7% (HMP) HMP/Npxn

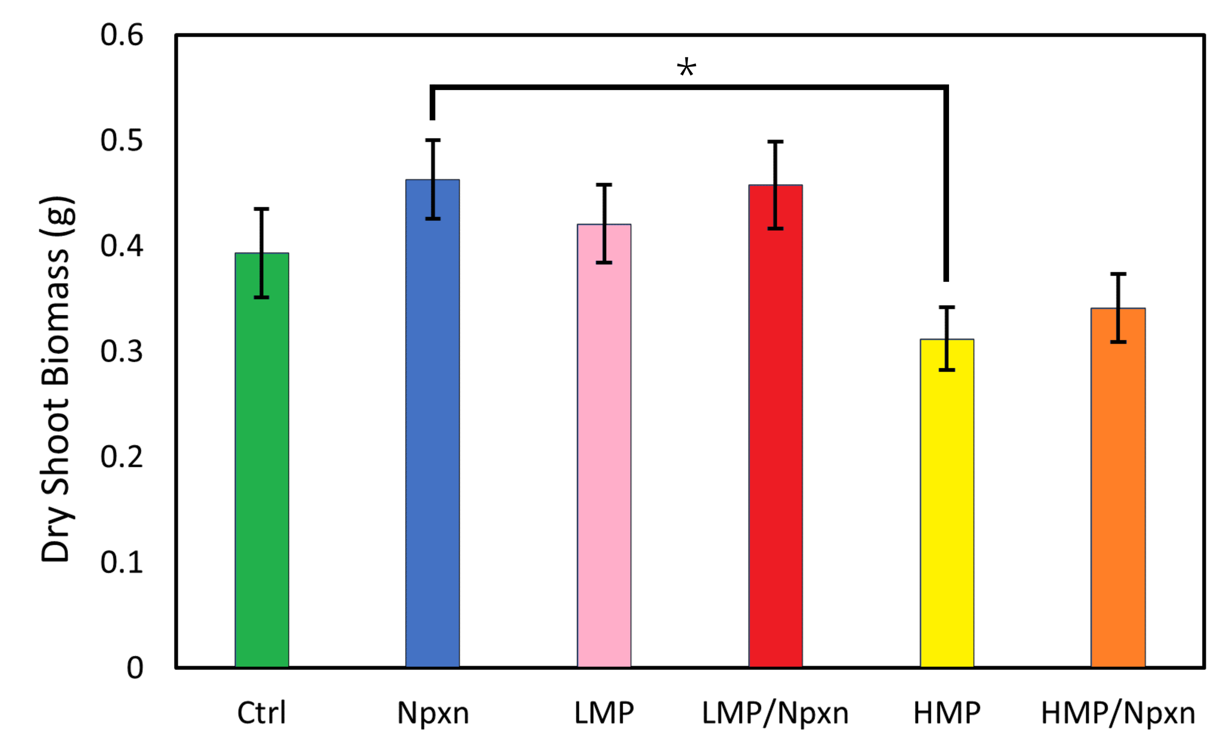



Figure 1. **Bar graph showing average dry shoot biomass.** Averages ± 1 SE are shown. N=18 per treatment group. One way ANOVA with Tukey's pairwise test, p=0.01637. Lines connecting bars together with an asterisk on top indicate a significant difference.

**Takeaway:** Biomass does not differ significantly across groups. This means that the plants are spreading out their mass in different ways, like making leaves thicker instead of longer (ie. more waxy cuticle to prevent moisture loss).

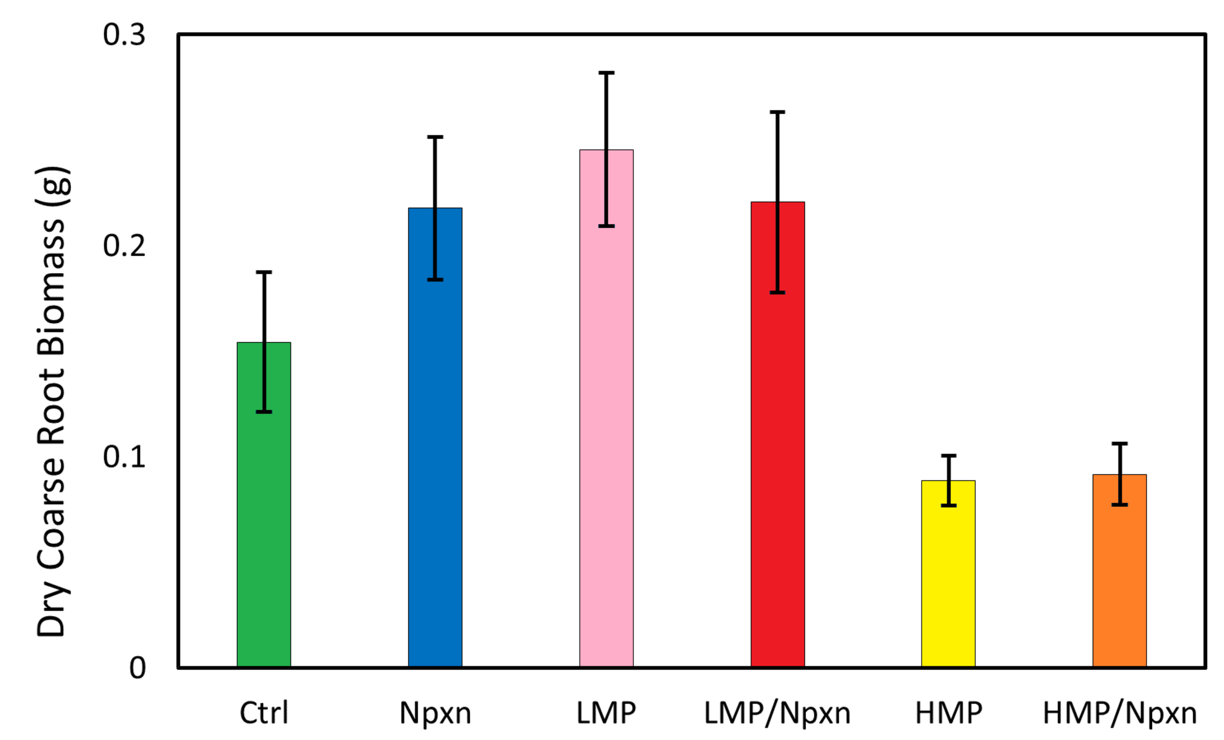



Figure 2. **Bar graph showing average dry coarse root biomass.** Averages ± 1 SE are shown. N=16 for HMP, N=18 for the rest of treatment groups. One way ANOVA with Tukey's pairwise test and square root transformation, p=0.0004283. Difference between: (Npxn, LMP) & (HMP, HMP/Npxn); LMP/Npxn & HMP/Npxn.

**Takeaway**: HMPs reduce coarse root formation, which may impede the plant's ability to anchor into soil and support itself, and thus may increase soil erosion.

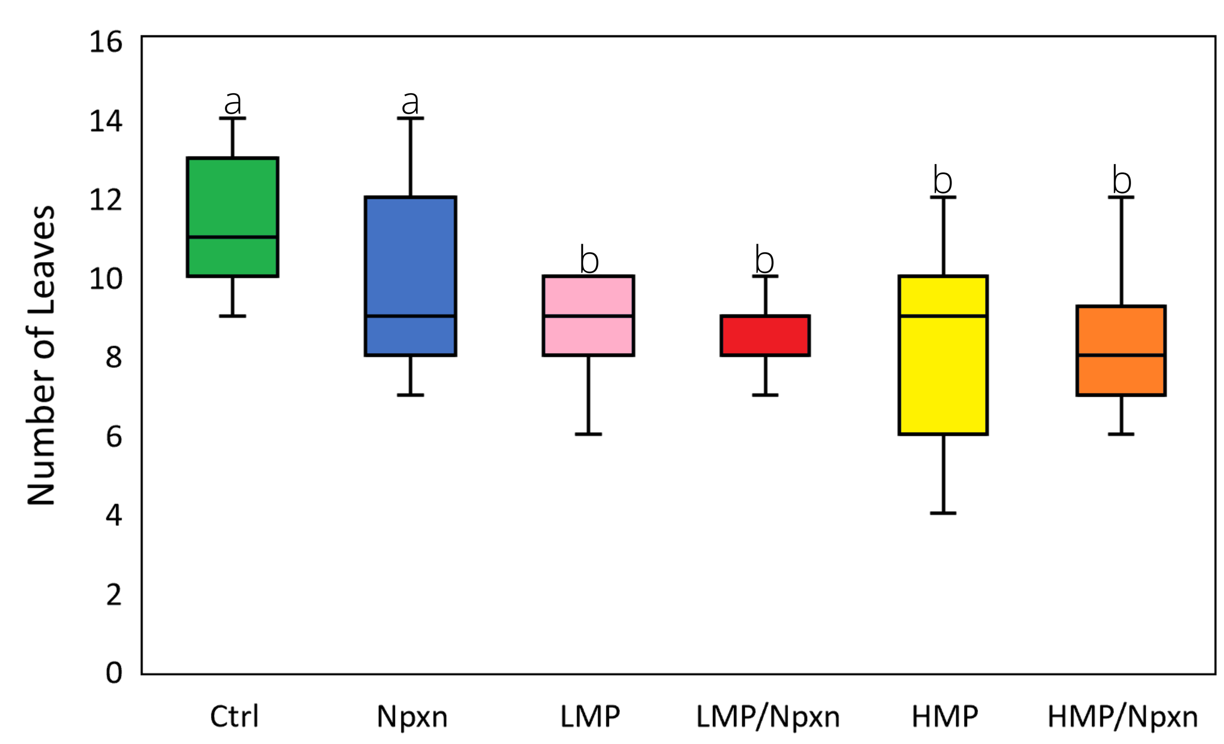



Figure 3. **Box and whisker plot showing number of leaves by treatment group.** Medians, first and third interquartile ranges, minimum values, and maximum values excluding outliers are shown. N=18 per treatment group. One way ANOVA with Tukey's pairwise test and square root transformation, p=2.347E-05. Different superscript letters between boxes indicate a significant difference.

**Takeaway:** Both MP concentrations decreased the number of leaves in lettuce. Leaves are the most economical part of lettuce and thus could mean reduce yield/profits.

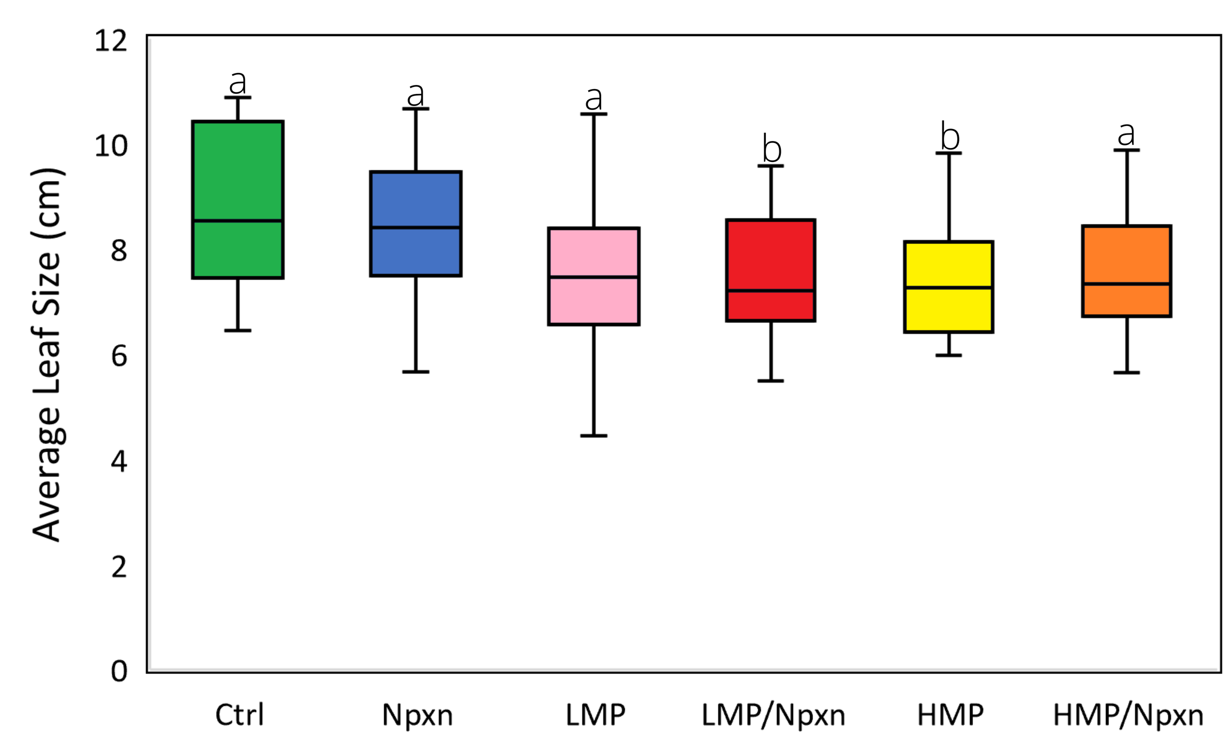



Figure 4: **Box and whisker plot showing average leaf size by treatment group.** Medians, first and third interquartile ranges, minimum values, and maximum values excluding outliers are shown. N = 18 per treatment group. One way ANOVA with Tukey's pairwise test, p=0.005385. Different superscript letters between boxes indicate a significant difference.

**Takeaway:** HMPs and LMP/Npxn significantly decreased leaf size in lettuce. Leaves are the most important part of the lettuce economically and could mean less yield/profit.

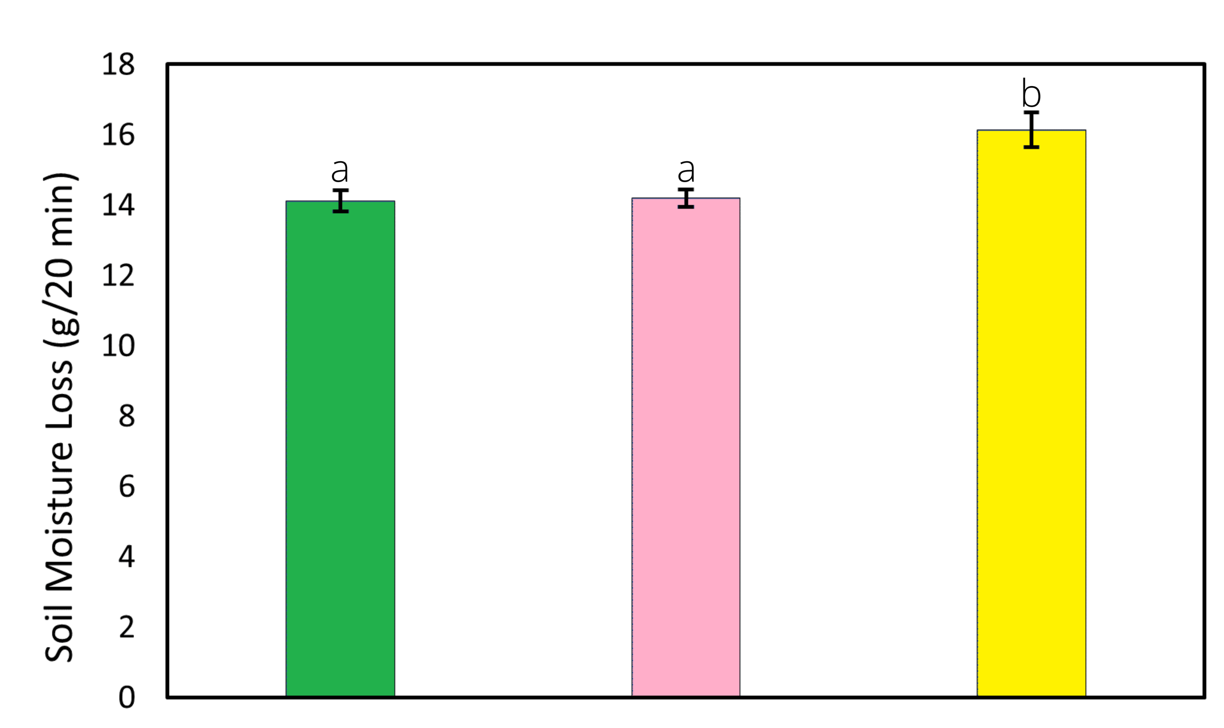



Figure 5. **Bar graph showing average rate of soil moisture loss by MP treatment group.** Averages ± 1 SE are shown. N=6 per treatment group. One way ANOVA with Tukey's pairwise test and log transformation, p=0.005385. Different superscript letters between boxes indicate a significant difference.

**Takeaway:** HMPs significantly increased soil moisture loss. This means there is less water available for the plants, thus making them wilt faster and leading to stress responses (i.e. pinking of leaves).

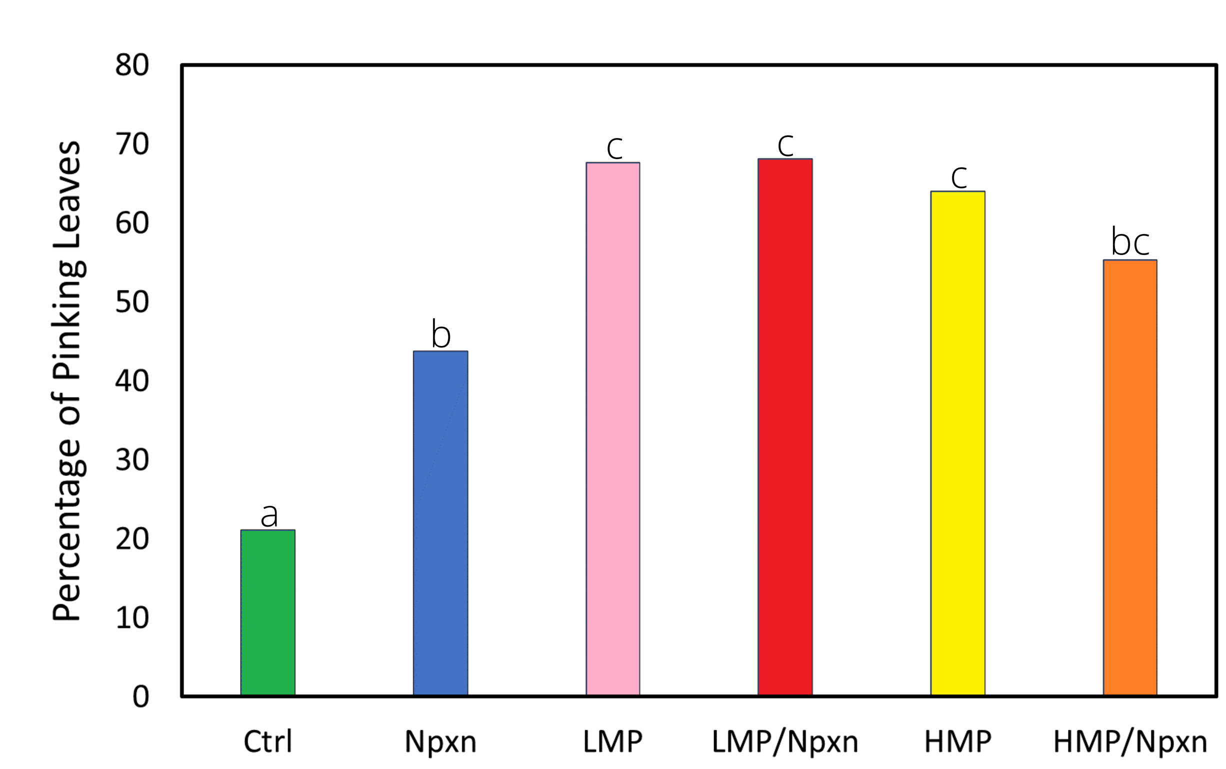



Figure 6. **Bar graph showing a percentage of leaves indicating oxidative stress by treatment group.** N=18 per treatment group. Chi squared test of independence and a pairwise chi squared post hoc test with Bonferroni correction, p=4.83E-25. Different superscript letters between boxes indicate a significant difference.

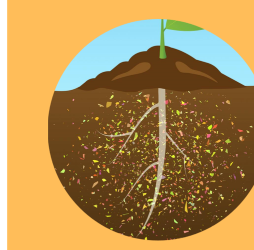
**Takeaway:** All treatments led green lettuce to discolor pink, meaning the plants are stressed and the leaves are possibly deteriorating. Consumers often buy produce by appearance, and pinking leaves could be commercially/economically less valuable.

## What It Means

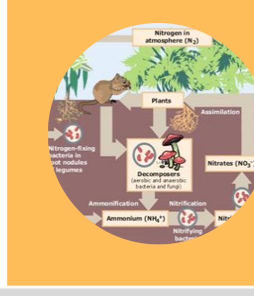
- HMP significantly **reduced number of leaves** & **average leaf size** but not dry shoot biomass
  - Observed thickening in HMP leaves; resource allocation: leaf thickening > leaf extension
- End of the experiment, HMP groups had significantly **greater percentage of pinking leaves** (sign of **oxidative stress**)
  - Possibly due to water stress availability caused by MPs and/or due to Npxn
- HMP significantly **decreased coarse root biomass**
  - Other research has shown MPs increase fine root biomass due to less soil aggregation
  - Coarse roots important for anchoring plant & soil
  - Less coarse roots & soil aggregation may result in more soil erosion
- Strong impact of HMP may have overridden any interactive effects of Npxn

## What's Next

Do MPs impact soil microbial communities & activity?



Do MPs accumulate in plant tissue?



Do MPs impact cation exchange capacity, soil nutrient cycling, and leaching?


## Who We Want To Thank

Taylor Hendrickson, lab preparator for BIOL 115, for setting up our equipment; Dr. Nicholas Buss (Hua Lab) for providing MPs preparation protocol; Irene Martinez (Sobel Lab) for providing protocol to measure soil pH; Binghamton University for providing funds for purchasing equipment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References