A compost application rate for sustainable hemp agriculture in Wisconsin

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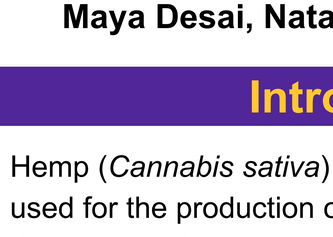
Introduction

- Hemp (*Cannabis sativa*) is an alternative crop that can be used for the production of fiber and cannabidiols (CBD).
- It was illegal to grow hemp in Wisconsin (1970-2018) resulting in a lack of research and loss of knowledge on agricultural production of hemp.
- Wisconsin farmers lack information on soil management actions necessary to grow hemp in a sustainable manner.[1]
- Compost amendments are known to positively influence soil quality and are considered one of the tenants of sustainable agriculture.[2]
- This experiment was conducted to determine a compost amendment application rate for hemp.

Methods

- The field experiment was a completely randomized design with 48 plots (10 ft^2).
- The soil on the plot is Billett series, coarse-loamy, mixed, superactive, mesic Mollic Hapludalfs.
- Treatments were replicated 12 times and included 0 (control), 5, 7.5, and 10 gallons (gal) of compost per plot.
- Treatments were applied and seedlings were transplanted from the UWSP-CNR greenhouse on 06/09/23.



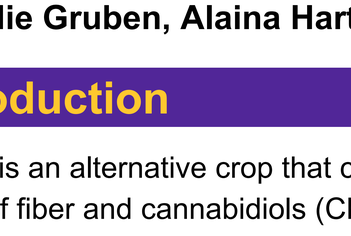
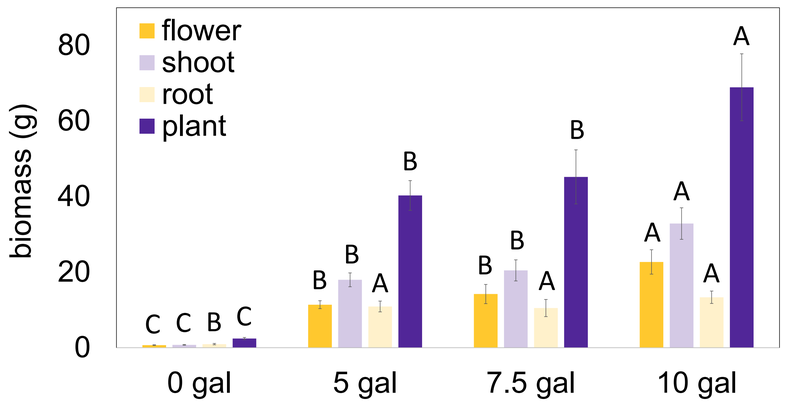
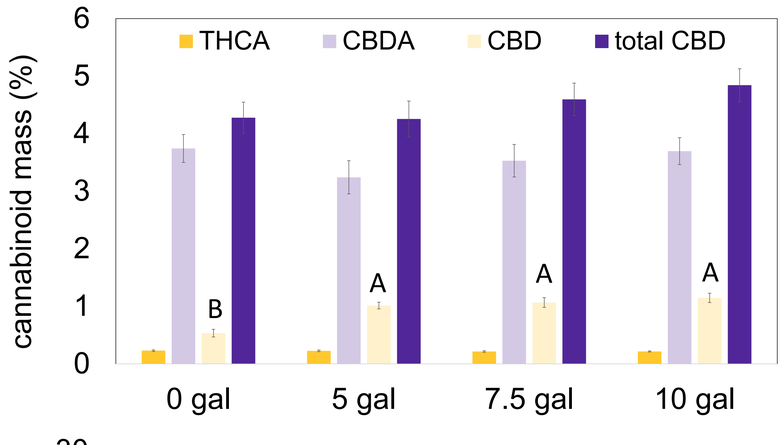


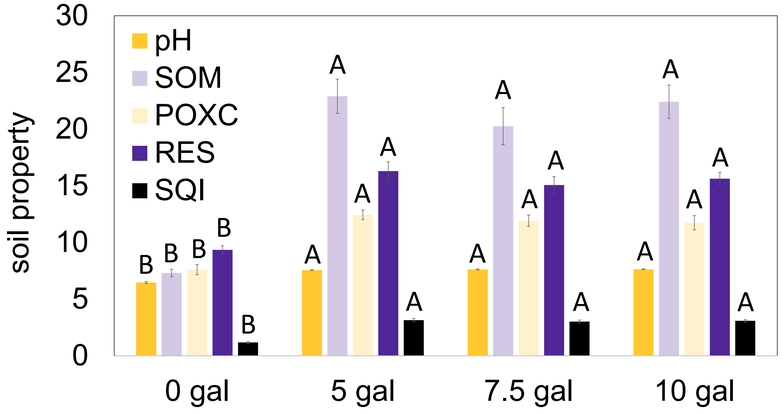
Image 1 (left) and 2 (right). Hemp seedlings and 10 gal compost treatment.

- Plants were harvested and rhizosphere and bulk soil was collected on each plot on 09/15/23.
- The dry mass of the shoots, roats, and flowers were determined.
- Cannabinoids were extracted in methanol and water, sonicated, and centrifuged at 4000 rpm, followed by a 10-fold dilution, and analyzed by high performance liquid chromatography.[4,5]
- Bulk and rhizosphere soils were analyzed for pH, soil organic matter % (SOM), permanganate oxidizable carbon, cg kg^{-1} (POXC), and respiration, dg kg^{-1} d^{-1} (RES).[6]
- A Soil Quality Index (SQI) (0-5) was computed with more is better scoring functions and differential weights for rhizosphere (0.15) and bulk soil (0.1) properties.[3]
- Statistical analyses included ANOVA, Tukey-Kramer HSD mean separation tests, and linear regressions (JMP version 17.2).

Results







Figures 1 (top), 2 (middle), and 3 (bottom). Hemp plant biomass, cannabinoid mass, and soil property with 0, 5, 7.5, and 10 gal of compost treatment per plot. Bar are treatment means with standard error of the mean. Letters indicate mean separation tests using Tukey-Kramer HSD test. ANOVA treatment effects for plant biomass and soil properties (P<0.0001) and CBD (P=0.001).

References

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Discussion

- Flower, shoot, root, and total plant biomass was significantly greater with all compost treatments compared to the control. Flower, shoot, and total biomass was significantly greater with the 10 gal treatment compared to the 5 and 7.5 gal compost treatment (Figure 1).
- THCA, CBDA, and total CBD did not differ among the treatments, but CBD was significantly greater with the compost treatments compared to the control (Figure 2).
- Soil pH, SOM, POXC, RES, and SQI were significantly greater with all compost treatments compared to the control (Figure 3).
- Positive significant (P<0.05) linear relationships were found with all soil properties and all plant biomass data (R^2 0.10 to 0.37).

Image 3 (top) and 4 (bottom). Hemp plants from 0 and 5 gal treatments. Scale on measure tape in cm.

Conclusion

- Compost improved soil quality which has likely led to increased hemp biomass. Compost did not elevate the THCA concentration.
- Minimal plant and soil improvements differed among the compost treatments, suggesting a lower limit compost application rate of 5 gal, which is equivalent to ½ gal ft^2.

Image 5 (left) and 6 (right). UWSP student and faculty researchers planting and harvesting hemp.

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