Effects of Different Charcoal Types on Plant Growth and Soil Properties Over Two Consecutive Plantings.

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Introduction

- Potential benefits of charcoal as a soil amendment include:
  - Effective reuse of by-product from modern pyrolysis methods for biofuel production
  - Alternative to slash and burn agricultural practice
  - Long term sequestration of carbon in soil
  - Enhanced soil fertility and crop productivity (i.e., *Terra Preta* of Amazonia)

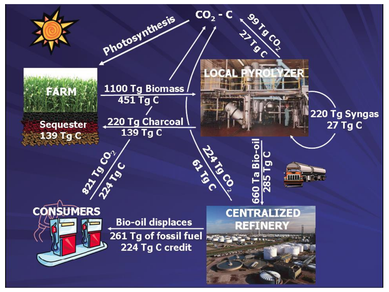

Figure 1. Summary of Charcoal Vision
(Laird, D.A. 2008. Agrn. J. Vol. 100(1):178-181)

- Previous studies have shown that high volatile matter (VM) charcoals combined with fertilizer induced nitrogen (N) immobilization (N tied up by microbes) causing poor plant growth, whereas low VM charcoal combined with fertilizers increased plant growth compared with fertilized control (Deenik et al., 2009)

Objective and Hypotheses

- Objective
  - To investigate the influence of time on the performance of charcoal as a soil amendment
- Hypotheses
  - The negative effect of high VM charcoal on plant growth will disappear due to the exhaustion of the labile carbon pool.
  - The positive effect of low VM charcoal will persist upon second planting

Methodology

- Soil: infertile Ultisol (very fine, ferruginous, kanhaplohumolt)

Table 1. Types of charcoal used in the experiments and selected chemical properties.

Proximate Analysis (%)	HVM Cob	LVM Cob	Kiawe	Binchotan	Gasification (Leucaena)
VM	63.4	7.68	23.9	2.19	2.22
Ash	1.57	5.19	1.17	1.67	18.1
Fixed Carbon	35.1	87.1	75	96.1	79.7

- Twelve treatments with 4 replicates arranged in a randomized complete block design

Table 2. Treatments tested in the two greenhouse experiments.

1	Control (Soil Alone)	7	Control + lime + NPK + Micronutrients
2	Control + HVM char	8	Control + HVM char + NPK
3	Control + LVM char	9	Control + LVM char + NPK
4	Control + kiawe	10	Control + kiawe + NPK
5	Control + binchotan	11	Control + binchotan + NPK
6	Control + Gasification	12	Control + Gasification + NPK

- Exp1. Corn was planted on Oct. 23 and harvested on Nov. 26th, 2008
- Exp2. Corn was planted on Feb 17th and harvest on March 20th, 2009
- Data collection and Laboratory Analyses
  - Fresh and dried above ground biomass were measured at harvest
  - Soils were analyzed at the Agricultural Diagnostic Service Center (ADSC) at the University of Hawaii, Manoa, for pH, available cations and phosphorus.
- Statistical Analysis
  - Treatment effects were analyzed using analysis of variance (ANOVA) and means were compared using Fisher's protected LSD (P<0.05)

Results

1. Treatment Effects on Plant Growth

First Planting

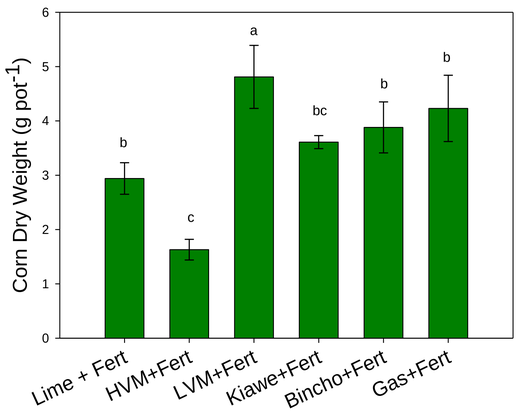

Figure 2. Corn dry biomass production in first planting

Second Planting

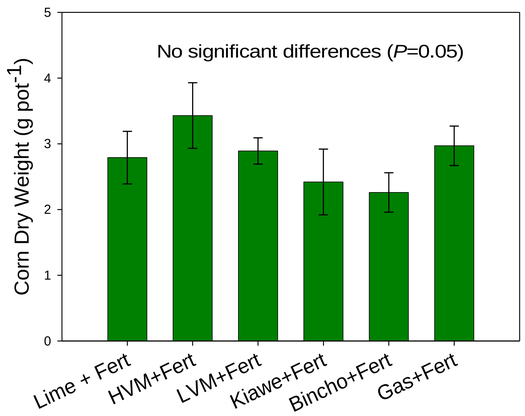

Figure 3. Corn dry biomass production in second planting

Figure 4. Corn growth before harvest in first planting

Figure 5. Corn growth before harvest in second planting

- First Planting
  - Low VM charcoal had significantly higher corn biomass production compared to fertilizer control
  - High VM charcoal had significantly lower corn biomass production compared to fertilizer control
- Second Planting
  - There was no significant effect of high or low VM charcoals on the corn biomass production

2. Treatment Effects on Soil Properties

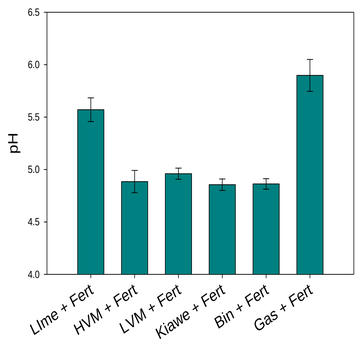

Figure 6. pH measured after first harvest

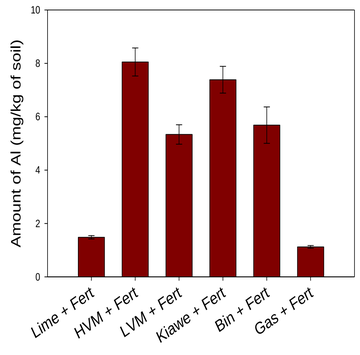

Figure 7. Extractable soil aluminum after first harvest

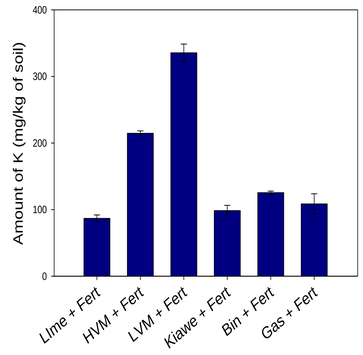

Figure 8. Extractable soil potassium after first harvest

Discussion

- First Planting
  - Low VM charcoal significantly improved plant growth due to improved K nutrition.
  - Gasification charcoal improved plant growth due to a liming effect.
  - High VM charcoal had a negative effect on plant growth due to immobilization of N (McClellan et al., 2009).
- Second Planting
  - Positive effect of low VM charcoals (corn cob and gasification) on plant growth did not persist with time.
  - These findings are puzzling, and we are currently analyzing soil and plant tissues.
  - Negative effect of high VM charcoal on plant growth did not persist in the second planting indicating that the labile carbon pool fueling N immobilization was exhausted (McClellan et al., 2009).

Conclusion

- VM content of charcoals influenced plant growth and soil properties in the short term.
- However, no long term effect of VM content on plant growth and soil properties was observed.
- Further research is needed to investigate the interaction of charcoal type, soil and time and its effect on plant growth and soil properties at the fielde scale.

References

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Acknowledgements

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