Application of Pistachio Shell Biochar with Organic Cow Manure for Sustainable Agriculture Practice

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Background

Strengthen resilience of agriculture & food systems to climate changes & variability

Food and land-use system

- Sustainable food security
- Support to rural and urban livelihoods
- Reduced GHG emissions from agricultural activities
- Carbon sequestration on farmland

(CSA: climate smart agriculture)
Major issues in agriculture practice

• Increase in global atmospheric temperature
• Reduction in rainfall
• Soil infertility
• Loss of nutrients from the soil
• Excessive use of chemical fertilizers
Impact of climate change on agriculture production

*Drought
# heat

Daryanto et al. (2016); Nam et al. (2001); Kamara et al. (2003); Bala et al. (2011); Lafitte et al. (2007); Li et al. (2010); Nayyar et al. (2006); Samarah et al. (2006); Mazahery-Laghab et al. (2003); Isfaq et al. (2020)
Food waste and major issues

Global food waste generation: 1.3 billion tonnes

- Sea food 50%
- Fruits and vegetables 52%
- Grain 38%
- Milk 20%
- Meat 22%

Impact on environment

- Odor and germs
- Land acquire
- Leachate
- Harmful to cattle and birds

Pistachios shell

Mixed vegetable wastes

Biochar

Desert sand

2% biochar application was benefit for plant growth

Previous study (Pradhan et al., 2021)

Worldwide (United States Department of Agriculture, Foreign Agriculture)
Biochar a solution

- 30% of the weight of the nut is the shell
- Not easily degradable and take almost more than two years to decompose.
- The shell contains 7% moisture, which requires less or no energy for drying
- Therefore, produce biochar from pistachio shell and application to the soil could be impact on sustainable agriculture practice.

Slow pyrolysis at 350, 450 and 550 °C

Physico chemical properties analysis

Biochar

Organic cow manure

Biochar amendment

Pot test

0%, 2%, 4%, and 8%

Egg plant seeds

Soil quality improvement
Plant growth test
Water retention test
Plant biomass production
Nutrients retention

Pistachio shells
Impact of pyrolysis temperature on biochar properties

Physicochemical properties biochar produced by three pyrolysis temperature
Impact of pyrolysis temperature on biochar nutrients

Ni, Al, Cd, As, Cr, Mo, Pb and Sr are not detected
Impact of biochar amendment to organic cow manure

Biochar produced at 450 °C amended with the manure
BC: biochar
Impact of biochar on plant growth and water retention capacity

**CC:** chlorophyll content
**SC:** Stomatal conductance

### Graphs

**Diagram (a):** Plant height (cm)
- Control
- 2% BC
- 4% BC
- 8% BC
- D11
- D21
- D31

**Diagram (b):** Number of leaves
- Control
- 2% BC
- 4% BC
- 8% BC
- D11
- D21
- D31

**Diagram (c):**
- Max leaf length (cm)
- Max leaf width (cm)
- Number of branches

**Diagram (d):**
- CC (SPAD)
- SC (mmol m⁻² s⁻¹)
- D21
- D31

**Diagram (e):**
- Soil water retention (mL)
- Total water loss (mL)
- Volume of water (mL)

**Diagram (f):**
- Shoot biomass (g)
- Root biomass (g)
- Total biomass (g)/Total water supply (mL)
- Weight (g)

Values:
- Control
- 2% BC
- 4% BC
- 8% BC
Impact of biochar on nutrient content

(a) Root nutrient concentration

(b) Shoot nutrient concentration

(c) Nutrients retained in manure

(d) Nutrients leached
• Pistachio shell biochar produced at 450 °C is a suitable amender to improve soil quality compared to the biochar produced at higher pyrolysis temperature.
• The cow manure itself promoting better eggplant growth as it is a nutrient rich substrate but showed highest water and nutrient loss.
• Lower fraction (2%) biochar application impact more on plant growth by reducing nutrient loss by leaching and enhancing water retention.
• Application of 8% biochar showed good water retention but suppress the plant growth with manure.
• Application of 2% biochar showed maximum nutrient uptake by egg plant shoot while 4% biochar showed maximum nutrient uptake by root.
• This short-term study indicates lower (2%) fraction of biochar application to the nutrient rich organic cow manure is a promising amendment to improve soil fertility and reduced nutrient loss.
• This study demonstrated that the valorization of pistachio shell to biochar in application to agriculture practice is a sustainable solution to reduce the fertilizer cost, water demand cost and boost a circular bioeconomy.

• Extended pot testing with a few more crops is the future scope of this research for long-term resilience.
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References


