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Impact of Biochar Amount on Water Evaporating Capacity of Biochar Blended Soil

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Abstract: *Biochar is most commonly produced material through an energy conversion process known as pyrolysis.Biochar is a fine-grained and porous form of charcoal that is specifically made for use as a soil amendment and soil conditioner. Added to soil, it can help to boost soil health, with positive benefits to plant growth and disease resistance.It is now the subject of academic research which will establish its potential to support reduced fertilizer use, reduced irrigation and increased yields. Because it supports higher levels of microbiological populations it can be a particularly valuable soil amendment for organic growers. Present study focused on impact of biochar amount on water drying capacity of biochar blended soil. Various combinations of biochar blended soil and different amounts of water levels (batch mode) were used in the study and identified the suitable combination of biochar blended soils to reduce the water evaporation rate.*

Keywords: *Biochar, Pyrolysis, water evaporation rate, biochar blended soil.*

1. INTRODUCTION

Biochar is a fine-grained and porous form of charcoal that is specifically made to use as a soil improver. Added to soil, it can help to boost soil health, with positive benefits to plant growth and disease resistance.The concentration of microbial life within biochar also supports greater moisture retention [1,2].Biochar is most commonly produced product through an energy conversion process known as pyrolysis of carbonaceous materials (Ex: crop stubble, wood chips, manure and municipal waste) in the complete or near absence of oxygen. Pyrolysis converts easily broken down organic matter into a highly stable form of carbon, which is mainly used as a soil additive to improve nutrient retention and carbon storage. Other products of pyrolysis may include synthetic or synthesis gas and pyrolysis liquor [3].

Advantages of biochar addition to soil:

a) ***Soil biota:*** Biochar's porosity provides a safe habitat for beneficial soil microorganisms such asmycorrhizal fungi and actinomycetes bacteria (abundant in worm casts). Thesemicroorganisms are food for mites, protozoa, nematodes and other soil biota, particularly when soil is disturbed by ploughing or rotovation. The porous cavities of biochar provide a refuge for these desirable fungi and bacteria. Biochar helps keep microbiological populations at a higher level, while simultaneously reducing the rate at which soil gives off greenhouse gases [1,2].
b) ***Mineral retention:*** Biochar has a weak cation exchange capacity that helps inretaining the dissolved nutrient minerals from being leached from the soil by rain or irrigation. By keeping minerals in the upper layers of soil they encourage more nutrient availability to plants. This leads to reductions in the usage of fertility inputs with consequent cost savings.[1,2]
c) ***Water retention:*** Biochar's porosity traps water and therefore delays drying out of soils and composts in which it has been incorporated. Trials have shown this can save as much as 50% onirrigation costs. The concentration of microbial life within biochar also supports greater moisture retention [1,2].
d) ***Soil structure:*** A soil that has a high population of mycorrhizal fungi will benefit from their production of glomalin, a substance which assists soil particle agglomeration, giving it structure and reducing the escape of stored soil carbon. By encouraging fungal growth, biochar indirectly supports improved soil structure. In some instances, biochar can remain stable in soil for hundreds to thousands of years example: Terrapreta soils in Amezon. [4]

Preliminary results on biochar use as soil amendment have been documented in factsheets and brochures, published by the Department of Agriculture, Fisheries and Forestry, under the Climate Change Research Program. A number of other biochar projects are underway throughout Australia and are listed on the Australia and New Zealand Biochar Researchers Network. Through these initiatives, the knowledge gaps are likely to diminish. Once knowledge of the biological processes involved is enhanced, a coordinated government approach will be needed to develop standards and regulations for the industry to safeguard against contamination of agricultural soils, and to integrate this technology into an accredited emissions trading scheme. Present work is focused on drying or evaporation rate of water from biochar blended soils.

Experimental

Biochar was produced using abundantly available saw dust and rice husk, which was procured from local market of Udupi from Karnataka State. As shown in the Fig. 1, two metal barrels were used to prepare the biochar. The smaller barrel was filled with saw dust, rice husk and kept small opening on top of the barrel.This waskept inside the larger barrel and the hollow space between these barrels was completely filled with fire wood. This firewood was used to provide the heat once the fire starts.

Fig. 1: Experimental setup for preparation of biochar

The rice husk and saw dust would undergo the pyrolysis process. The process continues 2 hrs and stop the fire with the help of mud. The detailed procedure was explained elsewhere[5,6]. The prepared biochar was analysed after cooling to room temperature. The biochar was grounded to smaller size and packed in polyethylene cover till further use.

Biochar blended soil and Water evaporation rate

Local soil collected (50 kg's) from in and around udupi paddy fields. Rectangular trough's of 10 no.s (50 cm x 30 cm) with a height of 10 cm were purchased to conduct the evaporation test. One trough was used as blank and others were used for experiment. Table 1 show the various combinations of soil blended biochar and water amount used for the evaporation/drying test.

Table 1: Combinations of Biochar Blended Soils with Water Matrix.

S. No	Tray no	Wt of tray (kg)	Wt of soil (kg)	Wt of biochar (kg)	Wt of water (kg)
1	1A	0.22	3	0.09	0.45
2	1B	0.22	3	0.18	0.45
3	1C	0.22	3	0.27	0.45
4	2A	0.22	3	0.09	0.65
5	2B	0.22	3	0.18	0.65
6	2C	0.22	3	0.27	0.65
7	3A	0.22	3	0.09	0.85
8	3B	0.22	3	0.18	0.85
9	3C	0.22	3	0.27	0.85

Tray 1A means 3 kg of soil, 0.09 kg of biochar (0.03 kg/kg of soil basis) [7]. An amount of 0.45 kg of water added only once to the above trough such that the water distributed uniformly through the trough on day 1. Tests were conducted during day time (8 hrs period) from 9 AM to 5 PM and collected the total weight of the trough at 9 AM and 5 PM. This trough was kept open drying on terrace such that it exposed to solar light. Similarly other 9 troughs also filled with biochar blended soil with various combinations as shown in Table 1.The experiments were conducted 5 days, most of the water evaporated during this time interval. Use of water 0.45 kg was termed as lower water addition, 0.65 kg was termed as intermediate and 0.85 was termed as higher water addition.

2. RESULTS AND DISCUSSION

The data obtained was amount from the experiment and calculated the drying or evaporation rate with following formula.

X= amount of water evaporated /amount of biochar blended soil.

dX/dt = amount of water evaporated/amount of biochar blended soil x time

Fig. 2 show the variation of rate of evaporation with time (days). As the time or days passing the evaporation rate, the reason might be evaporation rate is proportional to water content in biochar blended soil. Day 1 was more evaporation and day 5 less evaporation rate. Similar observations can be seen from Fig. 3 and 4 with increased biochar blended soils.

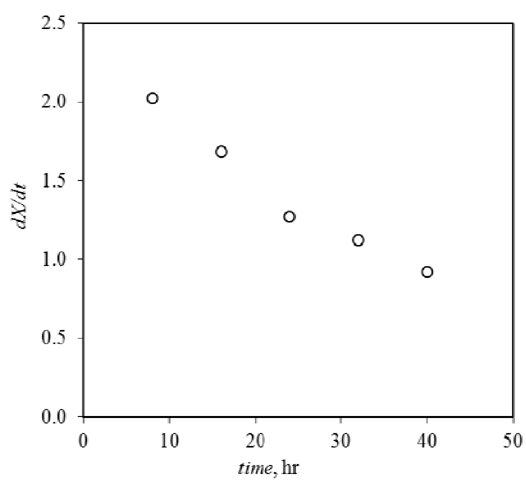

Fig.2 Variation of evaporation rate for Tary 1A

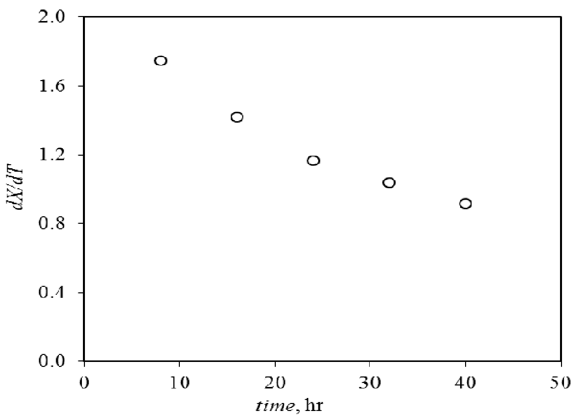

Fig.3 Variation of evaporation rate for Tary 1B

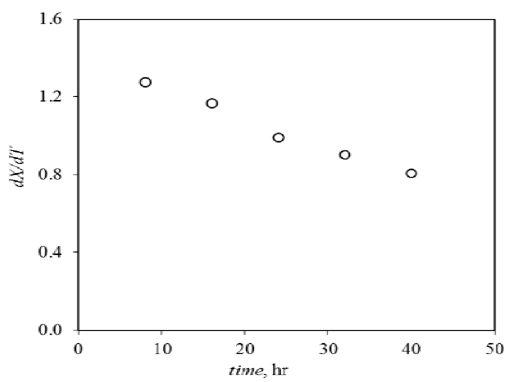

Fig.4 Variation of evaporation rate for Tary 1C

Effect of Biochar amount blended to soil:

Fig. 5 show the effect of amount of biochar added on evaporation rate for fixed amount of water 0.45 kg once only during the 5 day experiment. Tray A had shown highest water evaporation rate than tray B and C. Tray B shown intermediate evaporation while tray C had less evaporation rate.

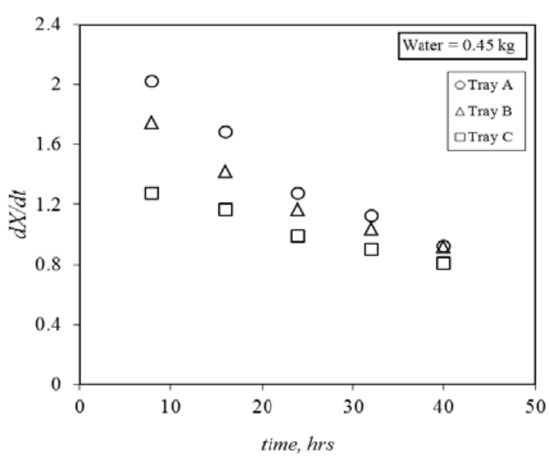

Fig.5 Comparition of evaporation rate for constant water

Tray C contains more amount of biochar than tray A and B. It is very clear that, increase in amount of biochar reduces the evaporation rate [8]. This is true for all the days. Similar observations can be made from Figures 6 and 7 for intermediate and higher water addition to the biochar blended soils.

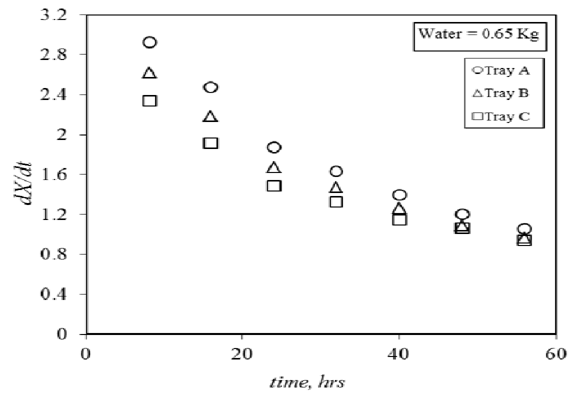

Fig.6 Comparition of evaporation rate for constant water

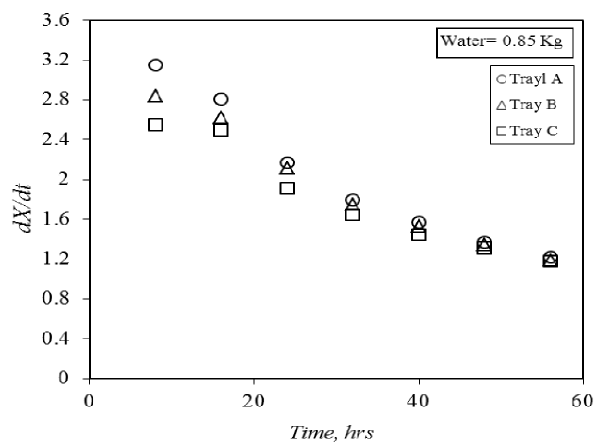

Fig.7 Comparition of evaporation rate for constant water

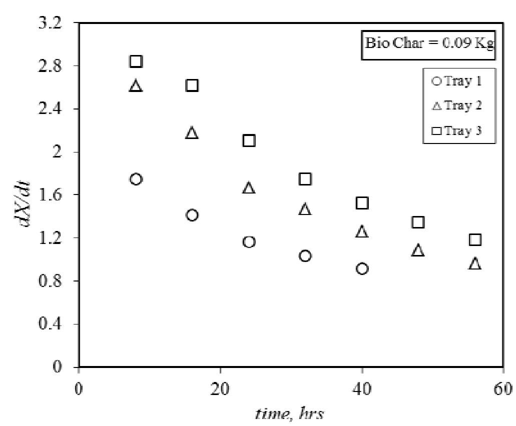

Fig.8 Comparition of evaporation rate for constant Biochar

Effect of water loading

Fig. 8 show the effect of amount of water added on evaporation rate for amount of biochar present in soil (0.09 kg). Tray 3 had shown highest water evaporation rate than tray 2 and 3. Tray 2 shown intermediate evaporation while tray 1 had less evaporation rate. Tray 3 contains more amount of water than tray 2 and 1. It is very clear that, increase in amount of water increases the evaporation rate [8]. This is true for all the days. Similar observations can be made from Figures 9 and 10 for intermediate and higher biochar addition to soils.

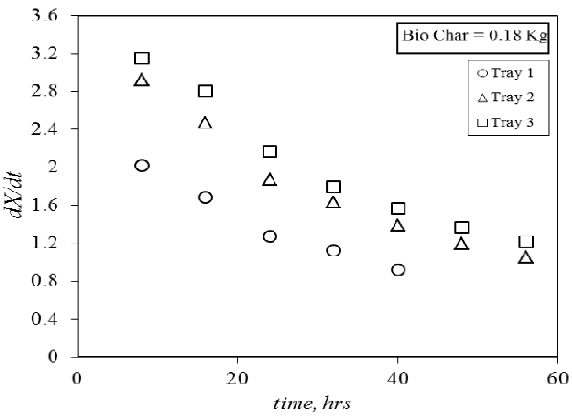

Fig.9 Comparition of evaporation rate for constant biochar

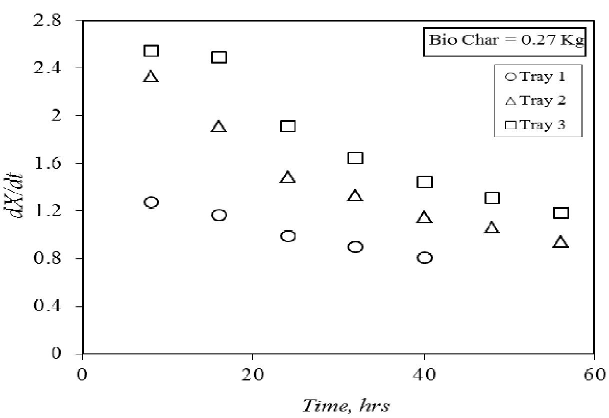

Fig.10 Comparition of evaporation rate for constant biochar

3. CONCLUSIONS

The following conclusions can be drawn from the present study.

1) Biochar addition has positive effect for soil improvement
2) Addition of more biochar will be helpful to retain more amount of water in soil or less evaporation rate.
3) More amount water will lead to more evaporation rate.

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