Chemical characterization of Biochars using parameters that are relevant to its use as a component of a peat based growing media

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Abstract
Biochar probably has the potential for reducing peat usage/replacement and affecting positive plant yield. Biochar can be produced from several organic waste sources using pyrolysis with varying nutrients and metal concentrations. In the present study, the chemical properties of biochars from five feedstocks were examined with potential use in growing media. Biochars pH can varied from 6.6 to 9.5, while most of the examined material had moderate electrical conductivity (EC) with some made from softwood bark and wood chips are very low, almost the same as peat (Table 1). A number of workers have considered that biochar can be added to peat to correct the pH. It has been claimed and shown that when biochar is mixed with peat it has an additional advantage in saving in the use of dolomitic limestone. However the use of dolomitic lime is added not only to neutralize the acidity of peat but also to supply essential nutrients such as calcium and magnesium. However we have found variation in of exchangeable Ca and Mg even at the same pH (Table 2). This variation might be reflected to the biochar chemical or structural composition as well as depending on the feed stock. It should be noted that previous publications have not mentioned or highlighted the Ca and Mg angle re use of biochar for acidity neutralization of peats. The electrical conductivity is an important parameters for growing media. When organic materials are added to the peat as a component of a growing media or with the intention of reducing peat usage the EC is a very important parameters and can be a limiting factor to their use as a peat replacement, and thus reflecting the use as growing media. Peat has a very low EC and it allows one to start with a clean sheet and nutrients can be added as required. Most of the biochar has moderate EC but the biochars have the ability to reduce the EC of growing media.

Previous work had shown that extractable nitrogen in peat biochar mixture was reduced at weeks 6 and 14. Samples taken after 104 weeks of incubation showed there was increase of extractable nitrogen in relation to 14 week sampling. The increase was more marked where the rate of biochar was low (i.e. 10%) while the highest increase was in peat control. As far we are aware there is little or no information of nitrogen availability over such a long period of incubation of peat/biochar in the context of growing media. The trend was of an increase in extractable P in the peat control but was not clearly evident in the peat+biochar treatments. There was a big increase in extractable K at the 104 week sampling and as expected at the highest rate of biochar (50%) indicating some of the K earlier fixed may get released over time. This trend was in the biochar treatment and was not in the control peat treatment. At the last sampling all the NH_4-N had disappeared presumably as a result of nitrification. As such NO_3-N increased in the last sampling reflecting the nitrification. However the NO_3-N in the peat biochar treatment was significantly lower than the peat control.

The effect of nutrient availability from biochar at different particle sizes as far as we are aware has not been studied. We found a consistent increase in availability of extractable plant available nutrients e.g. potassium, calcium and magnesium of the three biochars, as the particle size decreased from 2-4 mm to less than 1 mm (Table 3). These results indicate that it is important to characterize biochars not only as regards feedstock but also as regards particle size as it can have a profound effect on nutrient availability. In the present study, it is also presented results from of our ongoing plant growth studies on peat-biochar mixtures. In conclusion we can state that a proper chemical characterization of biochar using tests relevant to growing media needs to be done before a lime and nutrient addition regime is decided upon for plant growth studies.

Keywords: Biochar; particle size; peat replacement; nutrient dynamics; calcium; magnesium

Table 1. The pH and Electrical Conductivity dS m^{-1} (1:5 v/v) of biochar from various feedstocks used in growing media.

Feedstock	pH	EC	Reference
Bamboo	8.6 - 9.0	0.45 -0.69	Prasad unpublished
Woodchips	6.6	0.05	Prasad et al., 2017
Wood sievings	9.6	0.41	Prasad et al., 2017
Forest wood	9.5	0.64	Prasad et al., 2017
Husk/Wood sieving	9.5	0.65	Prasad et al., 2017

Table 2. Variation in extractable Ca and Mg mg/L at similar pH of three biochars

Biochar	pH	Ca	Mg
A	9.5	699	37.6
B	9.6	486	57.7
C	9.6	572	31.9

Table 3. Effect of particle size on extractable nutrients mg/L of three biochars

	Fraction	K	Ca	Mg
Biochar A	<1mm	1320	1100	53
	1-2mm	610	765	32
	2-4mm	220	240	29
Biochar B	<1mm	1115	725	54
	1-2mm	685	595	25
	2-4mm	510	380	18
Biochar C	<1mm	1450	715	108
	1-2mm	615	480	43
	2-4mm	385	255	23