

Biochar Basics 2

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Part 2: Biochar's Effects on Plant Growth

Is Biochar Good or Bad for Plant Growth?

This is not an easy question to answer. Mixing biochar into soilless substrates may have negative, zero, or positive effects on plant growth.

Biochar made from green waste mixed with peat at 50% by volume has been shown to increase prayer plants' (*Maranta leuconeura*) total biomass and leaf surface. Adding 10% by volume of sewage sludge biochar with peat-based substrates can increase lettuce biomass by 184%–270%. Mixing pruning-waste biochar with peat-based substrates at 50% or 75% by volume can also increase lettuce biomass. Mixing 20% or 35% (weight per weight) of coir biochar with 0.5% or 0.7% humic acid into a composted green-waste medium showed increased biomass of rattlesnake plants (*Goeppertia insignis*) compared to those without biochar and humic acid amendments (Zhang et al., 2014).

Mixed hardwood biochar (50% by volume) and sugarcane bagasse biochar at 50% or 70% with a bark-based substrate increased basil plants' average root diameter (Yu et al., 2019). Mixed hardwood biochar at 20%–80% by volume increased photosynthesis, shoot fresh weight, and shoot dry weight of chocolate mint, peppermint, Kentucky Colonel mint, spearmint, and orange mint plants. Also, pinewood biochar mixed with pine bark increased chrysanthemum shoot fresh and dry weights.

Pinewood biochar (at 20%–80% by volume) mixed with a peat-moss-based substrate had no effects on Easter lily or poinsettia plant growth compared to those in a 100% peat moss-based substrate (Guo et al., 2019). Tomato crop green-waste biochar did not affect tomato plant growth, fruit number, or fruit yield when applied in sawdust-based soilless substrates.

Biochar may also have adverse effects on plant growth. For example, we tested one type of biochar with high salinity; plants grown in these biochar mixes wilted within 30 min. When plants do not have enough water to dissolve the extra salts, they die.

Biochar **percentage** also plays a significant role in the effects on plant growth. Generally speaking, low biochar percentages may increase plant growth, while high biochar percentages decrease plant growth. For instance, biochar at 40% and 60% (by volume) mixed with bark could increase the growth index of tomato plants, but when the biochar rate was increased to 80% and 100% (by volume), the growth index of tomato plants significantly decreased. Also, biochar at 30% (by volume) did not affect the dry weight of leaves or growth of whole aerial parts of geraniums (*Pelargonium*). However, when the percentage increased to 70% (by volume), geranium plant growth and flowering traits were significantly decreased (Altland & Locke, 2017).

What Determines the Effects of Biochar on Plant Growth?

There are four main factors in determining the effect of biochar on plant growth: biochar type, rates, plant species, and other substrate components.

Biochar type and **rate of application** influence plant growth differently. We tested sugarcane bagasse biochar and mixed hardwood biochar on tomato and basil plant growth (Figures 2.1 and 2.2). Tomato and basil plants grown in sugarcane bagasse biochar or mixed hardwood biochar substrates had similar growth compared to those grown in commercial mixes. When we tested the same types of biochar with different rates on pepper and petunia (Figures 2.3 and 2.4), we found that pepper plants in 50% and 70% mixed hardwood biochar had similar growth compared to these in commercial substrates. On the other hand, petunias grown in the 50% sugarcane bagasse biochar had improved growth compared to those in 100% (Figure 2.4).

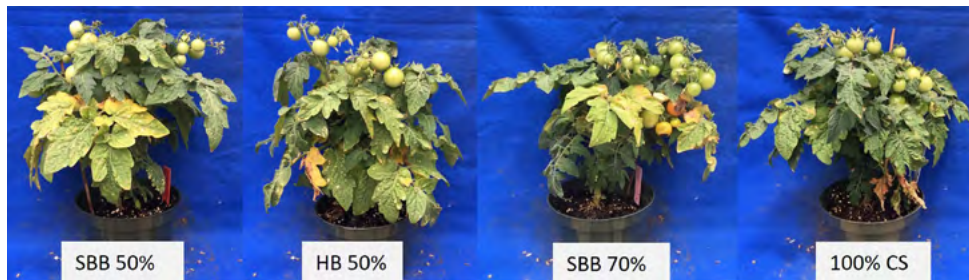


Figure 2.1. Tomato plants are grown under different percentages of sugarcane bagasse biochar (SBB) and 50% hardwood biochar (HB) mixed with a peat-moss-based commercial substrate (CS).

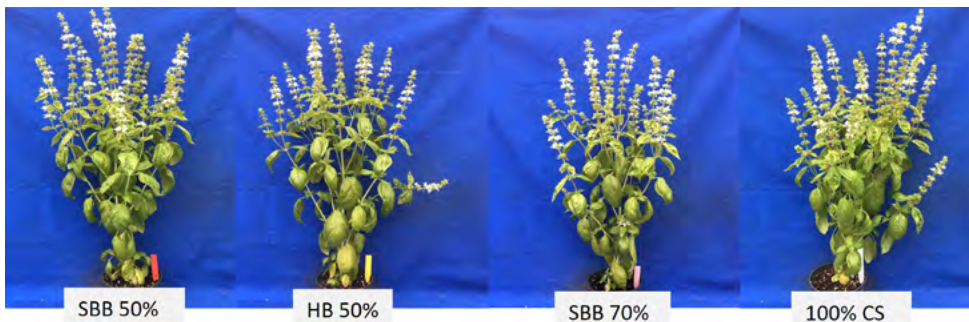


Figure 2.2. Basil plants are grown under different percentages of sugarcane bagasse biochar (SBB) and 50% hardwood biochar (HB) mixed with a peat-moss-based commercial substrate (CS).

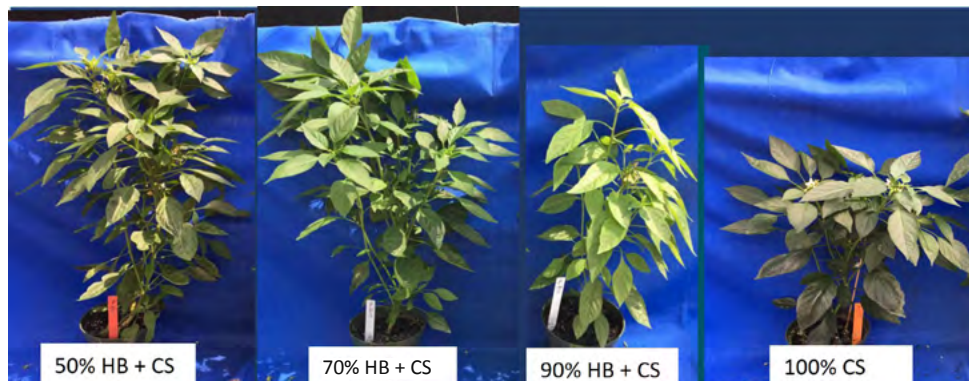


Figure 2.3. Pepper plants are grown under different percentages of mixed-hardwood biochar (HB) mixed with a peat-moss-based commercial substrate (CS).

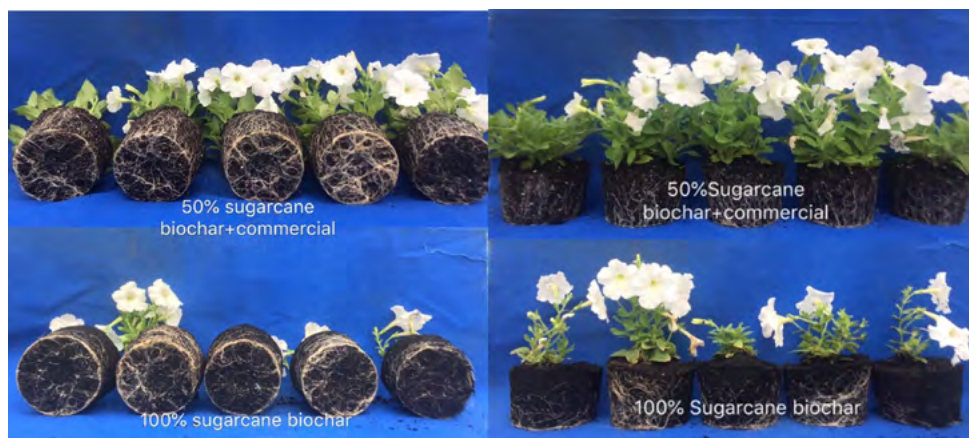


Figure 2.4. Petunia plants are grown in different percentages of sugarcane bagasse biochar mixed with a bark-based commercial substrate.

Plant species play a significant role in biochar's effects on plant growth. Similar biochar types may have variable effects on different plant species. For example, the mixture of Japanese oak biochar, peat, and vermiculite can improve zinnia shoot growth but has no effect on marigold or scarlet sage. Citrus wood biochar (1%, 3%, or 5% by weight) mixed with commercial soilless substrates (a mixture of 70% coconut fiber and 30% tuff by volume) increased the flower and fruit yield of pepper but had no effects on tomato plants (Graber et al., 2014),

Other substrate components in the biochar mix also could affect plant growth. Mixing biochar with bark did not affect the growth index of chrysanthemums, but mixing the same biochar with Sunshine #1 Mix increased the growth index of chrysanthemums. Gomphrena plants grown in pinewood biochar mixed with peat-based substrates had higher fresh dry weight than those grown in pinewood biochar mixed with bark substrates (Gu et al., 2013). Lettuce grown in deinking sludge biochar mixed with peat (50% each by volume) had higher total biomass, shoot, and root weight than those in deinking sludge biochar mixed with coir (50% each by volume; Méndez et al., 2015).

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