International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2018; 6(6): 415-417
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Received: 12-09-2018
Accepted: 13-10-2018

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Effect of enriched biochar on growth of mango seedlings in nursery

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Abstract
Biochar is a carbon rich product being used in production of many horticultural crops; the production of quality planting material is the key to enhance the yield and quality of the crops. The study on use of biochar for the production of quality seedlings of mango was undertaken with view of minimizing the cost of production of seedlings in eight treatments with three replication. The application of soil, sand and organic biochar in the ratio of 2:1:1 to a rooting media was found to enhance the germination percentage (100 %), rate of germination (1.53) and seedling vigour (3100). The growth attributes such as seedling height (45.63 cm), girth (7.95 mm), number of leaves (24.00) and leaf area (159.51 cm^2) at 150 days after germination was found to be maximum in T_2.

Keywords: Biochar, *Mangifera indica*, germination attributes

Introduction
The perennial fruit crops are commonly propagated by the vegetative means. Mango is one of the most popular of all tropical fruits. The production of large number of quality planting material of mango with minimum input cost is of great concern to nursery men. Potting media is most important input for better seedling production. It is responsible for healthy and uniform seedling production. Apart from the selection of proper ingredients, it is also necessary to maintain the porosity of the potting mixture so that proper development of roots takes place in mango (Srivastava *et al*., 1998) [9].
In recent years, addition of biochar to the agricultural soil has emerged a feasible strategy to enhance crop productivity and soil fertility (Major *et al*., 2010) by increasing the net soil surface area (Chan *et al*., 2008) [4] which consequently improves the soil water retention and soil aeration (Baronti *et al*., 2014) [3].
Biochar is the carbon-rich product obtained when biomass, such as wood, manure, or leaves are burnt under controlled container with little or no available air. In more technical terms, biochar is produced by thermal decomposition of organic material under limited supply of oxygen.

Material and methods
The experiment on effect of enriched biochar on germination and growth of mango was conducted in shade house at College of Horticulture, Bengaluru which is situated at a latitude of N13^{0}5'25.472" and at a longitude of E77^{0}33'40.605" with an altitude of 930 meters above the sea level.

Biochar and media preparation
The coconut husk biochar was prepared by using drum method (Ammu, 2015) and it was enriched with 5 per cent of cowdung slurry, cow urine and considered as organic biochar and the one enriched with 19:19:19 (NPK), 19:19:19 (NPK) + Zn and B as inorganic biochar.
Eight treatments with three replications were examined in this study: T_1: 2:1:1 (Soil: Sand: FYM) control, T_2: 2:1:1 (Soil: Sand: Biochar organic), T_3: 2:1:1 (Soil: Sand: Biochar inorganic), T_4: 2:1:1 (Soil: FYM: Biochar organic), T_5: 2:1:1 (Soil: FYM: Biochar inorganic), T_6: 2:1 (Soil: FYM), T_7:2:1 (Soil: Biochar organic) and T_8:2:1 (Soil: Biochar inorganic). Mango stones were sown in the month of July and was studied until the seedlings attain graftable thickness.

Plant growth monitoring

Five plants were selected from each replication for recording observations in each treatment. The growth parameters were recorded at 30 days interval from the date of germination till the attainment of graft able thickness. The germination attributes *viz*., rate of germination, days for first germination, germination percentage and seedling vigour. Growth attributes such as seedling height, girth, number of leaves, leaf area were recorded at 30 days interval from days of germination.

Results and discussion

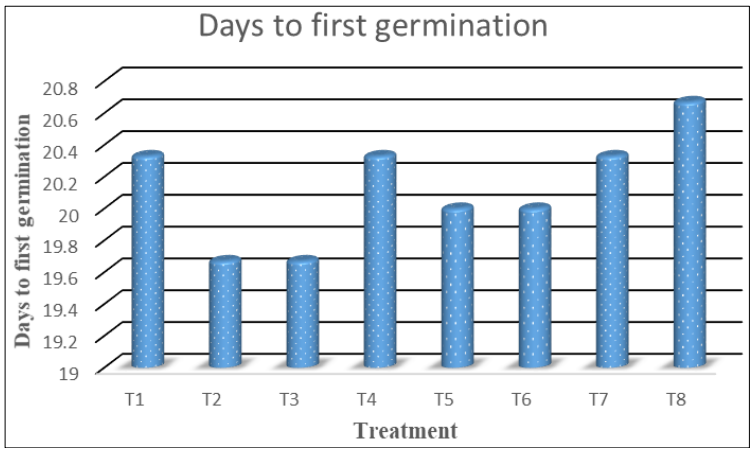

Fig 1: Effect of enriched biochar on days to first germination of mango seedlings

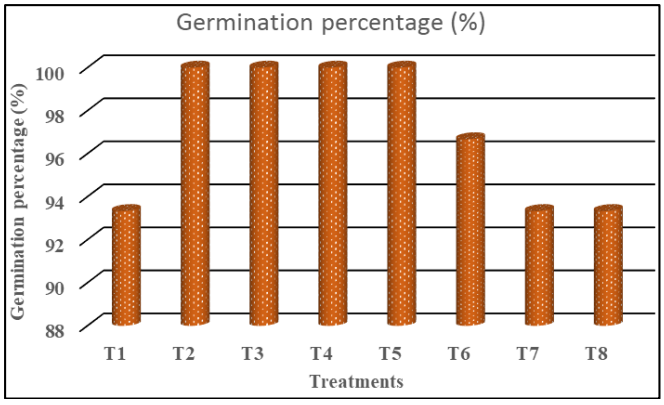

Fig 2: Effect of enriched biochar on germination percentage of mango seedlings

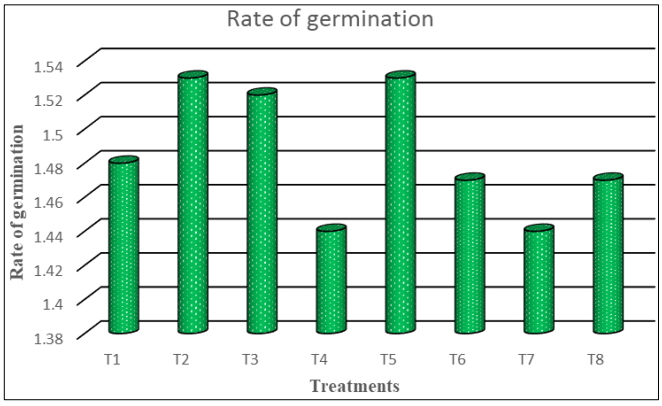

Fig 3: Effect of enriched biochar on rate of germination of mango seedlings

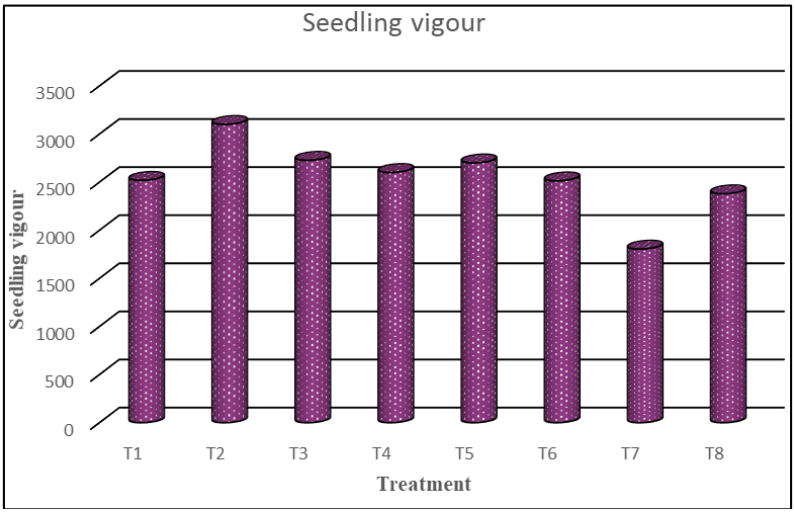

Fig 4: Effect of enriched biochar on seedling vigour of mango seedlings

There were no significant differences recorded among the treatments with regard to days for first germination, germination percentage and rate of germination. However, minimum days for first germination, maximum germination percentage and rate of germination were recorded in T_2 mention the treatment details. The significantly maximum seedling vigour of 3100 g was observed in T_2as shown in Figure 1-4.

Biochar contains organic compounds that may impact on plant germination and growth of seedling. The presence of small quantities of toxic components in biochar may induce a hormeotic response, which has a positive influence on

lowering the levels of chemical which show inhibitory effect on seedling germination or plant growth (Solaiman *et al*., 2012) [8]. The similar reports on germination attributes were reported by Bamberg *et al*. (1986) [2] on increased potato germination and seedling growth after biochar application to the soil.

Table 1: Effect of enriched biochar on seedling height (cm) of mango.

Days after germination					
Treatments	**30**	**60**	**90**	**120**	**150**
T_1	11.79	17.07	27.80	36.33	43.27
T_2	12.28	17.93	33.27	40.07	45.63
T_3	12.18	17.80	31.33	36.67	45.16
T_4	12.06	16.31	23.40	35.79	42.54
T_5	12.04	16.13	23.33	35.39	42.07
T_6	11.24	15.97	23.27	35.00	42.01
T_7	11.00	15.13	22.60	30.28	39.00
T_8	11.00	15.80	22.62	34.10	39.14
S.Em ±	NS	NS	1.41	0.29	0.18
CD@ 5%	NS	NS	4.26	0.88	0.56

The maximum increment of seedling height from 30 (12.28 cm) to 150 (45.63 cm) days after germination was recorded in potting mixture containing soil: sand: biochar organic (2:1:1) as shown in Table 1 and The results were in conformity with the observation made by Changxun *et al*. (2016) [5] the application of biochar to red soil had increased plant height of *Poncirus trifoliate*.

Table 2: Effect of enriched biochar on seedling girth (mm) of mango

Days after germination					
Treatments	**30**	**60**	**90**	**120**	**150**
T_1	4.39	5.23	5.79	6.30	6.64
T_2	4.87	5.70	6.10	7.60	7.95
T_3	4.59	5.35	5.93	6.45	6.88
T_4	4.12	4.85	5.69	6.23	6.61
T_5	4.18	4.95	5.70	6.24	6.62
T_6	4.10	4.73	5.42	6.16	6.59
T_7	3.46	4.02	5.25	6.07	6.55
T_8	3.88	4.65	5.40	6.05	6.57
S.Em ±	0.24	0.40	0.29	0.20	0.51
CD@ 5%	0.73	1.22	0.88	0.70	1.50

The treatment T_2 [2:1:1 (Soil: Sand: Biochar organic)] showed maximum increment of seedling girth from 30 (4.87 mm) to 150 (7.95 cm) days after germination (Table 2). The increase in seedling girth might be due to the presence of enriched biochar in soil which will significantly reduce the leaching losses of nitrogen, phosphorous and magnesium (Laird *et al*., 2010) and making them more available to the plant.

Table 3: Effect of enriched biochar on number of leaves of mango

Days after germination					
Treatments	**30**	**60**	**90**	**120**	**150**
T_1	5.80	9.67	18.83	20.53	21.00
T_2	6.33	12.87	19.80	22.17	24.00
T_3	5.93	10.67	19.37	20.73	21.10
T_4	5.53	8.43	16.60	18.90	19.20
T_5	5.67	8.53	17.07	19.27	20.80
T_6	5.33	8.33	16.00	17.97	19.20
T_7	4.27	7.40	15.87	17.40	18.00
T_8	4.87	8.33	16.00	17.60	18.50
S.Em ±	0.31	0.35	0.73	0.58	0.39
CD@ 5%	0.94	1.07	2.21	1.78	1.19

Table 4: Effect of enriched biochar on leaf area (cm^2) of mango

Days after germination			
Treatments	**90**	**120**	**150**
T_1	118.38	133.38	143.78
T_2	127.39	140.41	159.51
T_3	124.41	132.64	142.92
T_4	110.58	117.79	128.85
T_5	115.04	123.10	135.65
T_6	109.31	118.06	127.67
T_7	99.06	111.08	124.84
T_8	100.04	118.80	127.77
S.Em ±	0.66	0.28	0.44
CD@ 5%	2.00	0.86	1.34

Biochar usually has the potential of activating soil microorganisms and increasing the water retention capacity of the soil thereby increasing photosynthetic rate and consequent increase in growth of citrus plants (Changxun *et al*., 2016) [5].

Conclusions

The study revealed that, the potting media consisting soil, sand and biochar organic in the ratio of 2:1:1 recorded maximum seedling vigour, seedling height, girth, number of leaves and leaf area when compared to other media used for production of quality seedling production of mango under good nursery practices.

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