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Effect of Sugarcane Trash Biochar on Growth and Yield of Sugarcane Seed Crop

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A field experiment was conducted at Sugarcane Research Station, Cuddalore with the objective to ascertain the effect of sugarcane trash biochar on growth and yield of sugarcane seed crop during *special season* 2017- 2018. The variety used was CoC 25 and the treatment consists of Recommended NPK alone (300:100:200 kg ha^{-1}), Recom. NPK + sugarcane trash Bio-char @ 2 t ha^{-1}, 50 per cent Recom. NPK + sugarcane trash Bio-char @ 2 t ha^{-1}+ Bio-fertilizer @ 10 kg ha^{-1}, 75 per cent Recom. NPK+ sugarcane trash Bio-char @ 2 t ha^{-1} + Bio fertilizer @ 10 kg ha^{-1}, 100 per cent Recom. NPK + sugarcane trash Bio-char @ 2 t ha^{-1} + Bio-fertilizer @ 10 kg ha^{-1}, 125 per cent Recom. NPK + sugarcane trash Bio-char @ 2 t ha^{-1} + Bio fertilizer @ 10 kg ha^{-1}, 150 per cent Recom. NPK + sugarcane trash Bio-char @ 2 t ha^{-1} + Bio fertilizer @ 10 kg ha^{-1}. Integrated Nutrient Management practice of 150 per cent Recom. NPK + sugarcane trash Bio-char @ 2 t ha^{-1} + Bio-fertilizer @ 10 kg ha^{-1} recorded higher growth and yield attributes *viz.,* plant height, tiller population, root length, dry matter production, single cane weight and seed cane yield. This was followed by 125 per cent Recom. NPK + sugarcane trash Bio-char @ 2 t ha^{-1} + Bio fertilizer @ 10 kg ha^{-1}. But, higher benefit cost ratio was obtained with the application of 100 per cent Recom. NPK + sugarcane trash Bio-char @ 2 t ha^{-1} + Bio-fertilizer @ 10 kg ha^{-1}

Key words: Sugarcane, Biochar, Seed cane yield

Sugarcane isthe oldest crop known to mankind which is a major cash crop of tropical and sub-tropical regions.It plays a decisive role in the economy of sugarcane growing countries. India is the second largest producer of sugarcane in the world providesmajor source of sugar and wider variety of raw materials for sugar and its allied industries.

As a C_4 plant type, sugarcane have high potential of accumulating crop biomass up to 381 t/ha sugar content up to 14.5 per cent and it also produces 10 to 12 t of dry matter ha^{-1}, which could be obtained from the detrashed dried sugarcane leaves on 5th and 7th months. The detrashing operation would also facilitate easier adoption varied intercultural operations in grown up sugarcane crop (IARI, 2012).In addition, the studies by Srivastava *et al.,* (1994) revealed that the cane trash contains 68 per cent of organic matter, 0.42 per cent of nitrogen, 0.15 per cent of phosphorous, 0.57 per cent of potassium, 0.48 per cent of calcium and 0.12 per cent of magnesium and 25.7, 2045 and 236.4 ppm of zinc, iron and manganese respectively. However, conventionally thecane trashes are burnt after harvest which results in inadequate plant population, environmental pollution through carbon generation and exhaustion.Hence, utilization of available cane trash through viable, appropriate and economical decomposition technology it could be effectively utilized for sustainable productivity of sugarcane.

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Material and Methods

The experiment was conducted during *special season* 2017-18 in Randomised block design with three replications at Sugarcane Research Station, Cuddalore. The experimental site is geographically situated in the north eastern agro-climatic zone of Tamilnadu within 11.46' N latitude 79.48' E longitude and with an altitude of 4.6 m above MSL.

The soil of the experimental field was sandy loam in texture. The nutrient status of the soil during the start of the experiment was medium in available nitrogen (252 kg. ha^{-1}), high in available phosphorus (24 kg. ha^{-1}) and potassium (670 kg. ha^{-1}). As biochar is a micro particle, it should be applied by mixing it with farm yard manure as basal before planting of sugarcane and the details of biochar nutrient content was given in the Table 1.

The trial consisted of 7 treatments *viz.,* T_1- Recommended NPK alone (300:100:200 kg ha^{-1}), T_2 – Recom. NPK + sugarcane trash Bio-char @ 2 t ha^{-1}, T_3 - 50 per cent Recom. NPK + sugarcane trash Bio-char @ 2 t ha^{-1}+ Bio-fertilizer @ 10 kg ha^{-1}, T_4 – 75 per cent Recom. NPK+ sugarcane trash Bio-char @ 2 t ha^{-1} + Bio fertilizer @ 10 kg ha^{-1}, T_5 – 100 per cent Recom. NPK + sugarcane trash Bio-char @ 2 t ha^{-1} + Bio-fertilizer @ 10 kg ha^{-1}, T_6 – 125 per cent Recom. NPK + sugarcane trash Bio-char @ 2 t ha^{-1} + Bio fertilizer @ 10 kg ha^{-1}, T_7 – 150 per cent Recom. NPK + sugarcane trash Bio-char @ 2 t ha^{-1} + Bio fertilizer @ 10 kg ha^{-1}.

Sugarcane variety CoC 25 was used for planting. The experimental field was initially disc ploughed once and twice with tractor cultivator to brought out the field soil to a fine tilth condition. The ridges and furrows were formed at 120 cm apart uniformly using tractor drawn ridger. The experimental plots were also provided with irrigation and drainage channels. Excepting the control plot the calculated quantity of bio-char @ 2 t ha^{-1} was applied basally before the planting of sugarcane setts. The seed cane of seven month aged nursery crop available at SRS, Cuddalore was utilised for the experimentation. A seed rate of 75,000 two budded setts ha^{-1} were planted horizontally in the furrows continuously with the spacing of 120cm x 15 cm. The prescribed quantities of inorganic fertilizers were applied as per the treatment schedule. While the entire quantity of P was applied as basal dose through single super phosphate, nitrogen in the form of urea and potassium as muriate of potash were applied in three equal splits on 30, 60 and 90 days after planting.

Observations on growth characters *viz.*, plant height, tiller population, root length and dry matter production (DMP), single cane weight, seed cane yield were recorded at the time of harvest. Height of five tagged plants from the ground to the tip of the main stem was measured and the mean values were expressed in cm. Tiller count was recorded from the representative canes at harvest in each of the treatment plots and expressed as tiller ha^{-1}. Root length was recorded from the representative canes at harvest in each of the treatmental plots and expressed as cm. For DMP estimation, five plants were collected at random along with roots from the sampling row, sun dried for three days followed by oven drying at 60^0 C till constant weight has attained and dry matter production was expressed in kg ha^{-1}. Regarding single cane weight, the total weight of five sample canes were weighed and the mean was arrived and expressed in kg $cane^{-1}$.For single cane weight, the matured sugarcanes were harvested from each treatment and were weighed and expressed in kg ha^{-1}. The experimental data were subjected to statistical analysis using standard procedures (Gomez and Gomez, 1984).

Table 1. Details of biochar nutrient content

Properties	Values
pH	9.7
Cation exchange capacity	12.54
Carbon content (g kg^{-1})	30.80
C: N ratio	39.4
N content (g kg^{-1})	0.97
P content (g kg^{-1})	1.06
K content (g kg^{-1})	12.60

Results and Discussion

Growth attributes

The evaluated integrated nutrient management practises impart significant variations among the values of sugarcane growth attributes recorded at harvest. (Table 1, Fig 1 & 2). Among the treatments, the integrated applications of 150 per cent dose of recommended NPK + 2 t of bio-char + *Azospirillium* @ 10 kg ha^{-1} (T_7) registered higher sugarcane plant height, tiller population, root length and dry matter production of 212 cm, 95.67 000 ha^{-1}, 34.07 cm and 71.25 t ha^{-1} respectively. However, the resulted values are comparable with the resulted data with the integrated prescription of 125 per cent dose of NPK + 2 t of bio-char + *Azospirillium* @ 10 kg ha^{-1} (T_6) treatment. This is due to the addition of higher dose of fertilizers along bio-char and bio-inoculant,

Table 2. Effect of biochar and integrated nutrient management on sugarcane seed cane growth, yield and economics

Treatments	Growth parameters						Yield	Economics
	Plant height (cm)	Tiller population (000 ha^{-1})	DMP (t ha^{-1})	Individual cane weight (kg)	Number of internodes	Root length (cm)	Seed cane yield (t ha^{-1})	B : C ratio
T_1-NPK alone (300:100:200 kg ha^{-1})	197.83	88.85	57.25	1.49	12.86	25.17	82.9	1.88
T_2-NPK + Biochar @ 2 t ha^{-1}	204.03	89.44	60.12	1.56	13.27	28.13	90.4	1.86
T_3-50 % NPK + Biochar + Biofertilizer	167.45	85.66	48.53	1.16	12.11	21.47	67.8	1.27
T_4-75 % NPK + Biochar + Biofertilizer	172.42	87.44	53.91	1.26	12.12	23.20	78.5	1.55
T_5-100 % NPK + Biochar + Biofertilizer	205.54	91.71	68.98	1.67	13.82	30.20	93.7	1.96
T_6-125 % NPK + Biochar + Biofertilizer	207.70	93.80	69.58	1.76	14.18	32.93	96.2	1.95
T_7-150 % NPK + Biochar + Biofertilizer	212.40	95.67	71.25	1.80	14.39	34.07	97.8	1.93
SEd	5.75	2.63	2.87	0.05	0.39	0.92	3.23	NA
CD (P=0.05)	12.29	5.61	6.13	0.10	0.83	1.97	6.90	NA

Azospirillium ensured substantial accumulation of nitrogen, the key major nutrient responsible for all physiological activities, favouring early crop vigour, growth and better crop establishment in terms of augmented plant height, tiller production root length and dry matter production. Regardless the stages of crop growth the integration of 50 per cent dose of recommended NPK + 2 t of bio-char + *Azospirillium* @ 10 kg ha^{-1} (T_3) treatment registered lower values of the

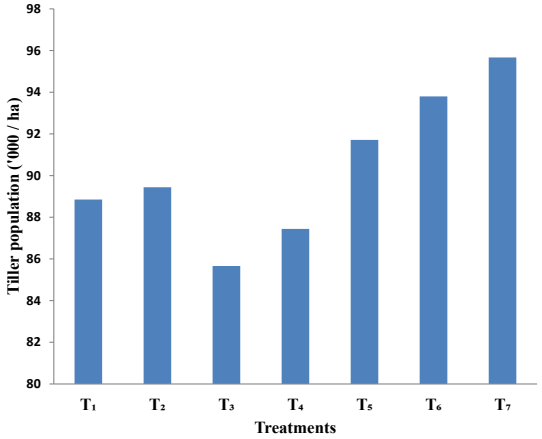

Fig.1. Effect of biochar and integrated nutrient management on sugarcane tiller population

T_1-NPK alone (300:100:200 kg ha^{-1}) ; T_2-NPK + Biochar @ 2 t ha^{-1} ; T_3-50 % NPK + Biochar + Biofertilizer ; T_4-75 % NPK + Biochar + Biofertilizer ; T_5-100 % NPK + Biochar + Biofertilizer ; T_6-125 % NPK + Biochar + Biofertilizer ; T_7-150 % NPK + Biochar + Biofertilizer

above mentioned growth attributes. This might be due to huge reduction of inorganic fertilizer components by 50 per cent.

Yield attributes and yield

The integrated nutrient management practises adopted impart significant variation in the values of yield attributes and seed cane yield at harvest. Among the treatments, the adoption of 150 per cent dose of recommended NPK along with 2 t of bio-char + *Azospirillium* @ 10 kg ha^{-1} (T_7) registered the higher single cane weight and seed cane yield of 1.80 kg

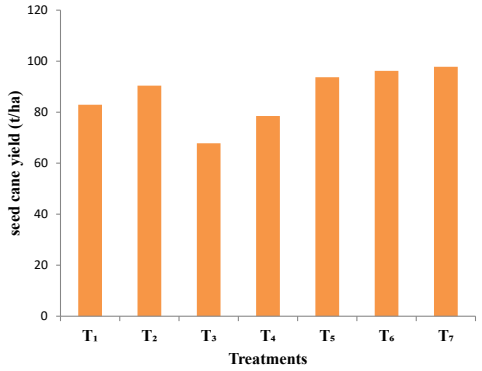

Fig.2. Effect of biochar and integrated nutrient management on sugarcane seed cane yield

T_1-NPK alone (300:100:200 kg ha^{-1}) ; T_2-NPK + Biochar @ 2 t ha^{-1} ; T_3-50 % NPK + Biochar + Biofertilizer ; T_4-75 % NPK + Biochar + Biofertilizer ; T_5-100 % NPK + Biochar + Biofertilizer ; T_6-125 % NPK + Biochar + Biofertilizer ; T_7-150 % NPK + Biochar + Biofertilizer

and 97.8 t ha^{-1} respectively. However, the resulted values are on par with the integrated application of 125 per cent dose of NPK along with 2 t of bio-char + *Azospirillium* @ 10 kg ha^{-1} (T_6) and the application of 100 per cent dose of NPK along with 2 t of bio-char + *Azospirillium* @ 10 kg ha^{-1} (T_5) treatments. The reason could be due to additional incorporation of organic rich bio-char in combination with 12.5 t of organic manure not only impart positive influence on varied soil physio-chemical characteristic and also results in considerable addition of macro and micro nutrients for effective growth and establishment of cane crop. Similarly the supplemental addition of biofertilizer component, *Azospirillium* enhances the nitrogen content of the soil and which would also improves microclimatic situations of crop rhizosphere region, favouring enhanced crop uptake moisture and other nutrients. The integrated application of 50 per cent dose of recommended NPK + 2 t of bio-char + *Azospirillium* @ 10 kg ha^{-1} registered lower single cane weight and seed cane yield of 1.16 kg and 67.8 t ha^{-1}. Lower dosage of inorganic fertilizer along with organics might be the reason for lower yield and yield attributes. The results were in line with the findings of Chan *et al.* (2008) and Zhang *et al.* (2010) also reported that biochar amended soils increased the maize yield and yield attributes.

Economics

Regarding the economic analysis of the varied integrated nutrient management treatments, the highest gross return (Rs. 293440 ha^{-1}) and net return (Rs.193365 ha^{-1}) were obtained with the application of 150 per cent NPK altogether 2 t of bio-char and *Azospirillium* @ 10 kg ha^{-1} (T_7). The application of 125 per cent recommended NPK + 2 t of bio-char + *Azospirillium* @ 10 kg ha^{-1} (T_6) and 100 per cent recommended NPK+ 2 t of bio-char + *Azospirillium* @ 10 kg ha^{-1} (T_5) followed the above treatment in declining trend. The lowest gross return and net return of Rs. 203400 ha^{-1} and Rs. 113955 ha^{-1} were obtained with the application of 50 per cent NPK altogether 2 t of bio-char and *Azospirillium* @ 10 kg ha^{-1} (T_3) treatment. The highest Benefit Cost Ratio of 1.96 was also obtained with the treatment T_5 involving 100 per cent NPK + 2 t of bio-char + *Azospirillium* @ 10 kg ha^{-1}) applications. The treatments 125 per cent NPK + 2 t of bio-char + *Azospirillium* @ 10 kg ha^{-1} (T_6) and 150 per cent NPK + 2 t of bio-char + *Azospirillium* @ 10 kg ha^{-1} (T_7) stands next in decreasing order. The minimum BCR value (1.27) was accounted with the treatment T_3 (50 per cent dose of NPK + 2 t of bio-char + *Azospirillium* @ 10 kg ha^{-1}).

Conclusion

The results of the investigation clearly indicated that application of 100 per cent recommended dose of NPK along with 2 t of bio-char + *Azospirillium* @ 10 kg ha^{-1} recorded higher benefit cost ratio of 1.96 for sugarcane seed cane production. Therefore, it can be suggested to the farmers when compared to other treatments.

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