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Effect of Prepared Bio-compost on Plant Growth Promotion Trait of Sorghum

R. P. Bambharolia[1*], Trupti K. Vyas[2], D. M. Damasia[1] and A. J. Deshmukh[1]

[1]College of Agriculture, Navsari Agricultural University, Waghai, Gujarat (394 730), India
[2]Food Quality Testing Laboratory, Navsari Agricultural University, Navsari, Gujarat (396 450), India

Corresponding Author

R. P. Bambharolia
e-mail: rpbmicro@gmail.com

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Abstract

The present study was aimed to test the effect of prepared bio-compost from sugarcane trash (W_1) and banana pseudostem (W_2) using *Bacillus subtilis* and *Schizophyllum commune* on plant growth promotion (PGP) trait of sorghum. Effect of different prepared compost on root length of sorghum was found non-significant at 30 days after sowing in a pot experiment. Whereas, shoot length was significantly affected by substrates (W) and microorganisms (M) in which W_2 gave higher shoot length of 24.69 cm while M_1 and M_3 among microorganisms, were equally found significant for shoot length (26.63 cm) followed by M_2 (22.44 cm). Compost prepared by using different substrates had a significant effect on the green and dry biomass yield of sorghum. W_2 yielded relatively higher green (8.84 g) and dry (2.03 g) biomass of sorghum. Various growth parameters like shoot length, green and dry biomass were found to increase with the application of compost prepared from banana pseudostem (W_2), cellulolytic+lignolytic microorganism (M_3) and in unsterilized condition (S_0).

Keywords: Bio-compost, *Bacillus subtilis*, plant growth promotion, *Schizophyllum commune*

1. Introduction

Sorghum is produced in many countries of the world and it is the fifth major cereal crop in the world in terms of tonnage after maize, wheat, rice and barley. Traditionally, sorghum has been known for being nutrient-use efficient and managed with low fertilizer rates, but yields can be increased with higher fertilizer application rates. Many studies have been published on N, P, or K fertilizer response in sorghum (Elkased and Nnadi, 1987; Kayuki et al., 2007), but these studies were limited to single nutrients and did not include a combination of nutrients.

Composting is the biochemical conversion of organic wastes by naturally occurring or inoculated microbes to organic fertilizer through biological processes (Gautam et al., 2010). It is done by different group of microorganisms including bacteria, fungi and actinomycetes such as *Pseudomonas* sp., *Bacillus* sp., *Aspergillus* sp., *Streptomyces rectus*, *Thermopolyspora bispora*, *Thermomonospora fusca*, *Thermoactinomyces* sp. and *Thermomonospora curvata* (Zeng et al., 2011). Fungal species such as *Aspergillus*, *Penicillium*, *Tricoderma* plays important role in the decomposition of various kind of waste material. Fungi are responsible for decomposing more than 80% of the cellulose (Betts and Dart, 1988). The success of the composting process and the usefulness of compost as an organic amendment are determined by microbial activity (Chroni et al., 2009). Bio-degradation of agricultural waste into compost and incorporation into soil may enhance the nutrient recycling and maintain soil fertility (Gaind and Pandey, 2006).

The quality of compost prepared by microbes is mostly dependent on its raw materials (Wang et al., 2004). However, other characters that can make good-quality compost are C:N ratio, moisture content, pH and the presence of plant growth-promoting microorganisms (Fourti et al., 2011). Compost is rich source of nutrients with high organic matter content and use of compost can be beneficial to enhance soil organic matter status. Physical and chemical properties of soil can be improved by using the compost, which may ultimately increase crop yield. Physical properties like bulk density, porosity, water permeability and hydraulic conductivity were significantly improved when compost was applied in combination with chemical amendments (Hussain et al., 2001). Application of compost not only benefits crop plants as it contains beneficial microbes that help the plants to mobilize and acquire nutrients but also promotes plant growth and inhibits plant pathogens (Perner et al., 2006). Gopalakrishnan et al. (2020) reported that sorghum bagasse compost prepared with potential microbes significantly enhanced plant growth promotion (PGP) traits of sweet sorghum (*Sorghum bicolor* (L.) Moench) including the plant height, leaf area, leaf weight, root weight, root length, shoot weight, panicle weight, seed number and seed weight over the bagasse compost prepared without microbes. Thus, this study was aimed to investigate the effect of prepared bio-compost on plant growth promotion trait of sorghum.

2. Materials and Methods

2.1. Preparation of bio-compost using microbes

Sugarcane trash (W_1) and banana pseudostem (W_2) were collected, chopped into 2-3 cm pieces and dried followed by inoculation of microorganism's *viz. Bacillus subtilis* and *Schizophyllum commune* as per treatments. This experiment was conducted using factorial CRD with three repetitions. In this, Factor I was Substrates *i.e.* Sugarcane trash (W_1) and Banana pseudostem (W_2); Factor II was Microorganism's *i.e.* Control (M_0), *Bacillus subtilis* (M_1), *Schizophyllum commune* (M_2) and *Bacillus subtilis+Schizophyllum commune* (M_3); Factor III was conditions *i.e.* Unsterilized (S_0) and Sterilized (S_1). Treatment wise initial and final composition *viz.* organic carbon, nitrogen, C:N ratio, P_2O_5 and K_2O of bio-composts were measure using standard methods i.e. organic carbon by Walkley and Black (1935), nitrogen and potassium by Jackson (1973) and phosphorus by Kitson and Mellon (1944).

2.2. Pot experiment

A Pot experiment was set up using factorial CRD with two repetitions at the College of Agriculture, Navsari Agricultural University, Waghai to test the prepared bio-compost on sorghum plants (GJ-42). A total of 32 (16 treatments×2 replications) pots were taken and filled with 1 kg soil. Four seeds were sown on each pot and recommended doses of fertilizer (10t prepared compost ha^{-1}, 40 kg N ha^{-1} as urea and 40 kg P_2O_5 ha^{-1} as SSP) were applied in mg kg^{-1}. Irrigation was done with distilled water as per the requirement. After germination, 2 healthy plants of each pot were maintained. After 1 month of sowing, the plants were harvested and observations on plant height, root length, fresh weight and dry weight of the plant were recorded.

3. Results and Discussion

C:N ratio and nutrient composition is important parameter of compost. The initial and final composition of prepared bio-compost is presented in Table 1. The lowest C:N ratio of 13.02 was observed in $W_1×M_3×S_0$, Lowest organic carbon of 17.85% was reported in $W_1×M_3×S_0$, highest nitrogen and P_2O_5 content of 1.37 and 0.40%, respectively was observed in $W_1×M_3×S_0$ and highest K_2O content of 2.68% was observed in $W_2×M_3×S_0$. This decrease in C:N ratio and increased nitrogen content might be due to C loss in substrate as well as increased N content by metabolic activities of microorganisms. Similar results were also reported by Shamini and Fauziah (2014); Diallo et al. (2017); Premalatha et al. (2017); Dhapate et al. (2018) and increased nutrient content may be due to the decomposition of complex molecules into simpler molecules with releasing of elements. These results are in agreement with the finding of Awasthi et al. (2014); Lakshmi et al. (2019) and Gopalakrishnan et al. (2020).

The bio-compost prepared by applying different treatments of microorganisms was tested on sorghum plants in a pot

Table 1: Initial and final composition of bio-compost

Sl. No.	Treatment detail	C:N ratio		Organic Carbon (%)		Nitogen (%)		P_2O_5 (%)		K_2O (%)	
		Initial	Final	Initial	Final	Initial	Final	Initial	Final	Initial	Final
T_1	$W_1M_0S_0$	55.54	34.55	36.20	28.70	0.65	0.83	0.12	0.20	1.20	1.48
T_2	$W_1M_0S_1$	57.55	53.15	36.35	34.10	0.63	0.64	0.13	0.14	1.21	1.22
T_3	$W_1M_1S_0$	54.83	20.39	36.25	22.45	0.66	1.10	0.13	0.34	1.22	1.66
T_4	$W_1M_1S_1$	54.57	25.09	36.00	22.95	0.66	0.91	0.12	0.31	1.22	1.53
T_5	$W_1M_2S_0$	56.96	21.67	36.05	22.65	0.63	1.05	0.12	0.35	1.22	1.62
T_6	$W_1M_2S_1$	55.83	28.18	36.30	25.25	0.65	0.90	0.12	0.29	1.23	1.53
T_7	$W_1M_3S_0$	55.46	13.02	36.15	17.85	0.65	1.37	0.13	0.40	1.23	1.78
T_8	$W_1M_3S_1$	55.40	16.70	36.45	19.80	0.66	1.19	0.13	0.44	1.22	1.74
T_9	$W_2M_0S_0$	78.57	41.69	32.05	26.00	0.41	0.63	0.23	0.28	1.48	1.82
T_{10}	$W_2M_0S_1$	82.56	75.67	31.95	30.85	0.39	0.41	0.23	0.24	1.48	1.47
T_{11}	$W_2M_1S_0$	79.48	21.71	32.25	21.05	0.41	0.97	0.22	0.30	1.49	1.96
T_{12}	$W_2M_1S_1$	84.77	23.20	32.20	21.65	0.38	0.93	0.23	0.27	1.49	1.83
T_{13}	$W_2M_2S_0$	82.12	24.68	32.10	22.80	0.39	0.92	0.23	0.28	1.50	2.03
T_{14}	$W_2M_2S_1$	79.85	25.75	32.40	23.25	0.41	0.91	0.23	0.28	1.49	1.90
T_{15}	$W_2M_3S_0$	77.68	16.17	32.55	18.70	0.42	1.16	0.24	0.32	1.48	2.68
T_{16}	$W_2M_3S_1$	81.12	18.57	32.35	19.75	0.40	1.06	0.23	0.34	1.50	2.62

experiment with regards to various plant growth parameters. Effect of different prepared compost on root length of sorghum was found non-significant at 30 days after sowing (DAS) in a pot experiment (Table 2 and 3 and Photo 1 and 2). Whereas, shoot length was significantly affected by substrates (W) and microorganisms (M) in which W_2 (banana pseudostem) reported significantly higher shoot length of 24.69 cm while M_1 and M_3 among microorganisms, were equally found significant for shoot length (26.63 cm) followed by M_2 (22.44 cm). The conditions and all the interactions were found non-significant.

Bio-compost prepared by using different substrates had a significant effect on the green and dry biomass yield of sorghum (Table 4 and 5 and Figure 1). Banana pseudostem (W_2) yielded relatively higher green (8.84 g) and dry (2.03 g) biomass of sorghum than sugarcane trash (W_1). Microorganisms also affected significantly in respect of green and dry biomass of sorghum in which M_3 (cellulolytic + lignolytic) recorded the highest green (11.93 g) and dry (2.58 g) biomass of sorghum. The green and dry biomass yields of sorghum were also significant in different conditions. Among these, S_0 (unsterilized) reported higher green (8.66 g) and dry (1.99 g) biomass of sorghum.

The interaction effect of different factors on green biomass was found non-significant for most of the interactions except M×S. Among these, M_3×S_0 (12.88 g) recorded significantly

Table 2: Effect of different treatments on root length (cm) of sorghum at 30 DAS

Substrate	Microorganisms			Conditions			Mean (W)
	M_0	M_1	M_2	M_3	S_0	S_1	
W_1	29.50	31.88	39.25	32.75	36.06	30.63	33.34
W_2	26.13	35.88	29.50	36.50	32.06	31.94	32.00
Mean (M, S)	27.81	33.88	34.38	34.63	34.06	31.28	

Substrate	S_0				S_1			
	M_0	M_1	M_2	M_3	M_0	M_1	M_2	M_3
W_1	37.50	34.75	39.00	33.00	21.50	29.00	39.50	32.50
W_2	25.00	31.25	28.50	43.50	27.25	40.50	30.50	29.50
Mean (S×M)	31.25	33.00	33.75	38.25	24.38	34.75	35.00	31.00
	W	M	S	W×M	W×S	M×S	W×M×S	
SEm±	1.48	2.10	1.48	2.96	2.10	2.96	4.19	
CD (*p*=0.05)	NS	NS	NS	NS	NS	NS	NS	
CV (%)					18.15			

Table 3: Effect of different treatments on shoot length (cm) of sorghum at 30 DAS

Substrate	Microorganisms			Conditions			Mean (W)
	M_0	M_1	M_2	M_3	S_0	S_1	
W_1	18.63	26.25	20.38	25.75	23.25	22.25	22.75
W_2	19.75	27.00	24.50	27.50	24.56	24.81	24.69
Mean (M, S)	19.19	26.63	22.44	26.63	23.91	23.53	

Substrate	S_0				S_1			
	M_0	M_1	M_2	M_3	M_0	M_1	M_2	M_3
W_1	20.50	27.25	19.25	26.00	16.75	25.25	21.50	25.50
W_2	19.25	26.50	24.50	28.00	20.25	27.50	24.50	27.00
Mean (S×M)	19.88	26.88	21.88	27.00	18.50	26.38	23.00	26.25
	W	M	S	W×M	W×S	M×S	W×M×S	
SEm±	0.50	0.70	0.50	0.99	0.70	0.99	1.40	
CD (*p*=0.05)	1.48	2.10	NS	NS	NS	NS	NS	
CV (%)					8.35			

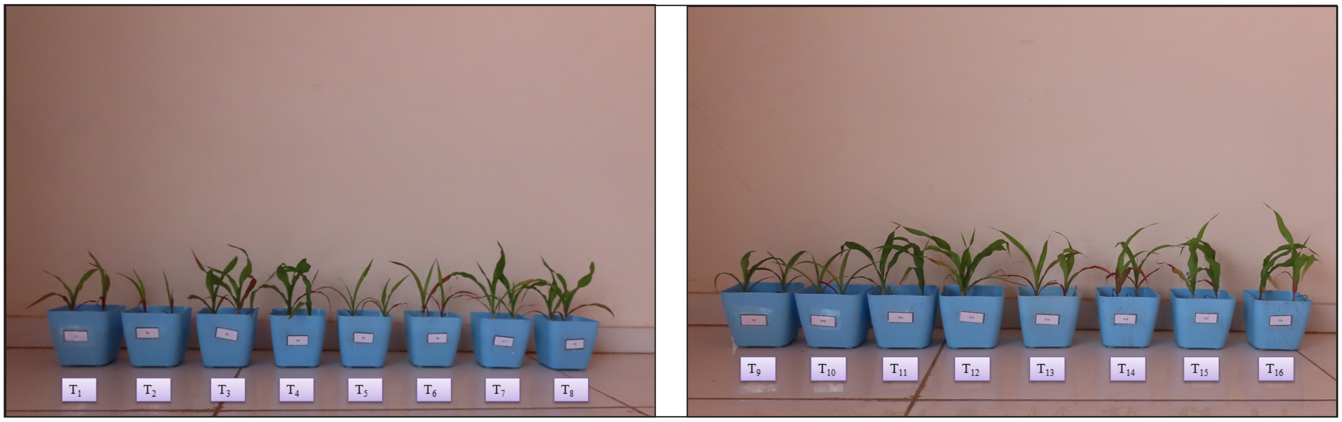
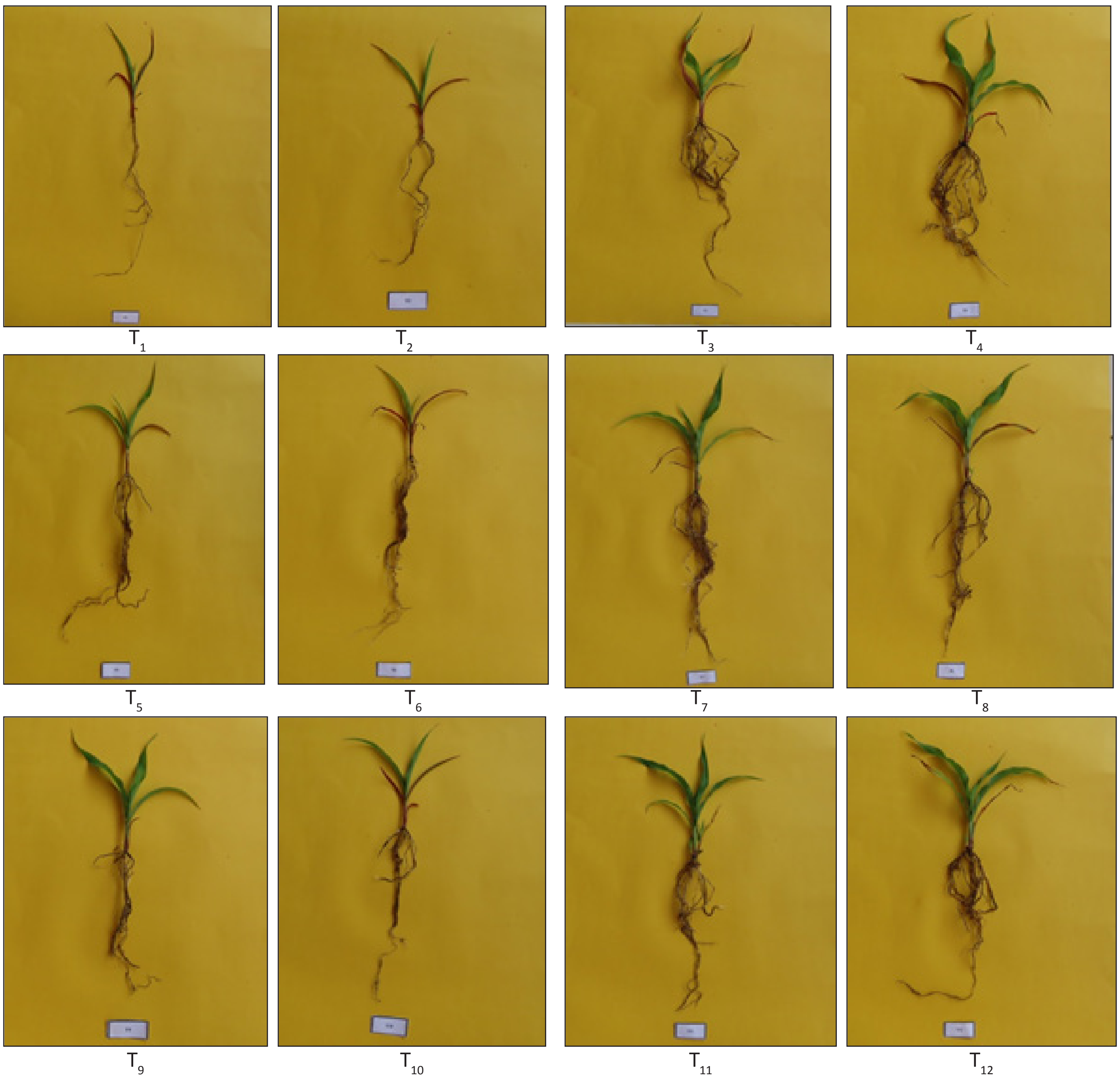


Photo 1: Pot experiment



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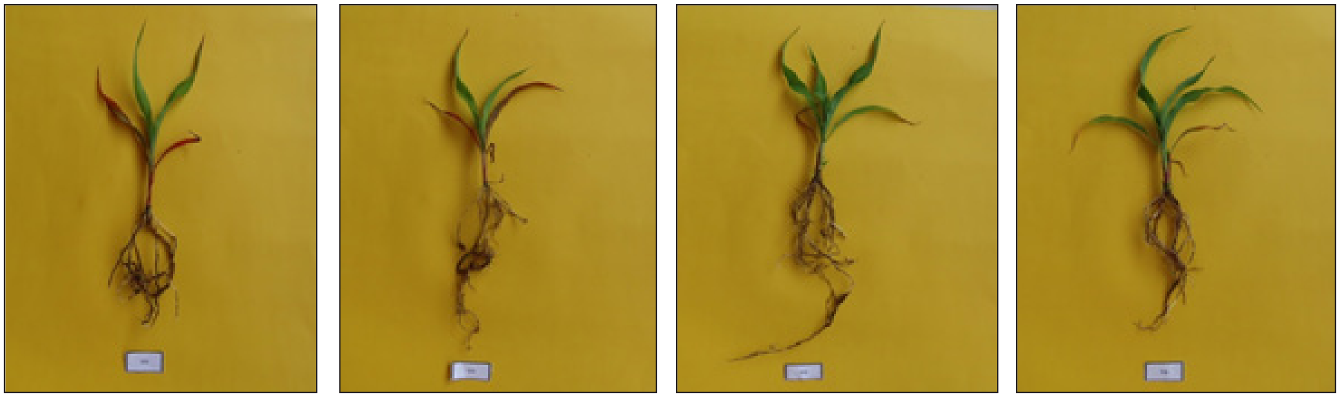

T13 T14 T15 T16

Photo 2: Root and shoot length of sorghum at 30 DAS

Table 4: Effect of different treatments on green biomass (g) of sorghum at 30 DAS

Substrate	Microorganisms				Conditions		Mean (W)
	M_0	M_1	M_2	M_3	S_0	S_1	
W_1	2.09	9.86	5.35	10.89	7.73	6.37	7.05
W_2	3.47	11.34	7.57	12.98	9.60	8.08	8.84
Mean (M, S)	2.78	10.60	6.46	11.93	8.66	7.23	

Substrate	S_0				S_1			
	M_0	M_1	M_2	M_3	M_0	M_1	M_2	M_3
W_1	2.91	11.16	5.22	11.64	1.28	8.56	5.49	10.15
W_2	3.86	12.75	7.64	14.13	3.07	9.93	7.50	11.83
Mean (S×M)	3.39	11.95	6.43	12.88	2.17	9.25	6.50	10.99
	W	M	S	W×M	W×S	M×S	W×M×S	
SEm±	0.15	0.22	0.15	0.31	0.22	0.31	0.44	
CD (p=0.05)	0.46	0.66	0.46	NS	NS	0.93	NS	
CV (%)					7.80			

Table 5: Effect of different treatments on dry biomass (g) of sorghum at 30 DAS

Substrate	Microorganisms				Conditions		Mean (W)
	M_0	M_1	M_2	M_3	S_0	S_1	
W_1	0.65	2.38	1.26	2.25	1.81	1.47	1.64
W_2	0.88	2.62	1.70	2.92	2.18	1.88	2.03
Mean (M, S)	0.77	2.50	1.48	2.58	1.99	1.67	

Substrate	S_0				S_1			
	M_0	M_1	M_2	M_3	M_0	M_1	M_2	M_3
W_1	0.92	2.74	1.24	2.32	0.39	2.03	1.28	2.17
W_2	0.93	2.96	1.83	2.99	0.83	2.27	1.56	2.85
Mean (S×M)	0.93	2.85	1.54	2.66	0.61	2.15	1.42	2.51
	W	M	S	W×M	W×S	M×S	W×M×S	
SEm±	0.04	0.06	0.04	0.08	0.06	0.08	0.12	
CD (p=0.05)	0.12	0.17	0.12	0.25	NS	0.25	NS	
CV (%)					8.94			

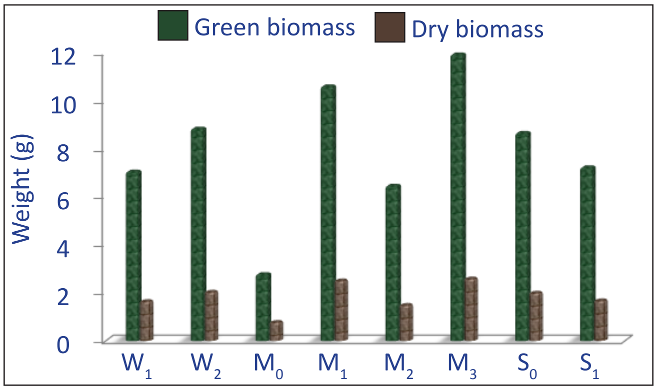

Figure 1: Green and dry biomass yield of sorghum as affected by different factors

higher green biomass which was at par with $M_1 \times S_0$ (11.95 g). Same interactions were analyzed for dry biomass of sorghum in which W×M and M×S interactions were found significant. $W_2 \times M_3$ recorded higher dry biomass of 2.92 g followed by $W_2 \times M_1$ (2.62 g) which was at par with $W_1 \times M_1$ (2.38 g). Considering M×S interactions, $M_1 \times S_0$ exhibited significantly higher (2.85 g) dry biomass of sorghum which was at par with $M_3 \times S_0$ (2.66 g). Higher-order interaction for green and dry biomass remained non-significant. The beneficial effect of such substrate, microorganism and condition on growth parameters of sorghum was also reported by Mawahib et al. (2015). Similar results had been also reported by Mahalakshmi and Naveena (2016) and Premalatha et al. (2019) in other crops. Gopalakrishnan et al. (2020) also reported enhancement of sweet sorghum growth parameter *viz.* plant height, leaf area, leaf weight, root weight, root length, seed number and seed weight by sorghum bagasse compost prepared with microbes.

4. Conclusion

This experiment demonstrated the effect of prepared bio-compost on plant growth promotion trait of sorghum. Overall it was observed that the compost prepared by using different substrates, microorganisms and conditions had a profound effect on various growth parameters of sorghum. Various growth parameters like shoot length, green and dry biomass were found to increase with the application of compost prepared from banana pseudostem (W_2), cellulolytic+lignolytic microorganism (M_3) and in unsterilized condition (S_0).

5. References

Awasthi, M.K., Pandey, A.K., Khan, J., Bundela, P.S., Wong, J.W.C., Selvam, A., 2014. Evaluation of thermophilic fungal consortium for organic municipal solid waste composting. Bioresource Technology 168, 214–221.

Betts, W.B., Dart, R.K., 1988. Biodegradation of lignin related compound by *Aspergillus flavus*. Journal of General Microbiology 134, 2413–2420.

Chroni, C.A., Kyriacoul, I., Georgaki, T., Manios, M., Kotsou, K., Lasaridi, 2009. Microbial characterization during composting of biowaste. Waste Management 29, 1520–1525.

Dhapate, S.S., Dilpak, S.A., Pawar, R.K., 2018. Studies on effect of cellulolytic fungi on decomposition of sugarcane trash. Journal of Pharmacognosy and Phytochemistry SP1, 2975–2977.

Diallo, N.D., Bengue, M.M., Guer, M.N., Ka, M., Tine, E., Mbaye, C.T., 2017. Composting of sugar cane bagasse by *Bacillus* strains. African Journal of Biotechnology 16(3), 113–123.

Elkased, F.A., Nnadi, L.A., 1987. Phosphorus response of grain sorghum in the Guinea savanna of Nigeria as influenced by rates, placement and plant spacing. Fertility Research and Practice 11, 3–8.

Fourti, O., Jedidi, N., Hassen, A., 2011. Comparison of methods for evaluating stability and maturity of co-composting of municipal solid wastes and sewage sludge in semi-arid pedoclimatic condition. Natural Science 3, 124–135.

Gaind, S., Pandey, A.P., 2006. Bioconversion of crop residues of barley (*Hordeum vulgare*) and rice (*Oryza sativa*) by *Gliocladium virens* and *Trichoderma reesei* QM 9414 under solid-state-fermentation conditions. The Journal of Indian Botanical Society 77, 205–212.

Gautam, S.P., Bundela, P.S., Pandey, A.K., Awasthi, M.K., Sarsaiya, S., 2010. Composting of municipal solid waste of Jabalpur city. Global Journal of Environmental Research 4, 43–46.

Gopalakrishnan, S., Srinivas, V., Kumar, A.A., Umakanth, A.V., Addepally, U., Rao, P.S., 2020. Composting of sweet sorghum bagasse and its impact on plant growth promotion. Sugar Tech 22, 143–156.

Hussain, I., Liqa, R., Hanjra, M.A., Marikar, F., Van der Hoek, W., 2001. Framework for analyzing socio-economic, health and environmental impacts of wastewater use in agriculture. IWMI working paper 26. International Water Management Institute, Colombo: Sri Lanka.

Jackson, M.L., 1973. Soil Chemical Analysis. Prentice Hall India Pvt. Ltd. New Delhi. India. pp. 1–498.

Kayuki, C.K., Byalebeka, J., Wortmann, C.S., Mamo, M., 2007. Low input approaches for soil fertility management in semiarid eastern Uganda. Agronomy Journal 99, 847–853.

Kitson, R.E., Mellon, M.G., 1944. Colorimetric determination of phosphorus as molybdivanadophosphoric acid. Industrial and Engineering Chemistry, Analytical Edition 16(6), 379–383.

Lakshmi, C.S.R., Sreelatha, T., Sireesha, A., Lakshmi, M.B., Jamuna, P., 2019. Efficient recycling of sugarcane byproducts through integrated composting. International Journal of Agriculture Sciences 11, 9004–9006.

Mahalakshmi, R., Naveena, M.L., 2016. Usage of banana pseudostem waste for the production of potassic biofertilizer using cellulolytic bacteria. International

Journal of Current Microbiology and Applied Sciences 5(8), 336–349.
Mawahib, E.M.E., Elfadil, A.G., Manal, F.A., BadrEldin, A.E.S., 2015. Effects of banana compost on growth, development and productivity of sorghum bicolor cultivar (Tabat). Journal of Advances in Biology 8(2), 1555–1561.
Perner, H., Schwarz, D., George, E., 2006. Effect of mycorrhizal inoculation and compost supply on growth and nutrient uptake of young leek plants grown on peat-based substrates. Horticultural Science 4, 628–632.
Premalatha, N., Sundaram, S.P., Anandham, R., Krishnamoorthy, R., Gopal, N.O., 2019. Composting of organic waste materials using the bacterial consortium and its effect on plant growth promotion. International Journal of Chemical Studies 7(3), 4751–4756.
Premalatha, N., Sundaram, S.P., Krishnamoorthy, R., Anandham, R., Kwon, S.W., Gopal, N.O., Thiyageshwari, S., Indirani, R., Kumutha, K., Paul, D., 2017. Organic waste composting with bacterial consortium and its effect on plant growth promotion. Asian Journal of Plant Science and Research 8(3), 22–30.
Shamini, K., Fauziah, S.H., 2014. Enhanced vermicomposting for combination of organic waste through subsequent treatment with selected microorganisms. Journal of Microbiology Research 4(2), 54–67.
Walkley, A., Black, C.A., 1935. An examination of digestion methods for determining soil organic matter and proposed modifications of the chromic acid titration method. Soil Science 37, 29–38.
Wang, C.M., Changa, C.M., Watson, M.E., Dick, W.A., Chen, Y., Hoitink, H.A.J., 2004. Maturity indices of composted dairy and pig manures. Soil Biology and Biochemistry 36, 767–776.
Zeng, G., Yu, Z., Chen, Y., Zhang, J., Li, H., Yu, M., Zhao, M., 2011. Response of compost maturity and microbial community composition to pentachlorophenol (PCP)-contaminated soil during composting. Bioresource Technology 102, 5905–5911.