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Composting of Rice Straw with Waste Decomposers and Effective Microorganisms and their Effects on Compost Quality

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ABSTRACT

Composting is one of the best ways to manage rice straw and reduce environmental pollution with added value to the soil. The experiment was conducted at Lovely Professional University, Punjab in the agriculture research field to study the effect of waste decomposers and effective microorganisms on composting of rice straw and evaluate the quality of compost in the *rabi* season (2021-22). The experiment was laid out in a split plot design (SPD) with 10 treatments and three replications. Treatment involved were: M_1 (main plot) – System of rice intensification (SRI) with 60:40:30 kg NPK/ha, M_2 – Conventional methods of rice cultivation (150:50:50 NPK/ha), S_1 (Sub-plot) – Rice straw (RS) alone, S_2 – Waste decomposer (WD) + RS, S_3 – Effective microorganisms (EM) + RS, S_4 – WD + EM + RS, S_5 – RS + soil, S_6 – WD + RS + soil, S_7 – EM + RS + soil and S_8 – WD + EM + RS + soil. The minimum C/N ratio was recorded in M_1 (10.32%) and S_4 (44.82%). The highest humic acid was observed in M_1 (9.90%) and S_4 (60.06%). M_1 (5.34%) and S_4 (58.2%) had the highest fulvic acid. The least CO_2 evolution was recorded in M_1 (5.71%) and S_4 (79.3%). This study suggested that the combined application of WD and EM with rice straw may be beneficial for increasing mineralization, shortening composting periods and promoting SRI farming methodology over conventional methods of rice cultivation.

Key words: Waste decomposer, effective microorganisms, rice straw, composting, C/N ratio

INTRODUCTION

Rice (*Oryza sativa* L.) is a staple crop that is vital throughout the Asian subcontinent, supporting food security and providing a source of income for millions of rural communities. The three major rice by-products are straw, rice husk and rice bran. About 760 million tonnes of rice straw are produced annually, which is 1.5 times the yield of rice grains per tonne. Straw has a high lignocellulose content of 25.1% of agricultural waste (Narisetty *et al.,* 2022). It produces a wide range of mineral nutrients and organic substances. Humic substances (HS) are the most important by-products of composting and are critical for carbon sequestration. Humic substance production took place during organic waste decomposition (Wu *et al.,* 2017). The most abundant component in straw is rich in humic acid (HA), fulvic acid (FA) and humus (Shi *et al.,* 2020). Because of its high carbon content and adsorption capability, HA may significantly boost soil fertility (Chen *et al.*, 2020a, b).

On another note, composting can emit CO_2, which is classified as an ecologically harmful gas. CO_2 known as one of the greenhouse gases increased levels of CO_2 above the threshold extremely harmful to human health. Increased CO_2 emissions reduce carbon sequestration during composting, thus lowering compost quality (Lu *et al.,* 2018). Furthermore, physical, chemical and biological pre-treatments improve lignocellulose biocompatibility and release substrates and precursors for microbial utilization. Dr. Krishan Chandra under the National Centre launched an indigenous waste decomposer culture in 2015 for organic farming (NCOF). The Indian Council for Agricultural Research (ICAR) has tested and approved this culture as a waste decomposer. Also been found to have a positive impact on soil and plant health and efficient way to compost organic waste. The waste decomposer, according to him, functions as a *biofertilizer*, a biocontrol agent, and a Soil Health Reviver (Kora *et al.,* 2022). This demonstrated that the waste decomposer had

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completed the acidogenic fermentation phase of composting, indicating that decomposition occurred more quickly in these treatments (Kaur and Katyal., 2021). Japanese researchers invented the idea of effective microorganisms (EM). TeruoHiga, M.D. The quality of the rice straw compost improved by employing effective microorganisms, which also improved lignocellulose degradation and speeded up the composting process (Ghasemzadeh *et al.,* 2022). The thermophilic phase persisted longer 4 days in studies with effective microorganisms and the rate of decomposition rose (16.1%), the compost reached its maximum temperature faster (3 days) and the maturation period shrunk (4 weeks). However, the maturation period would be longer than four weeks if effective microbes and thermal stimulation were not used (Charkhestani and Kebria, 2022).

Numerous studies carried out to increase the rate of decomposition in 30 days before the planting of wheat crops. Only a few uses of waste decomposers and efficient microorganisms were reported in the literature in India, particularly in the Punjab region. Determining how rice straw composting responds to environmentally-friendly decomposition and the amount of C/N ratio, humic substance, fulvic substance and CO_2 evolutions generated during the process in semi-arid circumstances is the goal of the current study.

MATERIALS AND METHODS

The study was conducted in a research field of Lovely Professional University, Punjab. The total area of the trial was 1080 m^2 for two consequent years (2021-22) under split plot design. Main plots (M) employed two treatments (farming methodology) viz., M_1 – SRI (System of rice intensification with N: P: K = 60:40:30 kg/ha) and M_2 – Conventional methods of rice cultivation (N: P: K = 150:50:50 kg/ha) based on highest productivity of paddy. The sub-plot (S) treatments included 10 treatments: S_1 : Control (only rice straw); S_2 : Rice straw + waste decomposer; S_3 : Rice straw + effective microorganisms; S_4 : Rice straw + waste decomposer + effective microorganisms; S_5 : Rice straw + soil; S_6 : Rice straw + waste decomposer + soil; S_7 : Rice straw + effective microorganism + soil and S_8 : Rice straw + waste decomposer + effective microorganism + soil. The area under each main-plot and sub-plot was 540 and 20 m^2.

After the harvesting of rice crops, the straw was shredded on the field itself as per the allotted treatment plot. The shredded rice straw was soaked in water for 24 h before starting the composting process. The mixtures used for all piles were arranged with the ratio as follows: 100% rice straw, 100% WD, 100% EM, in which 10 kg of rice straw was mixed with 15 liters of waste decomposer and 15 liters of EM solution as per the treatments in three replications each. In this study, commercial WD (a consortium of beneficial microorganisms derived from Indian cow dung) and EM (EM•1W) containing bacteria, lactic acid bacteria, yeasts, actinomycetes and fermenting fungi were used.

The solution contained microorganisms prepared from a WD and EM solution, an active suspension of the two materials in molasses (sugar cane), and non-chlorinated water or rice rinse water. It supplied the nutrients necessary for the growth of microorganisms. At five-day intervals, waste decomposer and effective microorganism solution were added to the heaps throughout the active composting period to maintain moisture. A three-day interval was used to turn the mixture and compost for the first week and later with 10 days intervals until the final day 30. To study changes in the physical and chemical properties of compost throughout composting, samples from each treatment were taken at 7, 15 and 30 days. Two samples were collected from the piles. One portion dried to constant weight (60 °C for two days) for chemical analysis. The dried samples were ground in a mortar to pass through a 2 mm sieve and were stored in screw-capped jars. The remaining portion was used for testing of total carbon.

The moisture level was measured using gravimetric techniques. Five grams of compost was weighed after drying for 24 hours at 105 °C (weighing and reweighing until a steady weight was attained). After allowing the samples to cool at room temperature, the final weight was measured. Kjeldahl's Method was used to calculate total nitrogen. A compostable sample (500 g) was taken with 10 ml sulphuric acid and digestion mixture, potassium sulphate (K_2SO_4), copper sulphate ($CuSo_4$) and selenium oxide (SeO_2) in the ratio of mixture

10:4:1 (w/w) for digestion in Kjeldahl's and titrated against 0.02 N hydrochloric acid and getting permanent pink as the endpoint. The dry combustion technique was used to measure total organic carbon (TOC). The compost sample (500 mg) was taken in a silica crucible and kept in the furnace at 500° for 1 h. The ash content in the silica crucible was determined by the next day. Then, the organic carbon was calculated by using the following formula:

Ash (%) = 100 x [(weight of ash)/(weight of compost)]

Organic carbon (%) = [100–ash (%)]/ 1.724

Where, Weight of compost – Weight of compost with crucible - the empty crucible; and weight of ash – Weight of ash with crucible – empty crucible.

Humic and fulvic substances were determined by the Kononova method 20 ml of sodium hydroxide (NaOH) with normality (N) 0.5 was added to one g of compostable material which was properly dried and kept overnight. The filtrate was transferred to a centrifuge at 10,000 rpm for 10 min and the residue obtained was dissolved in 25 ml of 0.5N NaOH and from it, only 5 ml was used for the determination. The Parmar and Schmidt methods were used to determine CO_2 evolution. Ten ml of 1N NaOH was taken in 25 ml capacity tubes and placed in the flasks. The flash was fitted with a rubber cork and with the help of wax sealing it was maid airtight and incubated at 30 ^{0}C. The CO_2 which evolved from the compost was absorbed in alkali and it was estimated by using 1NHCl (hydrochloric acid) titration. The CO_2 amount of evolution was calculated as:

1 mg of CO_2/100 g compost = {(B-R) x 22 x 12 x 10}/44

Where, B = ml of 1 N HCl used in the blank; R – ml of 1 N HCl used in a flask with compost and 1 ml of 1N HCl used against 1 N NaOH – 22 mg $C0_2$.

Statistical analysis was carried out using the statistical tool for agriculture software (STAR) and ANOVA to analyze the significant variation in the data.

RESULTS AND DISCUSSION

The C/N ratio is one of the important criteria for the determination of the quality of compost. By having a higher C/N ratio at starting scale, the biomass will have higher carbon contents and less nitrogen, which will result in longer processing times, immaturity and low quality of the finished compost (Esmaeili *et al.,* 2020). During the first year (2021), on day 7: Main plot – M_1 (SRI) obtained the lowest C/N ratio (18.14%) as compared to M_2 (conventional methods of rice cultivation). In sub-plots – S_8 (rice straw + waste decomposer + effective microorganism + soil) obtained the lowest C/N ratio (23.86%) followed by S4 (rice straw + waste decomposer + effective microorganism) = 20.45% compared to the control (S_1). At day 15: M_1 and M_2 : lowest C:N ratio was recorded at par (Table 1). In sub-plots, S_8 was observed with the lowest C/N ratio (39.38%), followed by S_4 (35.83%) compared to the control (S_1). On day 30: M_1 obtain the lowest C/N ratio (12.03%) as compared to M_2. In sub-plots, lowest C/N ratio was recorded in S_8 (46.14%) followed by S_4 (43.76%) as compared to the control (S_1).

During the second year (2022), on day 7: in main plot M1 (SRI) and M2 (Conventional methods of rice cultivation), the lowest C:N ratio was recorded at par. In sub-plots S_8 (rice straw + waste decomposer + effective microorganism + soil) obtained the lowest C/N ratio (24.0%) followed by S4 (rice straw + waste decomposer + effective microorganism) – 17.74% compared to the control (S_1). At day 15: M_1 and M_2 – the lowest C:N ratio was recorded at par. In sub-plots – S_8 observed with the lowest C/N ratio (20.94%), followed by S_4 (20.03%) compared to the control (S_1). On day 30: M_1 obtained the lowest C/N ratio (8.3%) as compared to M_2. In sub-plots, lowest C/N ratio was recorded in S_8 (43.31%) followed by S_4 (41.54%) as compared to the control (S_1). A reduction in the C/N ratio of more than 40% indicated compost maturity (Nair *et al.*, 2016). A high C/N ratio in compost is an indicator of the presence of unutilized complex C and N, while low C/N ratios showed the complete decomposition of biomass (Chen *et al.*, 2019a, b; Karanja *et al.*, 2019). Analyzing the pooled data of the two subsequent years 2021 and 2022, the best treatment M_1 (10.32%) was considered with the lowest C/N ratio as

Table 1. Effect of waste decomposer (WD) and effective microorganisms on change in C/N ratio during rice straw compositing

C:N ratio	DAY 7		DAY 15		DAY 30	
	2021	2022	2021	2022	2021	2022
M–Main plot						
M_1	63.02^{b}	74.66^{a}	59.66^{b}	71.61^{a}	47.95^{b}	45.86^{b}
M_2	76.98a	79.03^{a}	63.39^{a}	72.29^{a}	54.51^{a}	50.04^{a}
S. Em(±)	0.84	1.09	0.89	0.51	0.06	0.26
C. D. ($P \leq 0.05$)	5.09	6.61	5.39	3.13	0.34	1.56
S–Sub Plot						
S_1	85.52^{a}	88.66^{a}	79.42^{a}	82.50^{a}	66.77^{a}	62.75^{a}
S_2	72.63^{c}	77.79^{bc}	56.13^{cd}	69.43^{cd}	44.64^{c}	45.53^{c}
S_3	75.54^{b}	80.39^{b}	60.83^{bc}	73.45^{bc}	53.37^{b}	51.30^{bc}
S_4	68.03^{d}	72.93^{c}	50.96^{d}	65.97^{d}	37.55^{cd}	36.68^{d}
S_5	78.87^{b}	76.41^{bc}	68.67^{b}	77.21^{ab}	58.97^{ab}	56.76^{ab}
S_6	76.37^{bc}	76.67^{bc}	61.33^{bc}	71.56^{bcd}	56.74^{b}	47.73^{c}
S_7	73.91^{c}	74.52^{c}	66.73^{b}	70.26^{cd}	55.82^{b}	47.29^{c}
S_8	65.11^{d}	67.38^{d}	48.14^{d}	65.22^{d}	35.96^{d}	35.57^{d}
S. Em(±)	1.60	1.72	1.96	1.44	1.84	1.57
C. D. ($P \leq 0.05$)	4.63	4.99	5.67	4.16	5.33	4.55

Where, CD – Critical difference, M_1 – SRI, M_2 – Conventional methods of rice cultivation, S_1 – Control (rice straw alone), S_2 – Waste decomposer + rice straw, S_3 – Effective microorganisms + rice straw, S_4 – Waste decomposer + effective microorganisms + rice straw, S_5 – Rice straw + soil, S_6 – Rice straw + waste decomposer + soil, S_7 – Rice straw + effective microorganisms + soil and S_8 – Rice straw + waste decomposer + effective microorganisms + soil. Different superscripts differ significantly.

compared to S_2 (Fig. 1). In sub-plots, statistically, the lowest C/N ratio was at par but S_4 (44.82%) was recorded as the best treatment followed by S_8 (43.98%) as compared to S_1 (control – paddy straw alone) because they were under the marginal range of maturity of compost. The reduction in the C/N ratio of more than 40% indicated compost maturity (Nair *et al.*, 2016). The results of a similar study showed that the co-application of C/N ratio improvers and indigenous microorganisms caused a greater C/N ratio reduction (Sharafi *et al.*, 2023). Research conducted by Dash *et al.* (2021) also showed that microbial consortium lowered C/N ratio respectively at the 28th day of composting.

It is important to evaluate the degree of humification in compost to determine its quality from an agronomic standpoint (Li *et al.*, 2017). It disrupted the lignocellulosic structure and degraded organic fractions, resulting in humic acid production (Wu *et al.*, 2017). During the first year 2021 on day 30: Main plot M_1 (SRI) obtained the highest humic acid content (8.65%) as compared to M_2 (conventional methods of rice cultivation). In sub-plots, the highest humic acid was obtained at par in S8 (rice straw + waste decomposer + effective microorganism + soil) and S_4 (rice straw + waste decomposer + effective microorganism)

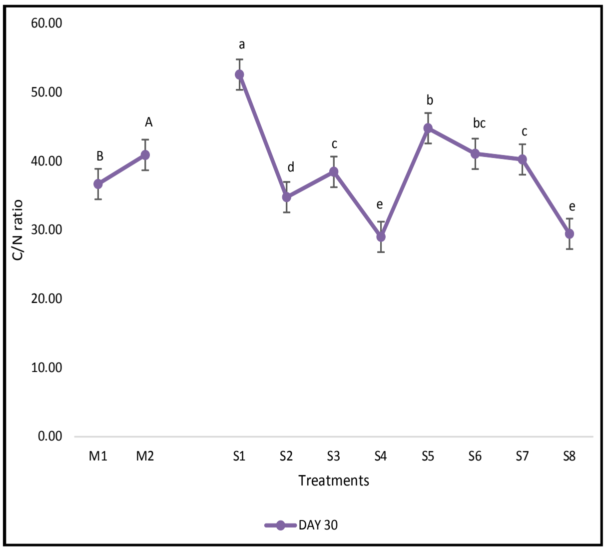

Fig. 1. Pooled data of the C:N ratio (2021-22) caused by the effect of waste decomposer (WD) and effective microorganisms.

Where, A, B = Ranking for the main plot, a, b, c, d, e – Ranking for the sub-plot, M_1 – SRI, M_2 – Conventional methods of rice cultivation, S_1 – Control (rice straw alone), S_2 – Waste decomposer + rice straw, S_3 – Effective microorganisms + rice straw, S_4 – Waste decomposer + effective microorganisms + rice straw, S_5 – Rice straw + soil, S_6 – Rice straw + waste decomposer + soil, S_7 – Rice straw + effective microorganisms + soil and S_8 – Rice straw + waste decomposer + effective microorganisms + soil.

compared to the control (S_1). During the first year 2021 on day 30: highest fulvic acid content was recorded at par in M_1 and M_2 (Tables 2 and 3). In sub-plots, S_8 was observed with the highest fulvic acid content (69.51 %), followed by S_4 (48.31%) compared to the control (S_1).
During the second year 2022 on day 30: in main plot M_1 (SRI) and M_2 (Conventional methods of rice cultivation), the highest humic acid substances were recorded in M_1 by 11.06%. In sub-plots, the highest humic acid content was at par in S_8 (rice straw + waste decomposer + effective microorganism + soil) and S_4 (rice straw + waste decomposer + effective microorganism) but far better as compared to the control (S_1). In the second year 2022: highest fulvic acid contents were recorded in M_1 (12.27%) as compared to M_2. In sub-plots, the highest fulvic acid content was recorded at par with S_2, S_4, S_6, S_7 and S_8 as compared to control S_1. The increase in the humic acid and fulvic acid content due to the decomposition of straw resulted in an increase in the level with time. For compost products to be of better quality, it is vital to increase the content of humic acid in compost and to promote its humification. By analyzing the pooled data of the two subsequent years, humic acid in main plots, M_1 (9.90%) was observed best treatment as compared to M_2. In sub-plots (S), the highest humic acid substance was recorded in S_4 and S_8 was at par with 28.8% and 26.09% as compared to S_1 compared to control (Fig. 2). Fulvic acid contents in the main plot: M_1 (5.34%) stood the best treatment by obtaining the highest fulvic content as compared to M_2 (Fig. 3). In subplots (S), S_8 (60.6%) and S_4 (58.2%) were observed with highest fulvic acid contents as compared to S_1 (Rice straw alone).
Microbial degradation allowed the conversion of organic materials into carbon dioxide (CO_2), which was then released into the environment. The CO_2 evolution from the composted straws was analyzed for four weeks after the 30 days of composting (Table 2). During the first year 2021, in 1st week: main plot the least CO_2 evolution in M_1 (SRI) and M_2 (conventional methods of rice cultivation) were recorded at par (Table 3). In sub-plots, the least CO_2 evolution was obtained at par with S_4 (rice straw + waste decomposer + effective microorganism) and S_8 (rice straw + waste decomposer + effective microorganism + soil)

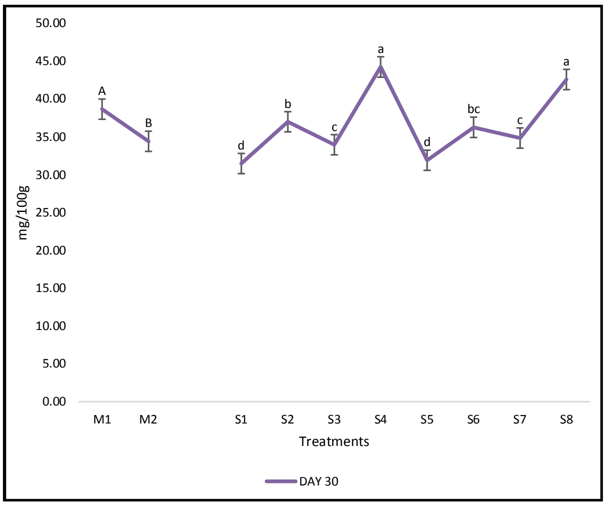

Fig. 2. Pooled data on humic substances (2021-22) caused by the effect of waste decomposer (WD) and effective microorganisms.
Where, A, B = Ranking for the main plot, a,b,c,d,e – Ranking for the sub-plot, M_1 – SRI, M_2 – Conventional methods of rice cultivation, S_1 – Control (rice straw alone), S_2 – Waste decomposer + rice straw, S_3 – Effective microorganisms + rice straw, S_4 – Waste decomposer + effective microorganisms + rice straw, S_5 – Rice straw + soil, S_6 – Rice straw + waste decomposer + soil, S_7 – Rice straw + effective microorganisms + soil and S_8 – Rice straw + waste decomposer + effective microorganisms + soil.

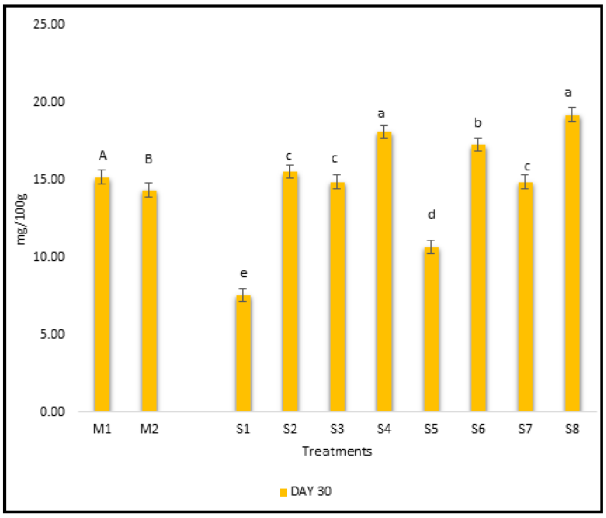

Fig. 3. Pooled data on fulvic substances caused by the effect of waste decomposer (WD) and effective microorganisms.
Where, A, B = Ranking for the main plot, a, b, c, d, e – Ranking for the sub-plot, M_1 – SRI, M_2 – Conventional methods of rice cultivation, S_1 – Control (rice straw alone), S_2 – Waste decomposer + rice straw, S_3 – Effective microorganisms + rice straw, S_4 – Waste decomposer + effective microorganisms + rice straw, S_5 – Rice straw + soil, S_6 – Rice straw + waste decomposer + soil, S_7 – Rice straw + effective microorganisms + soil and S_8 – Rice straw + waste decomposer + effective microorganisms + soil.

Table 2. Effect of waste decomposer (WD) and effective microorganisms on humic acid (mg/g) and fulvic acid (mg/g) content during rice straw compositing

Day 30	Humic acid (mg/g)		Fulvic acid (mg/g)	
	2021	2022	2021	2022
M–Main plot				
M_1	46.55^{a}	50.35^{a}	17.49^{a}	19.64^{a}
M_2	42.52^{b}	44.78^{b}	15.92^{a}	17.23^{b}
S. Em(±)	0.16	0.76	0.37	0.43
C. D. (P ≤ 0.05)	0.99	4.64	2.23	2.63
S–Sub plot				
S_1	37.29^{d}	39.07^{d}	10.44^{d}	11.15^{c}
S_2	45.96^{ab}	47.53^{bc}	18.50^{bc}	20.08^{ab}
S_3	42.30^{bcd}	45.37^{bc}	15.68^{c}	17.92^{b}
S_4	51.94^{a}	56.29^{a}	20.20^{b}	22.35^{ab}
S_5	38.99^{cd}	40.07^{d}	11.66^{d}	12.28^{c}
S_6	44.77^{bc}	48.68^{b}	19.84^{b}	21.07^{ab}
S_7	42.81^{bcd}	46.05^{bc}	16.44^{bc}	19.01^{ab}
S_8	52.22^{a}	57.47^{a}	35.33^{a}	23.60^{a}
S. Em(±)	1.41	1.31	0.98	1.08
C. D. (P ≤ 0.05)	4.09	3.79	2.84	3.12

The details of main plots and Sub-plots and superscripts given in Table 1.

with 49.31 and 47.45% compared to the control (S_1 rice straw alone). In 2nd week, the least CO_2 evolution was recorded in M_2 (6.97%) as compared to M_1. In sub-plots, S_4 (58.02%) and S_8 (55.73%) were observed at par with the least CO_2 evolution as compared to the control (S_1). In 3rd week, M_2 (11.20%) contributed less amount of CO_2 evolution as compared to M_2. In sub-plots, S_4 (69.44%) and S_8 (66.8%) were recorded the least CO_2 evolution as compared to the control. In the 4th week, M_2 (9.45%) produced the least amount of CO_2 evolution as compared to M_1. In sub-plots, S_4 (79%) produced the least amount of CO_2 as compared to S_1. During the second year 2022, in 1stweek: in main plot M_1 (SRI) and M_2 (Conventional methods of rice cultivation), the least CO_2 was released. In sub-plots, the least amount of CO_2 was with S_4 (rice straw + waste decomposer + effective microorganism + soil) and S_8 (rice straw + waste decomposer + effective microorganism) but was far better as compared to the control (S_1) by 44.23 and 42.49%. In 2nd week, M_2 (16.69%) was recorded as the least CO_2 evolution as compared to M_2. In sub-plots, the least amount of CO_2 evolution was obtained in S_4 (46.53%) as compared to the control (S_1). In 3rd week, M_1 and M_2 were recorded as with each other. In sub-plots, S_4 (63.57%) produced the least amount of CO_2 evolution as compared to the control. In the 4th week, M_2 (21.66%) was recorded as least CO_2 evolution as compared to M_1. In sub-plots, S_4 (79.45%) was recorded as the best treatment for the least amount of CO_2 evolution as compared to the control (S_1). The high amounts of CO_2 released during 1st week were an indication that the microorganisms used most of the present carbon. Due to the rapid decomposition of easily degradable organic matter at the beginning of composting, CO_2 emissions increased and then decreased gradually until the end of composting. By

Table 3. Effect of waste decomposer (WD) and effective microorganisms CO_2 evolution (mg/100 g) from farming methodology and composting agents during rice straw compositing

Treatments	1st week (mg/100 g)		2nd week (mg/100 g)		3rd week (mg/100 g)		4thweek (mg/100 g)	
	2021	2022	2021	2022	2021	2022	2021	2022
Main Plot								
M_1	98.86^{a}	103.54^{a}	79.76^{a}	98.43^{a}	58.72^{b}	61.73^{a}	55.13^{a}	67.44^{a}
M_2	97.63^{a}	98.43^{a}	74.20^{b}	82.00^{b}	66.13^{a}	59.13^{a}	49.92^{b}	52.83^{b}
S. Em(±)	0.52	0.96	0.38	0.25	0.52	0.89	1.61	1.13
C. D. (P ≤ 0.05)	3.19	5.81	2.33	1.51	3.16	5.39	4.66	6.86
Sub-plots								
S_1	137.40^{a}	141.23^{a}	123.25^{a}	130.04^{a}	106.00^{a}	101.63^{a}	97.62^{a}	99.73^{a}
S_2	84.81^{d}	84.11^{c}	59.94^{bcd}	77.01^{bc}	44.13^{bcd}	46.74^{bc}	30.00^{c}	27.95^{c}
S_3	94.84^{bc}	95.46^{b}	66.64^{b}	80.46^{bc}	61.17^{b}	51.65^{b}	55.00^{b}	45.25^{b}
S_4	69.64^{e}	78.77^{c}	51.73^{d}	69.52^{e}	32.17^{de}	37.02^{d}	20.34^{d}	20.49^{d}
S_5	139.66^{a}	144.24^{a}	128.34^{a}	133.25^{a}	109.65^{a}	103.43^{a}	101.74^{a}	103.18^{a}
S_6	88.26^{cd}	83.89^{c}	63.04^{bc}	76.84^{bc}	47.39^{bc}	48.92^{b}	34.19^{c}	31.03^{c}
S_7	99.17^{b}	98.93^{b}	68.32^{b}	83.29^{b}	63.71^{b}	54.97^{b}	58.58^{b}	47.57^{b}
S_8	72.19^{e}	81.22^{c}	54.56^{cd}	71.33^{de}	35.19^{cde}	39.08^{cd}	22.76^{d}	22.63^{d}
S. Em(±)	1.76	2.28	2.37	1.15	1.61	1.97	1.21	1.23
C. D. (P ≤ 0.05)	5.10	6.6	6.85	3.34	4.66	5.72	3.51	3.56

The details of main plots and Sub-plots and superscripts given in Table 1.

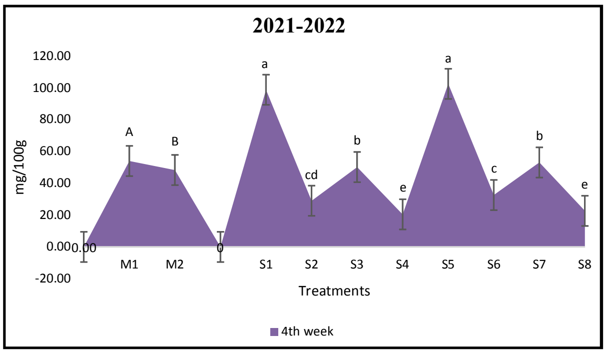

Fig. 4. Pool data on CO_2 evolution caused by the effect of waste decomposer (WD) and effective microorganisms.

Where, A, B = Ranking for the main plot, a, b, c, d, e – Ranking for the sub-plot, M_1 – SRI, M_2 – Conventional methods of rice cultivation, S_1 – Control (rice straw alone), S_2 – Waste decomposer + rice straw, S_3 – Effective microorganisms + rice straw, S_4 – Waste decomposer + effective microorganisms + rice straw, S_5 – Rice straw + soil, S_6 – Rice straw + waste decomposer + soil, S_7 – Rice straw + effective microorganisms + soil and S_8 – Rice straw + waste decomposer + effective microorganisms + soil.

analyzing the pooled data of the two subsequent years, the least CO_2 evolution in main plots: M_1 (5.71%) was observed best treatment as compared to M2. In sub-plots (S), the lowest CO_2 evolution was recorded in S_4 and S_8 was at par with 79.31 and 77% as compared to S_1 compared to control (Fig. 4).

CONCLUSION

Treatment plots as well as sub-pots showed similar patterns based on the composting parameters. When compared with those in the control, variables showed that decomposition occurred throughout the treatment. The C/N ratio, the humic substance, fulvic substances and the CO_2 changes showed that the degradation of rice straw happened over the course of 30 days. The decline of TOC values and the C/N ratio indicated that microorganisms consumed the organic compound inside the rice straw. There was a significant difference in the compost treated with S_4 waste decomposer with effective microorganisms as well as the compost that was not treated. These facts provided evidence in support, that waste decomposer with effective microorganisms' treatment had a larger humic and fulvic content. However, the CO_2 changes in compost that had waste decomposer with effective microorganisms were significantly less than those in compost that was not treated with waste decomposer or effective microorganisms. In terms of the C/N ratio, there was a significant high difference between the SRI and conventional methods for cultivating rice and thereby, promoting SRI over conventional methods of rice cultivation.

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