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The decomposition of farm wastes through microorganisms

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Abstract
An experiment was conducted at Plant Pathology Section, College of Agriculture, Nagpur during 2024-2025. A eight main treatment i.e. Paddy straw+ soybean straw (1:1), Paddy straw+ soybean straw (2:1), Wheat straw+ soybean straw (1:1), Wheat straw+ soybean straw (2:1), Paddy straw+ Tur straw (1:1), Paddy straw+ Tur straw (2:1), Wheat straw+ Tur straw (1:1) and Wheat straw+ Tur straw (2:1). The enrichment of biofertilizers i.e. *Azotobacter chroococcum*, PSB (*Bacillus subtilis*) and *Trichoderma viride* was procure from Department of Plant Pathology, College of Agriculture, Nagpur. and it was to investigate their greatest loss of weight in the sub-treatment Aw_1B_2 [i.e. Paddy + soybean straw (1:1)× PSB (*Bacillus subtilis*)] recorded maximum loss of weight at 30 days 20.91%, 125.45g and 60 days 52.02%, 312.11g and weight of straw at(30 and 60 days) 474.55g and 287.89g followed by sub-treatment Aw_5B_1 (i.e. Paddy + Tur straw (1:1)×*Azotobacter chroococcum*] at 30 days 20.73%, 122.31g and 60 days 51.00%, 300.90g and weight of straw at(30 and 60 days) 467.69g and 289.10g respectively.

Keywords: Farm wastes, *Azotobacter chroococcum*, PSB *(Bacillus subtilis)* and *Trichoderma viride*, decomposition

1. Introduction
India possesses significant potential in terms of both agricultural and industrial waste utilization. The primary agricultural sources include animal and human excreta, crop residues, tree litter, aquatic vegetation, green manures, waste from urban and rural areas, and tank silt. With the advent of high-yielding crop varieties and the adoption of intensive farming practices, large volumes of agricultural residues such as straw, leaves, twigs, stubble, and an abundance of grasses and weeds are readily accessible on farmlands. The burning of crop residues has offered a temporary solution for clearing agricultural fields; however, it has had severe long-term consequences, including the degradation of soil health, a decline in soil fertility, shortages of key nutrients (such as carbon, nitrogen, phosphorus, and potassium), reduced crop productivity and yield, and an increase in land becoming unsuitable for cultivation. Earlier research has highlighted the negative impacts of crop residue burning, particularly its contribution to air pollution through the release of harmful and toxic gases (Gadde *et al.*, 2009; Sahu *et al.*, 2015; Andini *et al.*, 2018) [14, 4].

2. Materials and Methods
During the present investigation, experiments were carried out on "Decomposition of Farm Wastes Through Microorganisms'' Materials used and methods adopted are described in this chapter. The present investigation was carried out during 2024-25 at Plant Pathology Section, College of Agriculture, Nagpur. The experiment was undertaken in CRD (Completely Randomized Design) with treatments and three replications and FCRD (Factorial Completely Randomized Design) with treatments and three replications. In this experiment carried out in polythene bag. Farm wastes materials taken in ratio i.e. main treatments Aw_1 - Paddy straw+ soybean straw (1:1), Aw_2 - Paddy straw+ soybean straw (2:1), Aw_3 - Wheat straw+ soybean straw (1:1), Aw_4 - Wheat straw+ soybean straw (2:1), Aw_5 - Paddy straw+ Tur straw (1:1), Aw_6 - Paddy straw+ Tur straw (2:1), Aw_7 - Wheat straw+ Tur straw (1:1) and Aw_8 - Wheat

straw+ Tur straw (2:1). was cut into pieces up to 1-2 inches and sterilized with autoclave. At first this substrate was added into Nagpur bio-decomposer, and after two months decomposition then enrichment of biofertilizer i.e. sub-treatments B1 - *Azotobacter chroococcum*, B2 - Phosphate Solubilizing Bacteria (*Bacillus subtilis*) and B3 - *Trichoderma viride*.

2.1 Percent loss in weight of substrates
The loss in weight of the organic material in the polythene bag was used to estimate the extent of decomposition. The weight loss was determined by subtracting the final weight from the initial weight.

3. Results and Discussion
3.1 Estimation of loss in weight: Decomposition of agricultural wastes by inoculum of fungal culture (Nagpur Bio-decomposer)
After 30 and 60 days of decomposition of substrates by fungal culture, the percent loss in weight during decomposition of agriculture wastes are furnished in table no.1 and fig.no 1 showed that the treatment Aw_1 [i.e. Paddy + Soybean straw (1:1)] were significantly superior over all other treatments. The treatment Aw_1 [i.e. Paddy + Soybean straw (1:1)] showed maximum loss in weight of agriculture wastes of all other treatments after 30 and 60 days of decomposition i.e. 20.27%, 41.66% and 0.63g, 1.29g followed by treatment Aw_5 [i.e. Paddy + Tur straw (1:1)]20.18%, 40.84% and 0.61g, 1.23g. The reduction in weight was more significant during the first 45 days. Andrea *et al*. (1998) [5], measured a weight loss 29%, and Gautam *et al.* (2010) [18] observed weight loss over a 45 days period. These results confirm the finding of Somani *et al.*, (1982) [27] reported maximum loss in weight of cotton, mung and arhar substrates by inoculation of *Coprinus lagopus* and *Memnoiella echinata*. Bhasme *et al*. (2006) [7] here we have to reported that weight loss of substrate at 15,30, 45 and 60 days during decomposition i.e. 24.13%, 36.50%, 46.14% and 56.52% Gade *et al.* (2010) [15] also reported that percent weight loss of agriculture waste material by the use of microorganisms during all three years maximum percent loss of weight of substrates was in *Trichoderma* + *Trichurus* + *Cellulomonas* is 57.00, 60.14 and 52.4

Table 1: Percent loss in weight of substrates at 30 and 60 days of inoculation of fungal culture during decomposition of farm wastes.

Treatment No.	Treatments	Ratio Of Straw	Initial weight of Dry straw(kg)	Initial weight of Wet straw(kg)	Weight of straw at 30 days (kg)	Loss of weight at 30 days (kg)	Loss of weight at 30 days in Percent(%)	Weight of straw at 60 days (kg)	Loss of weight at 60 days (kg)	Loss of weight at 60 days in Percent (%)
Aw_1	Paddy + Soybean straw	1:1	2.00	3.10	2.47	0.63	20.27	1.81	1.29	41.66
Aw_2	Paddy + Soybean straw	2:1	2.00	3.00	2.44	0.56	18.55	1.89	1.11	37.13
Aw_3	Wheat + Soybean straw	1:1	2.00	2.90	2.44	0.46	15.36	1.97	0.93	32.07
Aw_4	Wheat + Soybean straw	2:1	2.00	2.90	2.36	0.54	18.52	1.77	1.13	38.89
Aw_5	Paddy + Tur straw	1:1	2.00	3.00	2.39	0.61	20.18	1.77	1.23	40.84
Aw_6	Paddy + Tur straw	2:1	2.00	2.90	2.43	0.47	16.19	1.85	1.05	36.19
Aw_7	Wheat + Tur straw	1:1	2.00	2.80	2.39	0.41	14.46	2.12	0.68	24.46
Aw_8	Wheat + Tur straw	2:1	2.00	2.90	2.43	0.47	15.38	1.87	1.03	35.38
'F' Test				-	-	-	Sig	-	-	sig
SEm(±)				-	-	-	0.17	-	-	0.18
CD (P=0.05)				-	-	-	0.51	-	-	0.54

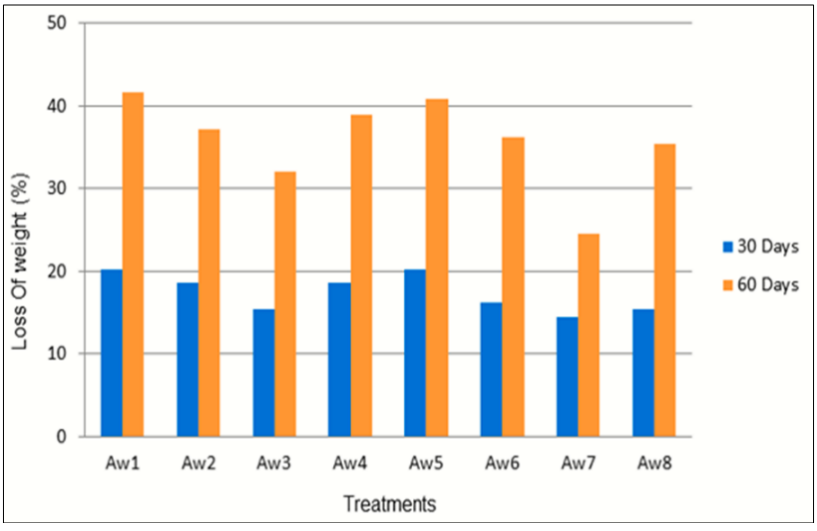

Fig 1: Percent loss of weight of substrate at 30 and 60 days of fungal culture inoculation.

3.2 Decomposition of agriculture wastes by inoculam of microbial (bacterial and fungal) culture

After 30 and 60 days of decomposition of substrates by Microbial (bacterial and fungal) culture, the percent loss in weight during decomposition of agriculture wastes, the results presented in Table no. 2 and 3 and fig.no.2. In treatment Aw_1 [Paddy + soybean straw (1:1)] showed that the sub-treatment Aw_1B_2[i.e. Paddy + soybean straw (1:1)× PSB (*Bacillus subtilis*)] were significantly superior over all other treatments. The sub-treatment Aw_1B_2[i.e. Paddy + soybean straw (1:1)× PSB (*Bacillus subtilis*)] showed maximum loss in weight of all other treatments at all intervals (30 and 60 days) i.e. 20.91%, 52.02% and 125.45g, 312.11g and weight of straw at (30 and 60 days) 474.55g and 287.89g followed by sub-treatment Aw_1B_3 (i.e. Paddy + soybean straw (1:1)× *Trichoderma viride*]i.e. 20.71%, 50.08% and 124.25g, 300.46g and weight of straw at (30 and 60 days) 475.75g and 299.54g respectively.

In treatment Aw_2 [Paddy + soybean straw (2:1)] showed that the sub-treatment Aw_2B_2 [i.e. Paddy + soybean straw (2:1)× Phosphate Solubilizing bacteria] were significantly superior over all other treatments. The sub-treatment Aw_2B_2 [i.e. Paddy + soybean straw (2:1)× PSB (*Bacillus subtilis*)] showed maximum loss in weight of all other treatments at all intervals (30 and 60 days) i.e. 19.15%, 45.91% and 121.25g, 290.59g and weight of straw at (30 and 60 days) 511.75g and 342.41g followed by sub-treatment Aw_2B_1 (i.e. Paddy + soybean straw (2:1)×*Azotobacter chroococcum*] i.e. 19.13%, 44.88% and 121.11g, 284.09g and weight of straw at (30 and 60 days) 511.89g and 348.91g respectively.

In treatment Aw_3 [Wheat + soybean straw (1:1)] showed that the sub-treatment Aw_3B_2 [i.e. Paddy + soybean straw (1:1)× PSB (*Bacillus subtilis*)] were significantly superior over all other treatments. The sub-treatment Aw_3B_2 [i.e. Paddy + soybean straw (1:1)× PSB (*Bacillus subtilis*)] showed maximum loss in weight of all other treatments at all intervals (30 and 60 days) i.e. 18.37%, 43.81% and 122.17g, 291.32g and weight of straw at (30 and 60 days) 542.83g and 373.68g followed by sub-treatment Aw_3B_1 (i.e. Paddy + soybean straw (1:1)×*Azotobacter chroococcum*] i.e. 18.35%, 42.28% and 122.03g, 281.19g and weight of straw at (30 and 60 days) 542.97g and 383.81g respectively.

In treatment Aw_4 [Wheat + soybean straw (2:1)] showed that the sub-treatment Aw_4B_1 [i.e. Paddy + soybean straw (2:1)×*Azotobacter chroococcum*] were significantly superior over all other treatments. The sub-treatment Aw_4B_1 [i.e. Paddy + soybean straw (2:1)×*Azotobacter chroococcum*] showed maximum loss in weight of all other treatments at all intervals (30 and 60 days) i.e. 19.54%, 47.34% and 115.31g, 279.33g and weight of straw at (30 and 60 days) 474.69g and 310.67g followed by sub-treatment Aw_4B_2 (i.e. Paddy + soybean straw (2:1)× PSB (*Bacillus subtilis*)] i.e. 19.40%, 46.10% and 114.46g, 271.99g and weight of straw at (30 and 60 days) 475.54g and 318.01g respectively.

In treatment Aw_5 [Paddy + Tur straw (1:1)] showed that the sub-treatment Aw_5B_1 (i.e. Paddy + Tur straw (1:1)×*Azotobacter chroococcum*] were significantly superior over all other treatments. The sub-treatment Aw_5B_1 (i.e. Paddy + Tur straw (1:1)×*Azotobacter chroococcum*] showed maximum loss in weight of all other treatments at all intervals (30 and 60 days) i.e. 20.73%, 51.00% and 122.31g, 300.90g and weight of straw at (30 and 60 days) 467.69g and 289.10g followed by sub-treatment Aw_5B_3 (i.e. Paddy + Tur straw (1:1)×*Trichoderma viride*] i.e. 20.60%, 46.28% and 121.55g, 273.07g and weight of straw at (30 and 60 days) 468.45g and 316.94g respectively.

In treatment Aw_6 [Paddy + Tur straw (2:1)] showed that the sub-treatment Aw_6B_1 [i.e. Paddy + Tur straw (2:1)×*Azotobacter chroococcum*] were significantly superior over all other treatments. The sub-treatment Aw_6B_1 [i.e. Paddy + Tur straw (2:1)×*Azotobacter chroococcum*] showed maximum loss in weight of all other treatments at all intervals (30 and 60 days) i.e. 18.86%, 45.58% and 115.97g, 280.31g and weight of straw at (30 and 60 days) 499.03g and 334.69g followed by sub-treatment Aw_6B_3 (i.e. Paddy + Tur straw (2:1)×*Trichoderma viride*] i.e. 18.81%, 44.06% and 115.65g, 270.96g and weight of straw at (30 and 60 days) 499.35g and 344.04g respectively.

In treatment Aw_7 [Wheat + Tur straw (1:1)] showed that the sub-treatment Aw_7B_2 [i.e. Wheat + Tur straw (1:1)× PSB (*Bacillus subtilis*)] were significantly superior over all other treatments. The sub-treatment Aw_7B_2 [i.e. Wheat + Tur straw (1:1)× PSB (*Bacillus subtilis*)] showed maximum loss in weight of all other treatments at all intervals (30 and 60 days) i.e. 18.24%, 44.56% and 127.66g, 311.96g and weight of straw at (30 and 60 days) 572.34g and 388.04g followed by sub-treatment Aw_7B_1 (i.e. Wheat + Tur straw (1:1)×*Azotobacter chroococcum*] i.e. 18.21%, 42.00% and 127.46g, 293.92g and weight of straw at (30 and 60 days) 572.54g and 406.08g respectively.

In treatment Aw_8 [Wheat + Tur straw (2:1)] showed that the sub-treatment Aw_8B_1 [i.e. Wheat + Tur straw (2:1)×*Azotobacter chroococcum*] were significantly superior over all other treatments. The sub-treatment Aw_8B_1 [i.e. Wheat + Tur straw (2:1)×*Azotobacter chroococcum*] showed maximum loss in weight of all other treatments at all intervals (30 and 60 days) i.e. 18.39%, 45.46% and 114.02g, 281.86g and weight of straw at (30 and 60 days) 505.98g and 338.14g followed by sub-treatment Aw_8B_2 (i.e. Wheat + Tur straw (2:1)× PSB (*Bacillus subtilis*)] i.e. 18.31%, 43.84% and 113.54g, 271.80g and weight of straw at (30 and 60 days) 506.46g and 348.20g respectively.

It was observed from the data in table no. 4 and 5. There was significant difference in treatments over other treaments. The sub-treatment Aw_1B_2 [i.e. Paddy + soybean straw (1:1)× PSB (*Bacillus subtilis*)] recorded maximum loss of weight at 30 days 20.91%, 125.45g and 60 days 52.02%, 312.11g and weight of straw at(30 and 60 days) 474.55g and 287.89g as it was found significantly superior over all other treatments. It was followed by sub-treatment Aw_5B_1 (i.e. Paddy + Tur straw (1:1)×*Azotobacter chroococcum*] at 30 days 20.73%, 122.31g and 60 days 51.00%, 300.90g and weight of straw at (30 and 60 days) 467.69g and 289.10g respectively. These results confirm the finding of Bahatkar *et al.,* (2023) [8] his observed that the bacterial cultures were applied on agriculture waste material comparising Soyabean straw, Pigeonpea straw, Wheat straw and cotton straw among all the cultures CDB 19 shown highest weight loss of the substrate (99.99%). It was also observed that maximum weight loss of cotton straw (99.99%) Osama *et al.,* here reported that loss of weight in cotton straw + chicken manure + *Azatobacter chroococcum* is 36.65%. Rupela *et al*., (2003) [24] his also observed that weight loss in rice straw at 30 days in bacterial inoculation is 38%.

Table 2: Percent loss in weight of substrate at 30 days inoculation of biofertilizer culture during decomposition of farm wastes.

Treatments	Initial weight (g)	Weight of straw at 30 days (g)	Loss in weight at 30 days (g)	Loss in weight at 30 days (%)	Initial weight (g)	Weight of straw at 30 days (g)	Loss in weight at 30 days (g)	Loss in weight at 30 days (%)	Initial weight (g)	Weight of straw at 30 days (g)	Loss in weight at 30 days (g)	Loss in weight at 30 days (%)	Initial weight (g)	Weight of straw at 30 days (g)	Loss in weight at 30 days (g)	Loss in weight at 30 days (%)
	Aw_1				Aw_2				Aw_3				Aw_4			
B_1	600	475.86	124.14	20.69	633	511.89	121.11	19.13	665	542.97	122.03	18.35	590	474.69	115.31	19.54
B_2	600	474.55	125.45	20.91	633	511.75	121.25	19.15	665	542.83	122.17	18.37	590	475.54	114.46	19.40
B_3	600	475.75	124.25	20.71	633	512.24	120.76	19.08	665	542.11	121.89	18.33	590	475.63	114.37	19.38
Mean	-	475.39	124.62	20.77	-	511.96	121.04	19.12	-	542.64	122.03	18.35	-	475.29	114.72	19.44
	A				B				A×B							
'F' Test	Sig				Sig				Sig							
SEm (±)	0.110				0.067				0.190							
CD(P=0.05)	0.313				0.191				0.542							

Table 3: Percent loss in weight of substrate at 30 days inoculation of biofertilizer culture during decomposition of farm wastes.

Treatments	Initial weight (g)	Weight of straw at 30 days (g)	Loss in weight at 30 days (g)	Loss in weight at 30 days (%)	Initial weight (g)	Weight of straw at 30 days (g)	Loss in weight at 30 days (g)	Loss in weight at 30 days (%)	Initial weight (g)	Weight of straw at 30 days (g)	Loss in weight at 30 days (g)	Loss in weight at 30 days (%)	Initial weight (g)	Weight of straw at 30 days (g)	Loss in weight at 30 days (g)	Loss in weight at 30 days (%)	
	Aw_5				Aw_6				Aw_7				Aw_8				Mean
B_1	590	467.69	122.31	20.73	615	499.03	115.97	18.86	700	572.54	127.46	18.21	620	505.98	114.02	18.39	19.24
B_2	590	469.55	120.45	20.42	615	500.11	114.89	18.68	700	572.34	127.66	18.24	620	506.46	113.54	18.31	19.19
B_3	590	468.45	121.55	20.60	615	499.35	115.65	18.81	700	573.40	126.60	18.09	620	506.18	113.18	18.25	19.16
Mean	-	468.56	121.44	20.58	-	499.50	115.50	18.78	-	572.76	127.24	18.18	-	506.21	113.58	18.32	-
	A				B				A×B								
'F' Test	Sig				Sig				Sig								
SEm (±)	0.110				0.067				0.190								
CD(P=0.05)	0.313				0.191				0.542								

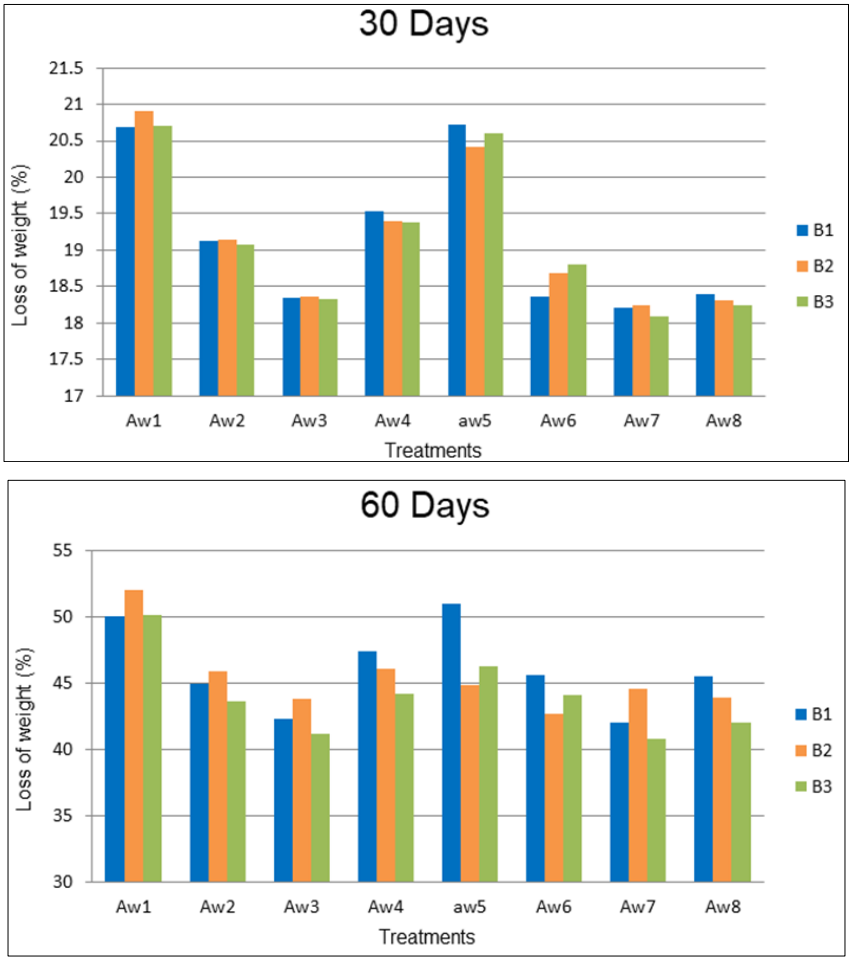

Fig 2: Percent loss of Weight of substrate at 30 and 60 days of Biofertilizer culture inoculation.

Table 4: Percent loss in weight of substrate at 60 days inoculation of biofertilizer culture during decomposition of farm wastes.

Treatments	Weight of straw at 60 days (g)	Loss in weight at 60 days (g)	Loss in weight at 60 days (%)	Weight of straw at 60 days (g)	Loss in weight at 60 days (g)	Loss in weight at 60 days (%)	Weight of straw at 60 days (g)	Loss in weight at 60 days (g)	Loss in weight at 60 days (%)	Weight of straw at 60 days (g)	Loss in weight at 60 days (g)	Loss in weight at 60 days (%)
	Aw_1			Aw_2			Aw_3			Aw_4		
B_1	306.10	293.90	48.98	348.91	284.09	44.88	383.81	281.19	42.28	310.67	279.33	47.34
B_2	287.89	312.11	52.02	342.41	290.59	45.91	373.68	291.32	43.81	318.01	271.99	46.10
B_3	299.54	300.46	50.08	375.12	275.88	43.58	391.46	273.54	41.13	329.14	260.86	44.21
Mean	297.84	302.16	50.36	349.48	283.52	44.79	382.98	282.02	42.41	319.27	270.73	45.88
	A			B			A×B					
'F' Test	Sig			Sig			Sig					
SEm (±)	0.64			0.39			1.11					
CD(P=0.05)	1.83			1.12			3.16					

Table 5: Percent loss in weight of substrate at 60 days inoculation of biofertilizer culture during decomposition of farm wastes.

Treatments	Weight of straw at 60 days (g)	Loss in weight at 60 days (g)	Loss in weight at 60 days (%)	Weight of straw at 60 days (g)	Loss in weight at 60 days (g)	Loss in weight at 60 days (%)	Weight of straw at 60 days (g)	Loss in weight at 60 days (g)	Loss in weight at 60 days (%)	Weight of straw at 60 days (g)	Loss in weight at 60 days (g)	Loss in weight at 60 days (%)	
	Aw_5			Aw_6			Aw_7			Aw_8			**Mean**
B_1	289.10	300.90	51.00	334.69	280.31	45.58	406.08	293.92	42.00	338.14	281.86	45.46	45.83
B_2	325.46	264.54	44.84	352.66	262.34	42.66	388.04	311.96	44.56	348.20	271.80	43.84	45.47
B_3	316.94	273.07	46.28	344.04	270.96	44.06	414.47	285.53	40.80	359.39	260.61	42.03	44.02
Mean	316.22	273.78	46.40	343.80	271.20	44.10	402.86	297.13	42.45	348.58	271.42	43.78	-
	A			B			A×B						
'F' Test	Sig			Sig			Sig						
SEm (±)	0.64			0.39			1.11						
CD(P=0.05)	1.83			1.12			3.16						

4. Conclusion

It is concluded from the present study evident that the decomposition of agriculture wastes by inoculation of fungal (Bio-decomposer) and bacterial culture. The maximum loss of weight sub-treatment Aw_1B_2 [i.e. Paddy + soybean straw (1:1)× PSB(*Bacillus subtilis*)] at 30 and 60 days.

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