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Studies on Biological Decomposition of Wheat-Straw II. Screening of Wheat-straw Decomposing Microorganisms under Field Conditions

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ABSTRACT

The straw decomposing ability of microorganisms which were previously screened under laboratory conditions was evaluated under field conditions. Out of sixteen microorganisms tested *Aspergillus* sp., *Cytophaga rubra*, mixed inoculation with all cultures, *Cellulomonas uda*, *Bacillus macerans* and *Serratia kiliensis* decomposed wheat straw within sixty days after inoculation. A gradual decline in total nitrogen and organic carbon contents was observed during decomposition period of 120 days. The inoculation of straw with different microorganisms had no significant effect on total phosphorus and potash content of compost, whereas humic acid synthesis was favoured.

INCREASED production of wheat due to intensive cultivation and mechanisation has resulted in a large surplus of the cereal straw. In India, an average production of wheat straw per annum was around 872.30 lakh tons in 1974. As straw is not degraded easily, it poses a practical problem of disposal. Composting of wheat straw by inoculating with different microorganisms may help in its disposal and also will help in augmenting the soil organic matter resources. With this in view the present studies were conducted to identify effective strains of microorganisms which can degrade the wheat-straw rapidly under field conditions.

MATERIAL AND METHODS

Sixteen isolates of bacteria and fungi which were previously screened under laboratory conditions on the basis of the amount of carbon mineralized (Wani and Shinde, 1977) were selected for these studies. The bacterial cultures were multiplied in nutrient broth (pH 7.0) in shake culture. The fungal cultures were multiplied on a medium containing partially crushed sorghum grains with calcium carbonate.

An experiment consisting of seventeen treatments including control, each replicated twice was laid out during *kharif*, 1974 at the Central Campus of M.P.K.V., Rahuri. The micropits measuring 3' × 3' × 3' at a distance of 1' and 5' between two rows were dug. Each pit was filled with 100 kg chopped (5–8 cm long) wheat straw in layers. The C:N ratio of straw was adjusted to 36:1 with urea. Super phosphate was added to straw so as to enrich

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the compost. Subsequently hundred ml microbial culture suspension (10^4 cells/ spores per ml) of different microorganisms was sprinkled on all layers before compaction. The final moisture content of straw was adjusted to 55–60 per cent. The pits were covered with polythene sheets and soil so as to avoid contamination with soil and prevent moisture evaporation.

Three turnings were given at an interval of 30, 60 and 120 days. At each turning, samples were collected the moisture content of straw was adjusted to desired level and then refilled in layers. The samples were analysed for moisture percentage, total nitrogen, organic carbon, total phosphorus, potash, and humic acid content by following the standard procedures (Black *et al.*, 1965).

Results and Discussion

Analysis of straw used in the present investigation is given in Table I. It is

Table I

Analysis of straw used

		Per cent
1. Moisture	.....	9.90
2. Dry matter	.....	90.10
3. Total carbon	.....	36.00
4. Total nitrogen	.....	0.45
5. Total phosphorus	.....	0.025
6. Total potash	.....	0.30
7. C:N ratio	.....	80.00

evident from the results presented that inoculation of wheat straw with different microorganisms had varied effects on total nitrogen, organic carbon contents and C:N ratio during its decomposition. In general, a gradual decline in the amount of total nitrogen content was observed during decomposition up to 120 days, but in the case of inoculation with *Cytophaga rubra–III, C. rubra-IV* and *Aspergillus* SP–I an increase in nitrogen content over adjusted nitrogen level (before decomposition) was observed at 60 days decomposition period. This increase in nitrogen might be due to favoured asymbiotic nitrogen fixation. Fixation of atmospheric nitrogen in compost due to free-living nitrogen fixers have been recorded earlier by Alexander (1961), and Dobereiner (1961). The inoculation of wheat-straw with different microorganisms lowered the organic carbon content and thereby narrowed the C : N ratio. Similar results were recorded by Gaur *et al.*, 1971. Debnath and Hajra, (1972) and Wani and Shinde (1977). The inoculation of compost with mixed cultures significantly lowered the C:N ratio of the straw over the control after 60 days. Inoculations with some of the other microorganisms also proved efficient in narrowing the C:N ratio of the residue. *Aspergillus* sp.–II, *Cytophaga rubra*–II, mixture of all cultures, *C. rubra*–III, *Cellulomonas uda*, *Bacillus macerans*–II, *Serratia kiliensis*, *C. rubra*–IV, *B. macerans*–III and *Aspergillus*, Sp. I proved more efficient in this regard. These results suggest that some of these microorganisms decomposed wheat straw rapidly. The results regarding temperature in compost pits showed the similar trend. After 60 days, decline in temperature was noted which indicated the completion of decomposition (Wani and Shinde, 1975). *Aspergillus* sp. II proved most efficient in decomposing the straw amongst the sixteen cultures under field conditions. At 120 days period, the lowest C:N ratio of 8.72 was noted in case of mixed inoculation of cultures. These results are in agreement with the results observed under laboratory conditions by Wani and Shinde (1977) and with the findings of Kalekar *et al.* (1976) who also reported that fungi are more efficient than bacteria in decomposing cellulosic materials.

Inoculation of straw with different microbial cultures had no significant effect on total phosphorus and potash content in straw compost (Table III). The humic acid content in straw compost at 120 days of decomposition period varied significantly

TABLE II

Effect of organic carbon (per cent) and C : N ratio of wheat straw during its decomposition

Name of treatment	Decomposition period in days					
	60			120		
	Nitrogen	Organic carbon	C:N ratio	Nitrogen	Organic carbon	C:N ratio
1. *Serratia kiliensis*	895	17.25*	19.44*	800	10.65*	13.31*
2. *Bacillus subtilis*	925	21.00	22.73	835	13.65	16.38
3. *Bacillus firmus*	965	21.75	22.52	870	14.40	16.57
4. *Bacillus mecerans-I*	890	22.50	25.25	770	15.60	20.41
5. *Cytophaga rubra-I*	915	20.25	22.24	825	8.10	9.70
6. *Cytophaga rubra-II*	825	14.25	17.26	745	9.30	12.40
7. *Bacillus macerans-II*	925	18.00	19.43	820	9.45	11.48
8. *Cytophaga rubra-III*	1030	18.75	18.27	925	8.10	8.73
9. *Bacillus macerans-III*	875	18.00	20.55	790	8.25	10.46
10. *Cytophaga rubra-IV*	1050	21.00	20.09	940	11.70	12.42
11. *Cellulomonas uda*	950	18.00	18.91	850	8.70	10.18
12. *Penicillium* sp.	760	17.25	22.71	660	13.05	19.82
13. *Aspergillus* sp. I	1010	21.75	21.58	900	8.25	9.14
14. *Aspergillus* sp. II	880	15.00	17.04	780	13.95	17.88
15. *Aspergillus* sp. III	885	19.50	22.77	765	9.30	12.17
16. Mixture of all cultures	875	15.75	18.00	790	6.90	8.72
17. Control	825	25.50	30.91	715	15.00	20.00
Calculated 'F' value	4.794**	3.641**	4.041**	4.786**	4.142**	5.76**
C.D. at 5%	104.63	4.61	5.09	100.42	3.89	5.30

Note : * = Average of two replications
** = Significant at 1% level

over control. All the treatments except the mixed inoculation of all cultures showed significant increase in humic acid content over control. The highest humic acid content of 12.60 per cent was recorded with *Bacillus firmus* and the lowest of 5.45 per-cent humic acid content was noted where a mixed inoculation was done. Low humic acid content where inoculated with mixed culture than in control might be due to possible degradation by some micro-organisms. The above results clearly indicate the important role played by microorganisms in the synthesis of humic acid from wheat straw during its decomposition. These results confirm the findings of earlier workers, Kononova and Aleksandrova (1959); Kutzner (1968) Sundaman (1970), and Gaur *et al.* (1971), who reported the role of microorganisms in the synthesis of humic acid. Where the inoculation with mixed cultures was done, the humic acid content may be higher during an earlier period of decomposition. However, due to possible degradation of humic acid by microorganisms, might have resulted in lowering the humic acid content at the final stage of studies. Table II and III reveal that treatment recording the highest humic acid content of 12.60 per cent had the C:N ratio of 16.57, which indicates a possible correlation between C:N ratio and humic acid content. This however, needs further confirmation.

TABLE III

Effect on amount of total phosphorus, potash (mg/100 g wheat straw) and humic acid (per cent) content in wheat straw at 120 days of its decomposition

Name of treatment	Phosphorus as P	Potash as K	Humic acid as Na-humate
1. *Serratia kiliensis*	100.00*	225.00*	11.30*
2. *Bacillus subtilis*	100.00	250.00	11.20
3. *Bacillus firmus*	112.50	200.00	12.60
4. *Bacillus macerans-I*	150.00	225.00	9.45
5. *Cytophaga rubra-I*	125.00	275.00	10.85
6. *Cytophaga rubra-II*	50.00	225.00	10.85
7. *Bacillus macerans-II*	87.50	200.00	10.30
8. *Cytophaga rubra-III*	125.00	150.00	10 80
9. *Bacillus macerans-III*	87.50	150.00	9.97
10. *Cytophaga rubra-IV*	150.00	175.00	9.05
11. *Cellulomonas uda*	75.00	175.00	9.60
12. *Penicillium* sp.	50.00	250.00	10.50
13. *Aspergillus* sp. I	100.00	175.00	9.45
14. *Aspergillus* sp. II	137.50	250.00	9.25
15. *Aspergillus* sp. III	62.50	200.00	9.20
16. Mixture of all cultures	87.50	250.00	5.45
17. Control	50.00	225.00	7.15
Calculated 'F' value	1.70	2.29	86.197**
C.D. at 5%	N.S.	N.S.	0.53

Note : * = Average of two replications
** = Significant at 1% level
N.S. = Non-significant

Further studies on the role of microorganisms in degradation of humic acid would give some idea about this aspect.

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