DEPARTMENT OF AGRIL. CHEMISTRY AND SOIL SCIENCE
COLLEGE OF AGRUICULTURE, DAPOLI, DIST. RATNAGIRI

Title of thesis : Studies on quality assessment of manures from Konkan region of Maharashtra

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Registration Number : 1713 Year : 2004-2006

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ABSTRACT

The studies on quality assessment of manures from four districts of Konkan region of Maharashtra State were carried out in the laboratory of the Department of Agricultural Chemistry and Soil Science. One hundred manure samples collected from farmers and agro service centres were analysed for different physical, chemical and biological attributes. The manure samples are divided into two the three distinct categories based on the standard values given by two different organizations such as Maharashtra State Department of Agriculture and Indian Institute of Soil Science (I.C.A.R.), Bhopal for confirming their maturity.

Out of one hundred manures examined, seventy seven per cent manure samples were found possess dark brown to black colour. Less than 20 per cent moisture was registered in 43 per cent manure samples. Total nitrogen content of all manures ranged from 0.56 to 5.28, 0.78 to 4.70 and 0.89 to 4.59 per cent, when nitrogen content in manure was determined by colorimetric method, Kjeldahl's method and modified Kjeldahl's method, respectively. The phosphorus content in manures determined by diacid digestion method, triacid digestion method and dry ashing method, ranged from 0.27 to 18.32, 0.73 to 19.14 and 0.22 to 14.48 per cent, respectively. The potassium content in manures determined by diacid digestion method, triacid digestion method and dry ashing method varied from 0.16 to 8.28, 0.16 to 8.52 and 0.12 to 8.52 per cent, respectively. The total organic carbon content of manure samples was in the range of 4.34 to 55.97 per cent and 4.95 to 43.65 per cent

when determined by dry combustion method and wet digestion method, respectively. The calcium and magnesium content of the manure samples in the range of 0.5 to 1.0 per cent was recorded in 24 per cent and 33 per cent manure samples, respectively. As regards to micronutrient content of one hundred manures, it is noted that 34 per cent manures had zinc in the range of 500 to 1000 mg kg^{-1}, while 93 and 96 per cent manure samples were found to posses less than 1000 mg kg^{-1} and 300 mg kg^{-1} of manganese and copper content, respectively. The total iron content in the range of 1.0 to 2.0 g kg^{-1} was registered in 56 per cent manure samples. Fifty two per cent manure samples registered boron content in the range of 25 to 50 mg kg^{-1}. he cation exchange capacity in the range of 65 to 130 c mol (p^+) kg^{-1} was recorded in 92 per cent manure samples. Ninety seven per cent manures had electrical conductivity less than 4 dS m^{-1} indicating their salt content below tolerable limit.

Nitrogen content of manures determined by three methods such as colorimetric, Kjeldahl's and modified Kjeldahl's methods had significant positive correlation with their organic matter content determined by dry combustion as well as wet digestion methods. A significant positive correlation of organic matter content of manures was noted with the cation exchange capacity and water soluble carbohydrates content of the manure samples. There was significantly positive relationship between total nitrogen content determined by all the three methods with that of total organic carbon determined by two methods.

Thus, most of the manures produced and being sold in Konkan region are observed to be stable from the point of compost maturity and good sources of major as well as micronutrients.

ACKNOWLEDGEMENT

As the end of my post graduation is in sight, a sudden realization makes me ponder over the last two years. I picture my self about research and as I weld down the memory lane the first name strike distinctively with a deep sense of gratitude to Dr. S.C. Talashilkar, Professor, Department of Agril. Chemistry and Soil Science, College of Agriculture, Dapoli and Chairman of my Advisory Committee and Research Guide. I heartly express my sincere gratitude, deep affection, respect and virtual veneration to him for his generosity, constant inspiration, constructive criticism, straight forward approach, valuable suggestions, keen interest and dynamic guidance that I could obtain from him during the course of present investigation and also in preparation of this manuscript.

It is my proud privilege to place on record my sincere and grateful thanks to the members of my advisory committee, Dr. T.S. Mahajan, Deputy Director of Research (Agri.), Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Dr. K.D. Patil, Soil Scientist, R.F.R.S., Vengurla and Dr. A.C. Sawant, Associate Professor, Department of Agronomy, College of Agriculture, Dapoli.

I am greatful to Dr. S.S. Magar, Hon. Vice-Chancellor, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Dr. V.B. Mehta, Dean, Faculty of Agriculture, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli and Dr. G.D. Joshi, Associate Dean, College of Agriculture, Dapoli for providing all the necessary facilities during the course of this study.

I gratefully acknowledge to the co-operation and help extended by Dr. S.S. Dhane, Head, Department of Agril. Chemistry and Soil Science, Dr. B.S. Konkan Krishi Vidyapeeth, Dapoli, Dr. J.H. Dongale, Associate Directorate of Research, Regional Rice Research Station, Karjat, Dr. R.G. Joshi, Chief Scientist, Central Experiment Station, Wakawal, Dr. A.B. Chandelkar, Dr. D.N. Gupta, Dr. M.R. Nagarale, Associate Professors, Department of Agril. Chemistry and Soil Science, Shri. D.J. Dabke, Shri. S.B. Dodke, Shri. V.G. Salvi, Shri. K.P. Vaidya, Shri. S.R. Akhawe, Sou. P.S. Sawant, Assistant Professors, Department of Agril. Chemistry and Soil Science for their valuable guidance and co-operation during course of my post graduation research work.

I would fail in my duties if I don't mention the words of thanks to Mr. A.A.K. Dosani for the help rendered by him in manure samples collection and their analysis.

I wish to convey greatest reverence and sincere feelings to respect my father Shri. Ravindra H. Nimbalkar and mother Sou. Latadevi R. Nimbalkar for shaping my educational career with love, affection and encouragement.

It is my sincere duties to express my greatful feeling to Vikas Dhamapurkar, Prakash Bhangrath, Mahendra Gavang, Pravin Rathod and Sandeep Diwale for their help in my research work.

I also owe my heartful thanks to my senior friends Somnath, Satish, Sushant, Ganpat, Neeta, Yogita and Shilpa for their encouragement and keen suggestions.

I extended my thanks to Kalyan, Nitin, Ganesh, Shahrukh, Berji, Hritik, Bajirao, Amol, Prashant, Mahesh, Ramesh, Bangwa, Kuldeep, Shivaji, Pravin, Dinesh, Anil, Shirish, Aba, Gaba, Sachin and all my junior friends for their help and excellent company during my post graduation.

I express my thanks to Shri. D.B. Zagde, Sou. Powar, Sou. Shegde, Sou. Shigwan, S/Shri. T.M. Lambe, J.M. Pawar, Sham Bhagwat, Ramesh Dubale, Shirke the staff members of Department of Agril. Chemistry and Soil Science for their direct and indirect help and co-operation.

Last but certainly not least my special thanks to Shri. Balasaheb Sandye for his help in timely preparation of this manuscript.

Place : Dapoli
Date : 31 May, 2006 (V.R. Nimbalkar)

APPENDIX II
PHYSICAL PROPERTIES OF MANURES

Sr. No.	Colour	Odour	Particle size (g)		Per cent moisture	Bulk density (Mg cm^{-3})	Water holding capacity (per cent)
			Remained in 4 mm sieve	Passed through 0.5 mm sieve			
1.	Black	Odourless	6	18	2.70	0.36	108.00
2.	Black	Soily	4	10	23.00	0.52	98.00
3.	Black	Odourless	3	7	26.00	0.54	92.00
4.	Dark brown	Odourless	--	10	27.30	0.54	85.00
5.	Dark brown	Odourless	--	2	22.30	0.60	77.00
6.	Dark brown	Soily	3	6	32.20	0.56	82.00
7.	Black	Odourless	9	13	21.00	0.53	80.00
8.	Dark brown	Odourless	4	4	34.80	0.49	89.00
9.	Dark brown	Odourless	3	3	24.10	0.67	70.00
10.	Black	Odourless	--	24	26.30	0.70	68.00
11.	Black	Odourless	8	15	22.60	0.66	72.00
12.	Dark brown	Odourless	--	4	27.50	0.50	86.00
13.	Black	Odourless	2	13	32.80	0.58	81.00
14.	Dark brown	Soily	--	16	21.80	0.55	87.00
15.	Black	Odourless	--	9	27.80	0.68	76.00
16.	Black	Odourless	--	7	25.80	0.49	91.00
17.	Black	Odourless	22	15	23.80	0.48	88.00
18.	Black	Soily	14	8	28.90	0.40	88.00
19.	Black	Odourless	--	10	29.70	0.38	94.00
20.	Black	Odourless	4	5	35.60	0.50	83.00
21.	Black	Odourless	12	23	31.40	0.61	74.00
22.	Black	Odourless	--	12	30.60	0.64	68.00
23.	Black	Soily	--	8	33.90	0.64	65.00
24.	Black	Odourless	--	26	37.00	0.63	70.00
25.	Black	Odourless	--	31	37.20	0.52	83.00
26.	Black	Soily	--	43	30.60	0.58	76.00
27.	Black	Odourless	--	13	32.60	0.51	85.00
28.	Black	Odourless	--	26	31.10	0.58	72.00
29.	Black	Odourless	--	23	25.70	0.61	69.00
30.	Black	Odourless	2	15	34.50	0.53	81.00
31.	Black	Odourless	6	12	34.45	0.50	73.00
32.	Dark brown	Odourless	16	17	29.90	0.65	66.00
33.	Gray	Odourless	4	16	26.80	0.48	89.00
34.	Black	Odourless	--	21	29.50	0.66	58.00
35.	Dark brown	Soily	--	16	33.00	0.36	78.00
36.	Black	Odourless	--	7	24.30	0.71	59.00
37.	Black	Odourless	--	13	27.80	0.72	55.00
38.	Black	Odourless	19	18	18.20	0.62	59.00
39.	Gray	Odourless	--	11	19.80	0.84	50.00
40.	Black	Odourless	--	14	18.90	0.69	59.00
41.	Black	Soily	15	19	28.40	0.65	57.00
42.	Black	Soily	9	8	20.70	0.74	51.00
43.	Black	Soily	--	10	31.20	0.60	65.00
44.	Gray	Soily	5	6	12.30	0.54	72.00
45.	Black	Soily	6	22	26.40	0.55	70.00
46.	Gray	Soily	--	15	22.50	0.69	58.00
47.	Black	Soily	--	21	21.70	0.64	55.00
48.	Black	Soily	12	14	18.30	0.65	53.00
49.	Dark brown	Odourless	--	10	4.10	0.42	80.00

Contd…

Contd…

Sr. No.	Colour	Odour	Particle size (g)		Per cent moisture	Bulk density (Mg cm^{-3})	Water holding capacity (per cent)
			Remained in 4 mm sieve	Passed through 0.5 mm sieve			
50.	Dark brown	Odourless	--	3	4.80	0.53	66.00
51.	Black	Odourless	--	21	24.30	0.59	62.00
52.	Black	Odourless	--	9	26.10	0.64	54.00
53.	Black	Odourless	--	14	0.40	0.32	131.00
54.	Gray	Other than soily	24	4	1.20	0.77	87.00
55.	Black	Odourless	--	15	35.00	0.71	80.00
56.	Dark brown	Odourless	3	7	14.50	0.93	68.00
57.	Dark brown	Odourless	6	4	22.00	0.54	89.00
58.	Dark brown	Odourless	--	35	9.10	0.89	54.00
59.	Black	Soily	--	22	28.40	0.58	78.00
60.	Black	Soily	3	10	14.30	0.49	87.00
61.	Dark brown	Odourless	--	8	8.10	0.49	84.00
62.	Dark brown	Odourless	6	12	10.20	0.59	72.00
63.	Dark brown	Odourless	9	24	22.10	1.07	40.00
64.	Gray	Soily	2	14	24.10	0.81	47.00
65.	Black	Odourless	7	13	22.90	0.49	81.00
66.	Gray	Odourless	13	5	4.10	0.53	72.00
67.	Gray	Odourless	8	13	13.10	0.82	43.00
68.	Dark brown	Soily	12	14	2.00	0.98	83.00
69.	Gray	Odourless	6	4	7.20	0.53	99.00
70.	Gray	Odourless	--	7	3.90	0.67	63.00
71.	Gray	Odourless	2	3	2.00	0.61	68.00
72.	Dark brown	Soily	--	31	19.00	0.89	57.00
73.	Black	Odourless	--	9	32.40	0.79	71.00
74.	Black	Odourless	--	27	26.50	0.73	76.00
75.	Dark brown	Odourless	--	14	2.20	0.99	48.00
76.	Black	Soily	--	11	24.80	0.47	83.00
77.	Black	Odourless	2	13	12.20	0.86	54.00
78.	Gray	Odourless	3	26	11.10	0.82	58.00
79.	Gray	Soily	--	13	9.30	0.55	79.00
80.	Gray	Soily	--	7	13.10	0.70	61.00
81.	Gray	Odourless	3	18	6.50	0.79	58.00
82.	Black	Soily	7	15	18.10	0.69	55.00
83.	Black	Odourless	3	9	15.70	0.88	49.00
84.	Black	Odourless	--	21	10.60	0.46	77.00
85.	Gray	Odourless	--	1	2.50	1.06	39.00
86.	Dark brown	Soily	--	5	8.10	0.65	58.00
87.	Gray	Soily	14	4	10.20	0.76	51.00
88.	Black	Odourless	9	8	22.90	0.60	67.00
89.	Black	Odourless	--	24	13.10	0.83	50.00
90.	Gray	Soily	28	7	10.30	0.65	63.00
91.	Black	Other than soily	--	11	17.60	0.65	56.00
92.	Dark brown	Odourless	--	7	4.30	0.65	51.00
93.	Gray	Odourless	18	29	8.70	0.84	48.00
94.	Dark brown	Odourless	--	18	3.80	0.61	72.00
95.	Gray	Odourless	--	38	5.40	0.87	55.00
96.	Gray	Odourless	--	34	6.30	0.85	51.00
97.	Dark brown	Other than soily	--	9	3.70	0.59	68.00
98.	Gray	Other than soily	8	4	3.90	0.49	73.00
99.	Gray	Odourless	12	2	4.30	0.78	54.00
100.	Black	Odourless	--	13	21.00	0.87	47.00
Avg.					**19.36**	**0.64**	**69.82**

APPENDIX III

CHEMICAL PROPERTIES OF MANURES

Sr. No.	Nitrogen (%)			Phosphorus (%)			Potassium (%)		
	N (1)	N (2)	N (3)	P_2O_5 (1)	P_2O_5 (2)	P_2O_5 (3)	K_2O (1)	K_2O (2)	K_2O (3)
1.	2.52	2.46	2.57	1.54	1.28	1.12	2.52	2.98	2.04
2.	2.91	1.56	2.24	2.66	3.25	3.48	3.36	3.55	3.24
3.	2.42	1.23	1.90	0.92	1.19	0.64	0.24	0.29	0.12
4.	0.56	0.67	1.56	1.37	1.56	1.28	0.36	0.65	0.26
5.	0.79	0.89	1.79	1.19	1.24	0.96	0.72	0.89	0.78
6.	0.81	1.12	1.68	0.92	1.10	0.85	0.48	0.62	0.73
7.	1.62	1.34	2.01	0.87	1.10	1.15	0.60	0.72	0.76
8.	1.89	1.56	2.68	1.37	1.67	1.33	0.72	0.91	0.75
9.	1.62	1.00	2.40	1.01	1.47	0.76	0.60	0.60	0.43
10.	1.23	1.23	1.56	0.34	0.94	0.46	0.38	0.43	0.48
11.	1.13	0.67	1.34	0.37	0.82	0.66	0.36	0.58	0.29
12.	0.75	1.23	1.90	0.85	1.40	0.82	0.48	0.53	0.44
13.	1.11	1.23	2.12	0.80	1.37	0.80	0.60	0.62	0.51
14.	1.66	1.45	1.68	1.05	1.35	0.92	0.55	0.60	0.49
15.	1.15	1.12	1.68	0.73	1.28	0.85	0.43	0.62	0.35
16.	0.70	1.23	1.34	1.12	1.56	1.35	1.15	1.22	0.83
17.	2.25	1.68	1.90	1.37	1.85	1.28	1.03	1.20	0.73
18.	1.95	1.34	1.79	0.82	1.19	0.92	0.24	0.48	0.26
19.	2.19	1.56	2.12	0.89	1.37	0.60	0.26	0.58	0.34
20.	2.71	1.79	2.01	1.10	1.53	0.85	0.65	0.84	0.44
21.	2.74	1.56	1.56	1.12	1.49	0.69	0.53	0.86	0.44
22.	1.74	1.12	1.45	1.10	1.40	1.68	0.58	0.67	0.43
23.	1.43	1.34	1.79	1.37	1.40	1.64	0.86	0.84	0.43
24.	2.06	1.23	1.68	0.76	1.44	0.73	0.91	0.73	0.46
25.	2.00	1.68	2.24	0.80	0.82	0.60	0.29	0.36	0.23
26.	1.27	1.90	2.01	0.87	1.17	0.62	0.19	0.22	0.14
27.	2.99	1.68	2.46	0.94	1.08	0.57	0.24	0.29	0.19
28.	0.83	1.12	1.68	1.92	2.11	1.37	0.74	0.84	0.87
29.	2.19	1.34	1.79	0.55	0.98	0.57	0.55	0.60	0.44
30.	1.78	1.56	2.12	2.66	2.40	2.73	1.20	1.68	0.90
31.	1.61	1.34	1.90	1.31	0.98	1.08	0.89	1.06	0.88
32.	1.40	1.23	1.79	1.63	1.83	1.92	0.48	0.46	0.49
33.	1.97	1.90	2.40	3.07	1.95	2.84	1.30	1.85	0.65
34.	1.72	1.00	1.79	1.60	1.42	1.51	0.91	1.13	0.47
35.	4.49	2.01	2.57	3.73	4.95	2.24	2.38	2.16	1.50
36.	3.09	2.56	1.56	1.24	0.94	0.92	1.18	1.31	1.40
37.	3.10	2.78	1.34	0.92	1.03	0.71	1.20	1.01	1.30
38.	1.64	1.12	1.68	2.38	2.56	1.81	0.94	1.03	1.33
39.	2.23	1.78	1.26	1.12	1.10	0.92	1.10	1.10	1.40
40.	1.45	1.23	1.68	1.58	1.79	1.49	1.13	1.20	1.32
41.	1.66	1.67	1.56	1.24	1.31	0.89	0.65	0.84	1.19
42.	1.25	1.45	2.12	2.91	2.70	2.22	1.15	1.08	1.16
43.	2.27	0.67	1.90	1.47	1.11	0.94	0.79	0.65	1.76
44.	1.32	1.40	2.35	1.90	1.83	1.56	0.91	0.96	1.72
45.	2.12	0.89	1.56	1.26	1.15	0.89	0.60	0.48	0.49
46.	1.21	1.67	1.34	0.98	1.05	0.57	0.29	0.22	0.22
47.	1.38	0.89	1.45	1.35	1.17	1.03	0.55	0.58	0.49
48.	2.04	1.56	1.79	3.76	3.02	2.38	1.66	1.54	0.52
49.	1.44	1.12	1.90	1.03	1.19	1.12	1.18	1.37	0.42
50.	2.16	1.23	1.45	4.97	4.67	2.98	2.42	2.54	1.10
51.	1.72	1.89	1.56	1.10	0.96	0.46	0.41	0.50	0.43
52.	2.01	1.00	1.90	1.47	1.08	0.92	0.43	0.41	0.47

Contd…

Contd…

Sr. No.	Nitrogen (%)			Phosphorus (%)			Potassium (%)		
	N (1)	N (2)	N (3)	P_2O_5 (1)	P_2O_5 (2)	P_2O_5 (3)	K_2O (1)	K_2O (2)	K_2O (3)
53.	1.15	1.79	1.93	1.39	1.74	0.78	1.10	2.33	1.61
54.	3.46	2.24	2.68	10.49	8.79	5.11	8.28	8.52	8.52
55.	1.53	1.68	2.12	2.63	2.29	2.20	5.52	5.64	3.72
56.	1.49	0.78	1.12	1.65	1.92	1.15	0.96	0.84	0.71
57.	1.85	1.34	1.68	3.48	2.89	3.37	0.36	0.36	0.13
58.	1.44	1.56	1.79	3.39	3.57	2.70	1.42	1.82	0.89
59.	1.40	1.56	1.56	0.69	1.26	0.55	0.17	0.22	0.12
60.	2.42	1.56	2.12	9.71	6.92	4.83	1.30	1.87	0.92
61.	2.00	1.56	2.35	6.76	5.89	3.55	1.39	1.90	0.92
62.	2.54	1.68	2.01	4.21	4.60	3.25	1.20	1.49	0.68
63.	2.31	1.67	1.45	18.32	19.14	15.98	0.29	0.22	0.22
64.	1.82	1.44	1.00	15.34	12.80	15.24	0.53	0.72	0.20
65.	1.42	1.79	2.12	3.66	3.07	3.25	0.98	1.63	0.78
66.	1.47	2.68	2.91	10.90	11.36	8.40	4.42	5.76	3.61
67.	1.64	1.90	2.30	2.68	2.68	2.73	0.89	1.15	0.47
68.	1.45	1.12	1.68	0.32	0.78	0.69	0.41	0.38	0.45
69.	1.58	2.44	2.12	1.19	1.88	1.42	0.86	1.20	0.83
70.	2.12	1.56	1.56	3.05	4.90	3.32	0.96	1.20	0.96
71.	5.28	4.70	4.59	3.02	3.57	2.54	0.91	1.20	0.80
72.	1.38	1.00	1.45	3.66	4.03	3.37	0.82	1.13	0.54
73.	4.37	2.56	2.12	2.31	5.50	2.56	0.50	1.03	0.80
74.	1.74	1.23	1.68	3.16	2.95	2.62	1.01	1.22	0.49
75.	3.82	1.12	1.34	0.92	1.65	1.05	0.62	0.79	0.36
76.	1.51	1.45	2.01	0.55	0.73	0.79	0.12	0.17	0.16
77.	0.72	1.44	1.34	0.53	0.82	0.48	2.14	3.24	1.94
78.	1.71	1.45	1.79	3.94	2.93	3.69	0.43	0.53	0.20
79.	2.50	1.34	1.90	2.89	3.60	2.47	2.38	3.26	2.96
80.	1.44	1.79	2.35	6.92	6.62	4.19	3.02	3.79	3.48
81.	1.32	0.78	1.56	0.76	1.44	0.85	0.72	0.86	0.75
82.	1.23	1.23	1.68	1.01	1.05	0.87	0.86	0.70	0.88
83.	1.27	1.00	2.12	1.85	1.44	1.47	0.31	0.36	0.26
84.	2.44	1.56	1.68	2.73	4.21	2.22	1.30	0.62	0.62
85.	1.32	1.33	0.89	0.27	0.87	0.23	1.27	1.44	1.40
86.	2.61	1.34	1.90	8.13	6.57	8.93	2.50	2.11	2.64
87.	2.74	1.79	2.12	21.62	16.99	14.48	0.31	0.24	0.16
88.	2.80	1.23	1.68	4.08	3.55	3.14	0.72	0.77	0.74
89.	2.93	1.23	1.34	4.03	3.02	2.70	1.56	1.68	1.55
90.	0.81	1.67	1.68	1.12	0.94	0.64	0.34	0.34	0.26
91.	3.18	1.00	1.56	1.88	1.53	1.33	1.18	1.22	1.25
92.	3.37	3.13	3.02	1.63	1.51	1.21	2.45	2.35	1.04
93.	1.32	0.89	1.34	4.51	4.21	3.53	0.70	0.72	0.17
94.	2.42	1.90	2.01	1.12	0.92	0.76	2.59	2.30	2.60
95.	2.08	1.23	1.45	0.76	0.82	0.50	0.17	0.17	0.12
96.	2.02	1.23	1.68	1.19	1.05	0.22	0.12	0.12	0.12
97.	2.95	2.68	2.91	1.10	0.92	0.53	2.47	2.40	1.07
98.	0.73	2.57	2.46	1.53	1.65	0.92	1.25	1.37	0.53
99.	1.51	1.68	2.24	5.31	6.00	4.85	0.91	0.96	0.72
100.	2.12	1.34	1.68	1.87	1.44	1.05	1.10	0.91	0.84
Avg.	**1.93**	**1.53**	**1.88**	**2.70**	**2.72**	**2.16**	**1.10**	**1.25**	**0.95**

Contd…

Contd…

Sr. No.	TOC (Per cent)		O.M. (Per cent)		Ash (per cent)		C:N ratio		
	D.C.	W.D	D.C.	W.D.	D.C.	W.D.	1	2	3
1.	38.86	26.85	66.84	46.18	33.16	53.82	15.42	15.80	15.12
2.	26.68	25.20	45.89	43.34	54.11	56.66	9.17	17.10	11.91
3.	24.94	22.50	42.90	38.70	57.10	61.30	10.31	20.28	13.13
4.	21.75	18.75	37.41	32.25	62.59	67.75	38.84	32.46	13.94
5.	16.24	17.10	27.93	29.41	72.07	70.59	20.56	18.25	9.07
6.	15.37	15.50	26.44	26.66	73.56	73.34	18.98	13.72	9.15
7.	20.01	22.50	34.42	38.70	65.58	61.30	12.35	14.93	9.96
8.	18.56	18.75	31.92	32.25	68.08	67.75	9.82	11.90	6.93
9.	15.19	14.70	26.13	25.28	73.87	74.72	9.38	15.19	6.33
10.	19.14	19.65	32.92	33.80	67.08	66.20	15.56	15.56	12.27
11.	13.34	22.50	22.94	38.70	77.06	61.30	11.81	19.91	9.96
12.	14.21	22.50	24.44	38.70	75.56	61.30	18.95	11.55	7.48
13.	15.37	18.45	26.44	31.73	73.56	68.27	13.85	12.50	7.25
14.	17.83	16.85	30.67	28.98	69.33	71.02	10.74	12.30	10.61
15.	18.27	19.80	31.42	34.06	68.58	65.94	15.89	16.31	10.88
16.	32.77	17.85	56.36	30.70	43.64	69.30	46.81	26.64	24.46
17.	34.51	20.70	59.36	35.60	40.64	64.40	15.34	20.54	18.16
18.	29.87	21.00	51.38	36.12	48.62	63.88	15.32	22.29	16.69
19.	29.29	14.85	50.38	25.54	49.62	74.46	13.37	18.78	13.82
20.	31.61	28.00	54.37	48.16	45.63	51.84	11.66	17.66	15.73
21.	15.66	13.05	26.94	22.45	73.06	77.55	5.72	10.04	10.04
22.	14.21	15.00	24.44	25.80	75.56	74.20	8.17	12.69	9.80
23.	26.10	18.75	44.89	32.25	55.11	67.75	18.25	19.48	14.58
24.	26.10	21.60	44.89	37.15	55.11	62.85	12.67	21.22	15.54
25.	35.09	17.90	60.35	30.79	39.65	69.21	17.55	20.89	15.67
26.	32.77	21.00	56.36	36.12	43.64	63.88	25.80	17.25	16.30
27.	32.77	25.15	56.36	43.26	43.64	56.74	10.96	19.51	13.32
28.	27.55	19.05	47.39	32.77	52.61	67.23	33.19	24.60	16.40
29.	26.68	16.95	45.89	29.15	54.11	70.85	12.18	19.91	14.91
30.	36.54	25.75	62.85	44.29	37.15	55.71	20.53	23.42	17.24
31.	28.71	16.20	49.38	27.86	50.62	72.14	17.83	21.43	15.11
32.	22.04	21.75	37.91	37.41	62.09	62.59	15.74	17.92	12.31
33.	27.26	18.00	46.89	30.96	53.11	69.04	13.84	14.35	11.36
34.	23.49	14.40	40.40	24.77	59.60	75.23	13.66	23.49	13.12
35.	47.56	31.35	81.80	53.92	18.20	46.08	10.59	23.66	18.51
36.	30.57	22.75	52.58	39.13	47.42	60.87	9.89	11.94	19.60
37.	28.71	15.75	49.38	27.09	50.62	72.91	9.26	10.33	21.43
38.	37.99	23.10	65.34	39.73	34.66	60.27	23.16	33.92	22.61
39.	12.18	18.75	20.95	32.25	79.05	67.75	5.46	6.84	9.67
40.	21.46	21.75	36.91	37.41	63.09	62.59	14.80	17.45	12.77
41.	39.15	19.50	67.34	33.54	32.66	66.46	23.58	23.44	25.10
42.	20.01	22.75	34.42	39.13	65.58	60.87	16.01	13.80	9.44
43.	33.06	27.55	56.86	47.39	43.14	52.61	14.56	49.34	17.40
44.	21.17	21.60	36.41	37.15	63.59	62.85	16.04	15.12	9.01
45.	42.05	39.20	72.33	67.42	27.67	32.58	19.83	47.25	26.96
46.	12.18	7.95	20.95	13.67	79.05	86.33	10.07	7.29	9.09
47.	40.09	36.50	68.95	62.78	31.05	37.22	29.05	45.04	27.65
48.	25.81	15.45	44.39	26.57	55.61	73.43	12.65	16.54	14.42
49.	27.84	25.50	47.88	43.86	52.12	56.14	19.33	24.86	14.65
50.	26.68	24.00	45.89	41.28	54.11	58.72	12.35	21.69	18.40
51.	44.37	34.40	76.32	59.17	23.68	40.83	25.80	23.48	28.44
52.	23.78	15.25	40.90	26.23	59.10	73.77	11.83	23.78	12.52

Contd…

Contd…

Sr. No.	TOC (Per cent)		O.M. (Per cent)		Ash (per cent)		C:N ratio		
	D.C.	**W.D**	**D.C.**	**W.D.**	**D.C.**	**W.D.**	**1**	**2**	**3**
53.	35.67	27.15	61.35	46.70	38.65	53.30	31.02	19.93	18.48
54.	22.62	17.55	38.91	30.19	61.09	69.81	6.54	10.10	8.44
55.	31.90	20.40	54.87	35.09	45.13	64.91	20.85	18.99	15.05
56.	26.68	22.45	45.89	38.61	54.11	61.39	17.91	34.21	23.82
57.	26.10	25.05	44.89	43.09	55.11	56.91	14.11	19.48	15.54
58.	43.05	44.25	74.05	76.11	25.95	23.89	29.90	27.60	24.05
59.	29.87	16.95	51.38	29.15	48.62	70.85	21.34	19.15	19.15
60.	22.66	21.30	38.98	36.64	61.02	63.36	9.36	14.53	10.69
61.	26.97	23.55	46.39	40.51	53.61	59.49	13.49	17.29	11.48
62.	20.88	17.55	35.91	30.19	64.09	69.81	8.22	12.43	10.39
63.	8.70	10.35	14.96	17.80	85.04	82.20	3.77	5.21	6.00
64.	10.15	10.95	17.46	18.83	82.54	81.17	5.58	7.05	10.15
65.	30.16	18.75	51.88	32.25	48.12	67.75	21.24	16.85	14.23
66.	22.62	11.85	38.91	20.38	61.09	79.62	15.39	8.44	7.77
67.	24.65	10.35	42.40	17.80	57.60	82.20	15.03	12.97	10.72
68.	15.08	11.10	25.94	19.09	74.06	80.91	10.40	13.46	8.98
69.	55.68	34.15	95.77	58.74	4.23	41.26	35.24	22.82	26.26
70.	29.29	21.75	50.38	37.41	49.62	62.59	13.82	18.78	18.78
71.	53.65	43.65	92.28	75.08	7.72	24.92	10.16	11.41	11.69
72.	18.27	13.20	31.42	22.70	68.58	77.30	13.24	18.27	12.60
73.	20.88	14.25	35.91	24.51	64.09	75.49	4.78	8.16	9.85
74.	18.27	13.35	31.42	22.96	68.58	77.04	10.50	14.85	10.88
75.	10.15	15.75	17.46	27.09	82.54	72.91	2.66	9.06	7.57
76.	35.38	24.00	60.85	41.28	39.15	58.72	23.43	24.40	17.60
77.	18.85	13.35	32.42	22.96	67.58	77.04	26.18	13.09	14.07
78.	22.18	20.25	38.15	34.83	61.85	65.17	12.97	15.30	12.39
79.	23.78	15.75	40.90	27.09	59.10	72.91	9.51	17.75	12.52
80.	23.49	14.40	40.40	24.77	59.60	75.23	16.31	13.12	10.00
81.	15.66	16.50	26.94	28.38	73.06	71.62	11.86	20.08	10.04
82.	15.66	12.30	26.94	21.16	73.06	78.84	12.73	12.73	9.32
83.	13.05	16.05	22.45	27.61	77.55	72.39	10.28	13.05	6.16
84.	31.03	20.35	53.37	35.00	46.63	65.00	12.72	19.89	18.47
85.	5.51	9.75	9.48	16.77	90.52	83.23	4.17	4.14	6.19
86.	24.07	24.00	41.40	41.28	58.60	58.72	9.22	17.96	12.67
87.	16.53	19.20	28.43	33.02	71.57	66.98	6.03	9.23	7.80
88.	32.48	21.00	55.87	36.12	44.13	63.88	11.60	26.41	19.33
89.	27.26	18.15	46.89	31.22	53.11	68.78	9.30	22.16	20.34
90.	20.30	10.95	34.92	18.83	65.08	81.17	25.06	12.16	12.08
91.	24.65	20.50	42.40	35.26	57.60	64.74	7.75	24.65	15.80
92.	50.46	35.25	86.79	60.63	13.21	39.37	14.97	16.12	16.71
93.	19.14	10.50	32.92	18.06	67.08	81.94	14.50	21.51	14.28
94.	33.06	41.40	56.86	71.21	43.14	28.79	13.66	17.40	16.45
95.	4.35	4.95	7.48	8.51	92.52	91.49	2.09	3.54	3.00
96.	21.75	23.45	37.41	40.33	62.59	59.67	10.77	17.68	12.95
97.	47.85	39.45	82.30	67.85	17.70	32.15	16.22	17.85	16.44
98.	55.97	38.85	96.27	66.82	3.73	33.18	76.67	21.78	22.75
99.	16.53	14.85	28.43	25.54	71.57	74.46	10.95	9.84	7.38
100.	20.01	14.25	34.42	24.51	65.58	75.49	9.44	14.93	11.91
Avg.	**25.86**	**20.57**	**44.48**	**35.38**	**55.51**	**64.62**	**15.57**	**18.03**	**13.95**

Contd…

Contd…

Sr. No.	C:N ratio 4	5	6	%Ca	%Mg	%S	Zn (mg/kg)	Mn (mg/kg)	Cu (mg/kg)
1.	10.65	10.91	10.45	2.08	0.96	0.51	787.00	682.00	27.00
2.	8.66	16.15	11.25	3.16	0.88	0.23	533.00	471.00	42.00
3.	9.30	18.29	11.84	0.24	0.60	0.29	151.00	443.00	19.00
4.	33.48	27.99	12.02	0.24	0.88	0.23	810.00	1130.00	32.00
5.	21.65	19.21	9.55	0.40	0.72	0.16	504.00	780.00	17.00
6.	19.14	13.84	9.23	0.36	0.70	0.22	1171.00	317.00	31.00
7.	13.89	16.79	11.19	0.16	0.60	0.19	1299.00	663.00	27.00
8.	9.92	12.02	7.00	0.20	0.76	0.18	155.00	631.00	113.00
9.	9.07	14.70	6.13	3.68	1.80	0.31	256.00	261.00	16.00
10.	15.98	15.98	12.60	1.56	0.60	0.25	423.00	682.00	28.00
11.	19.91	33.58	16.79	0.16	0.52	0.21	120.00	500.00	38.00
12.	30.00	18.29	11.84	0.80	0.28	0.17	596.00	130.00	47.00
13.	16.62	15.00	8.70	0.12	0.64	0.34	831.00	766.00	57.00
14.	10.15	11.62	10.03	0.20	0.96	0.25	661.00	514.00	41.00
15.	17.22	17.68	11.79	0.16	0.80	0.28	1830.00	612.00	70.00
16.	25.50	14.51	13.32	0.36	0.92	0.51	1393.00	948.00	30.00
17.	9.20	12.32	10.89	0.28	0.88	0.50	1742.00	698.00	17.00
18.	10.77	15.67	11.73	0.64	0.52	0.36	204.00	311.00	73.00
19.	6.78	9.52	7.00	0.36	0.84	0.38	182.00	325.00	72.00
20.	10.33	15.64	13.93	0.56	0.76	0.52	327.00	203.00	45.00
21.	4.76	8.37	8.37	1.08	0.44	0.43	833.00	135.00	21.00
22.	8.62	13.39	10.34	0.44	0.44	0.40	1228.00	457.00	29.00
23.	13.11	13.99	10.47	1.08	0.20	0.43	507.00	794.00	11.00
24.	10.49	17.56	12.86	0.28	1.40	0.37	259.00	551.00	16.00
25.	8.95	10.65	7.99	0.28	0.72	0.28	166.00	710.00	14.00
26.	16.54	11.05	10.45	0.36	0.52	0.36	553.00	415.00	22.00
27.	8.41	14.97	10.22	0.24	0.44	0.38	785.00	892.00	30.00
28.	22.95	17.01	11.34	0.40	1.04	0.43	250.00	485.00	97.00
29.	7.74	12.65	9.47	0.52	1.96	0.44	353.00	233.00	92.00
30.	14.47	16.51	12.15	0.56	1.80	0.77	704.00	976.00	27.00
31.	10.06	12.09	8.53	0.48	0.80	0.41	201.00	1133.00	52.00
32.	15.54	17.68	12.15	0.96	1.44	0.72	208.00	275.00	68.00
33.	9.14	9.47	7.50	1.24	1.28	0.97	388.00	674.00	63.00
34.	8.37	14.40	8.04	0.56	0.92	0.50	391.00	856.00	35.00
35.	6.98	15.60	12.20	0.60	0.92	0.56	819.00	664.00	28.00
36.	7.36	8.89	14.58	1.16	1.52	0.33	202.00	414.00	10.00
37.	5.08	5.67	11.75	1.16	1.80	0.14	109.00	981.00	14.00
38.	14.09	20.63	13.75	0.68	1.48	0.31	368.00	476.00	59.00
39.	8.41	10.53	14.88	2.60	2.52	0.05	614.00	1050.00	55.00
40.	15.00	17.68	12.95	1.32	2.16	0.48	217.00	1404.00	25.00
41.	11.75	11.68	12.50	0.80	0.96	0.04	490.00	192.00	82.00
42.	18.20	15.69	10.73	1.24	2.20	0.32	473.00	689.00	22.00
43.	12.14	41.12	14.50	1.80	0.60	0.02	631.00	525.00	47.00
44.	16.36	15.43	9.19	0.96	1.36	0.37	1262.00	838.00	29.00
45.	18.49	44.04	25.13	0.76	1.00	0.15	19.00	170.00	25.00
46.	6.57	4.76	5.93	1.88	1.64	3.74	135.00	573.00	18.00
47.	26.45	41.01	25.17	0.64	1.00	0.34	20.00	876.00	268.00
48.	7.57	9.90	8.63	0.64	1.40	1.47	324.00	646.00	89.00
49.	17.71	22.77	13.42	0.56	2.04	0.28	520.00	602.00	25.00
50.	11.11	19.51	16.55	2.60	1.52	0.62	677.00	623.00	15.00
51.	20.00	18.20	22.05	0.36	0.40	0.59	1174.00	303.00	68.00
52.	7.59	15.25	8.03	0.24	0.68	0.39	580.00	556.00	127.00

Contd…

Contd…

Sr. No.	C:N ratio			%Ca	%Mg	%S	Zn (mg/kg)	Mn (mg/kg)	Cu (mg/kg)
	(4)	(5)	(6)						
53.	23.61	15.17	14.07	1.24	0.44	0.52	767.00	488.00	47.00
54.	5.07	7.83	6.55	1.84	2.00	0.71	198.00	245.00	30.00
55.	13.33	12.14	9.62	1.08	1.64	1.28	1040.00	233.00	71.00
56.	15.07	28.78	20.04	1.32	2.44	1.29	450.00	261.00	298.00
57.	13.54	18.69	14.91	1.68	2.08	0.77	465.00	878.00	28.00
58.	30.73	28.37	24.72	3.64	2.44	0.48	916.00	693.00	27.00
59.	12.11	10.87	10.87	0.36	0.40	0.33	215.00	1156.00	30.00
60.	8.80	13.65	10.05	1.36	2.56	0.51	1088.00	500.00	46.00
61.	11.78	15.10	10.02	1.68	2.64	0.70	1104.00	485.00	19.00
62.	6.91	10.45	8.73	1.12	2.40	0.57	684.00	598.00	106.00
63.	4.48	6.20	7.14	2.40	3.24	0.28	982.00	485.00	193.00
64.	6.02	7.60	10.95	2.44	3.56	0.29	1140.00	822.00	63.00
65.	13.20	10.47	8.84	1.32	1.16	0.23	519.00	436.00	47.00
66.	8.06	4.42	4.07	1.08	2.12	0.77	347.00	457.00	55.00
67.	6.31	5.45	4.50	1.28	2.24	0.84	426.00	1035.00	77.00
68.	7.66	9.91	6.61	0.80	1.32	0.20	196.00	920.00	167.00
69.	21.61	14.00	16.11	0.24	0.56	0.34	538.00	303.00	29.00
70.	10.26	13.94	13.94	2.20	2.00	0.46	338.00	215.00	63.00
71.	8.27	9.29	9.51	0.40	0.20	0.40	1342.00	1214.00	21.00
72.	9.57	13.20	9.10	5.36	1.52	5.34	746.00	623.00	305.00
73.	3.26	5.57	6.72	0.80	2.92	0.45	402.00	415.00	69.00
74.	7.67	10.85	7.95	2.24	0.80	0.38	540.00	990.00	196.00
75.	4.12	14.06	11.75	2.00	2.40	0.42	663.00	724.00	348.00
76.	15.89	16.55	11.94	0.60	1.16	0.36	62.00	780.00	110.00
77.	18.54	9.27	9.96	1.52	0.76	2.11	1186.00	918.00	65.00
78.	11.84	13.97	11.31	5.56	2.04	1.15	194.00	223.00	51.00
79.	6.30	11.75	8.29	2.12	1.00	0.52	714.00	643.00	98.00
80.	10.00	8.04	6.13	0.64	1.64	0.40	585.00	245.00	152.00
81.	12.50	21.15	10.58	4.68	1.68	1.44	434.00	654.00	10.00
82.	10.00	10.00	7.32	1.36	1.68	0.43	840.00	780.00	359.00
83.	12.64	16.05	7.57	1.84	1.56	0.61	1290.00	864.00	345.00
84.	8.34	13.04	12.11	0.32	0.88	0.47	204.00	141.00	29.00
85.	7.39	7.33	10.96	0.64	3.24	0.37	110.00	668.00	21.00
86.	9.20	17.91	12.63	1.20	3.16	1.17	944.00	782.00	20.00
87.	7.01	10.73	9.06	2.84	0.36	0.61	298.00	665.00	21.00
88.	7.50	17.07	12.50	1.08	1.72	0.34	486.00	876.00	10.00
89.	6.19	14.76	13.54	1.28	1.72	1.26	546.00	801.00	124.00
90.	13.52	6.56	6.52	6.48	2.92	0.40	558.00	163.00	26.00
91.	6.45	20.50	13.14	1.00	2.24	0.70	1190.00	894.00	93.00
92.	10.46	11.26	11.67	0.44	0.44	0.83	296.00	304.00	97.00
93.	7.95	11.80	7.84	4.56	1.04	1.58	175.00	149.00	72.00
94.	17.11	21.79	20.60	0.32	0.32	0.58	1009.00	135.00	30.00
95.	2.38	4.02	3.41	0.60	0.70	0.05	175.00	261.00	47.00
96.	11.61	19.07	13.96	4.36	0.44	1.61	940.00	327.00	34.00
97.	13.37	14.72	13.56	0.36	0.64	0.34	494.00	116.00	27.00
98.	53.22	15.12	15.79	0.16	0.72	0.46	560.00	205.00	25.00
99.	9.83	8.84	6.63	2.12	2.20	0.55	300.00	556.00	79.00
100.	6.72	10.63	8.48	1.20	2.64	0.36	143.00	934.00	148.00
Avg.	**12.45**	**14.75**	**11.21**	**1.29**	**1.34**	**0.59**	**582.74**	**584.95**	**68.53**

Contd…

Contd…

Sr. No.	Fe (g/kg)	B (mg/kg)	% WSC	CEC c mol (p+) kg^{-1}	pH	EC ($dS\ m^{-1}$)
1.	2.26	26.92	2.02	111.00	7.73	0.15
2.	1.20	63.51	2.31	98.00	7.28	0.15
3.	1.34	19.90	0.91	118.00	6.10	0.15
4.	1.27	26.92	1.92	122.00	6.00	0.79
5.	1.23	30.81	0.73	116.00	6.51	0.34
6.	2.16	71.10	1.41	127.00	6.16	0.31
7.	1.24	53.08	0.50	129.00	6.06	0.72
8.	1.48	25.97	2.01	111.00	5.83	1.10
9.	4.57	26.68	0.93	108.00	6.34	0.15
10.	1.86	26.25	0.67	125.00	6.18	0.15
11.	1.27	22.75	0.47	123.00	6.36	0.15
12.	1.14	26.25	1.17	129.00	6.16	0.51
13.	1.02	19.90	0.49	131.00	6.40	0.15
14.	2.01	20.85	1.88	125.00	5.98	0.78
15.	2.61	21.14	1.52	119.00	8.19	0.80
16.	2.44	19.90	2.00	123.00	6.81	1.46
17.	2.12	19.90	1.71	125.00	6.70	0.14
18.	2.19	31.28	1.33	137.00	6.34	0.31
19.	1.01	44.55	1.22	109.00	6.27	0.45
20.	1.46	32.23	0.87	97.00	6.25	0.53
21.	3.23	26.54	0.52	119.00	6.31	1.05
22.	1.89	25.59	0.57	112.00	6.35	0.96
23.	1.98	25.59	0.75	88.00	6.13	1.06
24.	3.44	26.82	0.79	103.00	5.98	1.03
25.	0.83	41.71	0.60	127.00	4.44	0.98
26.	1.30	19.90	0.61	134.00	4.28	0.82
27.	2.44	25.59	0.66	139.00	4.38	0.58
28.	4.10	37.63	1.08	118.00	6.47	1.19
29.	2.40	27.49	0.89	123.00	5.72	0.85
30.	1.64	57.82	0.96	115.00	6.16	1.74
31.	2.23	42.66	1.00	107.00	6.60	1.72
32.	1.88	37.92	0.72	94.00	6.33	1.09
33.	1.29	66.36	2.54	100.00	6.61	2.36
34.	3.38	39.81	0.81	109.00	6.88	0.85
35.	1.23	47.40	1.28	132.00	7.55	0.20
36.	1.32	10.40	0.25	101.00	7.46	1.45
37.	1.45	68.25	0.27	93.00	7.40	1.19
38.	1.30	64.46	1.31	103.00	6.81	1.33
39.	3.67	33.18	0.82	96.00	7.01	0.83
40.	2.17	54.98	0.90	89.00	6.63	1.13
41.	0.88	23.70	1.11	112.00	7.03	0.68
42.	2.06	57.82	0.75	100.00	6.68	0.65
43.	1.07	23.70	0.72	113.00	7.26	0.59
44.	2.08	45.50	0.75	101.00	7.09	0.73
45.	0.56	36.97	0.61	124.00	7.14	0.49
46.	1.04	78.68	0.70	108.00	6.52	0.99
47.	1.50	74.89	0.52	113.00	6.24	1.12
48.	2.28	75.84	0.61	109.00	6.81	1.76
49.	2.21	40.76	2.52	102.00	6.99	1.08
50.	0.97	82.47	1.55	91.00	7.03	6.87
51.	1.87	10.42	0.41	116.00	5.73	1.54
52.	2.12	23.70	0.55	133.00	5.84	0.45

Contd…

Contd…

Sr. No.	Fe (g/kg)	B (mg/kg)	% WSC	CEC c mol (p+) kg^{-1}	pH	EC ($dS\ m^{-1}$)
53.	1.07	32.04	1.98	103.00	8.46	0.15
54.	0.40	18.96	0.72	92.00	6.13	0.14
55.	1.20	34.12	1.36	114.00	7.21	0.15
56.	1.26	25.97	0.51	110.00	7.16	0.15
57.	1.99	21.89	0.54	116.00	7.30	0.15
58.	1.63	26.54	0.52	111.00	6.66	1.97
59.	1.75	24.64	0.51	114.00	4.39	1.06
60.	1.59	25.97	2.09	101.00	6.37	1.85
61.	1.62	32.23	3.29	103.00	6.60	1.73
62.	2.53	29.86	0.75	99.00	6.89	1.42
63.	2.17	31.28	0.27	77.00	6.48	0.30
64.	1.74	32.23	0.28	93.00	6.77	0.35
65.	1.20	36.02	1.51	121.00	6.93	5.52
66.	1.88	52.14	0.56	107.00	6.28	0.91
67.	1.54	35.07	0.53	103.00	6.30	2.39
68.	6.31	31.28	2.16	122.00	5.33	0.37
69.	2.10	26.54	4.64	117.00	5.10	0.84
70.	1.37	52.14	3.83	96.00	6.56	1.11
71.	1.49	72.04	2.19	103.00	6.65	0.46
72.	2.46	53.08	0.45	86.00	7.13	2.68
73.	2.10	27.49	0.79	92.00	6.05	3.24
74.	3.39	40.76	0.65	103.00	5.85	2.54
75.	2.08	32.23	0.36	90.00	6.43	0.97
76.	4.24	43.60	1.00	95.00	5.02	0.55
77.	1.82	69.39	0.61	79.00	5.32	0.20
78.	0.83	43.60	0.36	75.00	6.47	1.57
79.	2.46	62.56	0.36	99.00	6.76	4.47
80.	1.61	42.66	1.08	104.00	6.66	6.70
81.	1.41	58.77	0.55	81.00	8.10	1.91
82.	1.86	30.71	0.54	114.00	7.15	1.54
83.	2.41	38.86	0.86	107.00	6.34	1.28
84.	1.82	58.68	1.37	99.00	5.77	0.01
85.	2.44	44.55	0.31	62.00	5.46	0.20
86.	1.69	92.90	2.16	95.00	6.78	2.66
87.	1.76	32.23	0.83	89.00	9.57	1.06
88.	1.21	12.32	0.81	118.00	6.65	1.41
89.	1.55	14.22	0.82	104.00	7.32	2.44
90.	0.86	43.60	0.69	87.00	6.86	0.48
91.	2.66	45.74	0.72	111.00	6.99	1.00
92.	1.23	75.84	5.70	113.00	4.87	1.83
93.	3.48	54.03	1.37	96.00	6.00	1.93
94.	1.62	53.08	4.19	115.00	4.18	1.83
95.	1.37	54.98	0.86	81.00	6.53	0.24
96.	3.10	78.68	0.21	63.00	8.96	0.62
97.	1.29	38.86	3.83	111.00	4.78	1.76
98.	1.42	92.90	4.90	119.00	4.23	0.71
99.	1.41	44.55	1.53	84.00	5.27	2.35
100.	2.80	56.88	0.74	128.00	6.41	1.10
Avg.	**1.91**	**40.63**	**1.21**	**107.09**	**6.43**	**1.19**

APPENDIX IV

BIOLOGICAL PROPERTIES OF MANURES

Sr. No.	CO_2 Evolution	Sr. No.	CO_2 Evolution
1.	13.20	52.	14.96
2.	15.80	53.	11.44
3.	16.06	54.	11.88
4.	13.86	55.	10.56
5.	15.62	56.	15.62
6.	14.96	57.	15.18
7.	13.14	58.	15.84
8.	14.08	59.	13.42
9.	13.86	60.	16.28
10.	15.18	61.	15.18
11.	12.76	62.	14.30
12.	13.64	63.	14.96
13.	14.96	64.	13.20
14.	14.30	65.	12.54
15.	15.18	66.	15.18
16.	16.06	67.	11.22
17.	15.62	68.	9.46
18.	15.40	69.	10.56
19.	14.96	70.	8.33
20.	16.28	71.	10.34
21.	14.74	72.	9.02
22.	15.18	73.	7.04
23.	14.96	74.	9.68
24.	14.96	75.	8.36
25.	16.50	76.	10.12
26.	14.74	77.	8.58
27.	14.96	78.	9.24
28.	13.64	79.	11.00
29.	12.76	80.	10.78
30.	14.08	81.	9.46
31.	13.64	82.	12.76
32.	14.96	83.	6.82
33.	13.86	84.	10.12
34.	12.54	85.	2.86
35.	14.08	86.	12.76
36.	12.76	87.	11.88
37.	11.88	88.	12.98
38.	11.22	89.	13.64
39.	9.90	90.	13.02
40.	9.24	91.	12.10
41.	10.78	92.	8.80
42.	11.66	93.	11.22
43.	12.32	94.	11.66
44.	9.68	95.	6.82
45.	12.98	96.	8.36
46.	14.08	97.	9.46
47.	13.86	98.	9.90
48.	12.76	99.	8.58
49.	10.78	100.	13.42
50.	10.34	**Avg.**	**12.50**
51.	13.86		

Contd…

APPENDIX - V

ABBREVIATIONS USED

Mt	:	Million tonne
et al.	:	and others (coworkers)
i.e.	:	that is
mg	:	milligram (s)
kg	:	kilogram (s)
Mg	:	Megagram
viz.,	:	namely
Fig.	:	Figure
etc.	:	et cetera
@	:	At the rate
^{0}C	:	Degree Celsius
%	:	Per cent
ppm	:	Parts per million
$<$	:	Lower than
$>$	:	More than
N (1)	:	Nitrogen determined by colorimetric method
N(2)	:	Nitrogen determined by Kjeldahl's method
N(3)	:	Nitrogen determined by modified Kjeldahl's method
P_2O_5(1)	:	Phosphorus determined by diacid digestion method
P_2O_5(2)	:	Phosphorus determined by triacid digestion method
P_2O_5(3)	:	Phosphorus determined by dry ashing method
K_2O(1)	:	Potassium determined by diacid digestion method
K_2O(2)	:	Potassim determined by triacid digestion method
K_2O(3)	:	Potassium determined by dry ashing method
TOC (D.C.)	:	Total organic carbon determined by dry combustion method

TOC (W.D.)	:	Total organic carbon determined by wet digestion method
O.M. (D.C.)	:	Organic matter determined by dry combustion method
O.M. (W.D.)	:	Organic matter determined by wet digestion method
Ash (D.C.)	:	Ash determined by dry combustion method
Ash (W.D.)	:	Ash determined by wet digestion method
C:N ratio (1)	:	Total organic carbon determined by dry combustion method and nitrogen determined by colorimetric method
C:N ratio (2)	:	Total organic carbon determined by dry combustion method and nitrogen determined by Kjeldahl's method
C:N ratio (3)	:	Total organic carbon determined by dry combustion method and nitrogen determined by modified Kjeldahl's method
C:N ratio (4)	:	Total organic carbon determined by wet digestion method and nitrogen determined by colorimetric method
C:N ratio (5)	:	Total organic carbon determined by wet digestion method and nitrogen determined by Kjeldahl's method
C:N ratio (6)	:	Total organic carbon determined by wet digestion method and nitrogen determined by modified Kjeldahl's method
Ca	:	Calcium
Mg	:	Magnesium
S	:	Sulphur
Zn	:	Zinc
Mn	:	Manganese
Cu	:	Copper
Fe	:	Iron
B	:	Boron
WSC	:	Water soluble carbohydrate
CEC	:	Cation exchange capacity
EC	:	Electrical conductivity

APPENDIX I

The detail information about manure samples collected from four districts of Konkan region of Maharashtra

Sr. No.	Name of producer or seller	Name of manure	Place of collection	Raw material used for manure preparation	Annual production (tonnes)	Price per 50 kg
1.	D.B. Bodekar	N.A	Kankawali, Sindhudurg	Goat manure, others	8-9	360
2.	Sagar S. Desai	N.A	Deogad, Sindhudurg	Neem cake, others	N.A	350
3.	Madhukar Rane	Rane vermicompost	Kasal, Kankawali, Sindhudurg	50 per cent Cow dung, tree leaves, crop waste, etc.	40	225
4.	Govt. Farm, Mangaon	Vermicompost	Mangaon, Kudal, Sindhudurg	Cow dung, mango and cashew leaves, grasses	14	200
5.	Govt. Farm, Mangaon	Compost	Mangaon, Kudal, Sindhudurg	Cow dung 70 per cent, tree leaves grass, etc.	8-10	160
6.	Govt. Farm, Mangaon	Vermicompost	Mangaon, Kudal, Sindhudurg	Cow dung ,agricultural waste tree leaves grass, etc.	14	200
7.	Mahesh G. Sawant	Vermicompost	Sawantwadi, Sindhudurg	Cow dung, agricultural wastes	28	200
8.	Rajaram Patil	Vermicompost	Mankhol, Sawantwadi, Sindhudurg	Cow dung, tree leaves, grasses	20	200
9.	R.F.R.S., Vengurla (I)	Vermicompost	Vengurla, Sindhudurg	Cow dung, grasses, tree leaves	1-2	N.A
10.	R.F.R.S., Vengurla (II)	Vermicompost	Vengurla, Sindhudurg	Cow dung, grasses, tree leaves	7-8	N.A
11.	Purushottam Dalvi	Vermicompost	Arawali, Vengurla, Sindhudurg	Cow dung, grasses, tree leaves	50-60	200
12.	Shankar S. Ghare	Vermicompost	Tulas, Vengurla, Sindhudurg	Cow dung, grasses, tree leaves	10	250
13.	Gopal Mestri	Vermicompost	Tulas, Vengurla,	Cow dung, agricultural	7-8	200

			Sindhudurg	waste, tree leaves		
14.	Pravin M. Gawade	Vermicompost	Vetore, Vengurla, Sindhudurg	Cow dung, kitchen waste, tree leaves	10	250
15.	Mahesh Shenye	Vermicompost	Vetore, Vengurla, Sindhudurg	Cow dung, grasses, crop waste	8-10	250
16.	Shridhar G. Ghatge	Vermicompost	Vetore, Vengurla, Sindhudurg	Cow dung, grasses, tree leaves	11-12	200
17.	Santosh G. Gadgil	Vermicompost	Vetore, Vengurla, Sindhudurg	Cow dung ,agricultural waste tree leaves grass, etc.	8-9	200
18.	Ghanashyam S. Manjarekar	Vermicompost	Vajrat, Vengurla, Sindhudurg	Cow dung, tree leaves, crop waste	3	200
19.	Vikas N. Chavan	Vermicompost	Vajrat, Vengurla, Sindhudurg	Cow dung, tree leaves, crop waste	5	200
20.	Anant A. Sawant Bhosale	Vermicompost	Vajrat, Vengurla, Sindhudurg	Cow dung, grasses, tree leaves	10	150
21.	Shivaram Arorkar	Vermicompost	Math, Vengurla, Sindhudurg	Cow dung 50 per cent, tree leaves grass, etc.	12-13	200
22.	Ramchandra S. Gawade	Vermicompost	Math, Vengurla, Sindhudurg	Cow dung, agricultural wastes	10-12	200
23.	Mahadeo Arolkar	Vermicompost	Goveri, Kudal, Sindhudurg	Cow dung, grasses, tree leaves	30	150
24.	Madhukar Gawas	Vermicompost	Goveri, Kudal, Sindhudurg	Cow dung, grasses, tree leaves	12	200
25.	Mahesh Shirodkar	Vermicompost	Kankawali, SIndhudurg	Cow dung, agricultural wastes	30	200
26.	Prakash Mahajan	Vermicompost	Kankawali, SIndhudurg	Cow dung, grasses, agricultural waste	10	200
27.	Gopal D. Parab	Vermicompost	Kankawali, SIndhudurg	Cow dung 70 per cent, tree leaves grass, etc.	8-10	250
28.	Pappu Barve	Vermicompost	Dapoli, Ratnagiri	Cow dung, grasses, agricultural	3	200

				waste		
29.	Prashant B. Gore	Vermicompost	Deogad Sindhudurg	Cow dung 70 per cent, tree leaves grass, etc.	8-10	250
30.	Devraj Zarapkar	Vermicompost	Khed, Ratnagiri	Cow dung, tree leaves, crop waste	12-15	250
31.	A.P. Phadke	Vermicompost	Dapoli, Ratnagiri	Cow dung, tree leaves, crop waste	4-6	275
32.	R.K. Chaugule	Vermicompost	Kalva, Thane	Cow dung, grasses, tree leaves	20	250
33.	Mrs. Shailaja Behere	Mixed manure	Pawas, Ratnagiri	Goat manure, bone meal, Turmeric wastes	N.A	300
34.	Rajesh D. Babal	Deogad plus organic manure (vermicompost)	Deogad, Sindhudurg	Cow dung, agricultural waste, tree leaves	N.A	250
35.	N.G. Gaurat	Poultry manure	Dapoli, Ratnagiri	Poultry wastes	23-25	300
36.	Namdev T. Bhise	Compost	Vasai, Murbad, Thane	Cow dung, tree leaves, grasses, others	4	200
37.	Mahesh B. Mahale	Compost	Vasai, Murbad, Thane	Cow dung, tree leaves, grasses, others	3	200
38.	Bhagwan M. Chaudhari	Vermicompost	Bikhadi, Shahapur, Thane	Cow dung 70 per cent, tree leaves grass, etc.	3-4	200
39.	Vasant G. Kharat	Vermicompost	Kudus, Wada, Thane	Cow dung, agricultural wastes	6	200
40.	Vijay D. Patil	Vermicompost	Zidka, Bhivandi, Thane	Cow dung, tree leaves, grasses	8-9	200
41.	Narayan T. Vishe	Vermicompost	Dolarewadi, Bhivandi, Thane	Cow dung, grasses, tree leaves	3	150
42.	Laxman S. Gadge	Vermicompost	Kelva, Palghar, Thane	Cow dung, grasses, tree leaves	5	200
43.	Murli M. Mali	Vermicompost	Maliwada, Palghar, Thane	Cow dung, grasses, tree leaves	10	200
44.	Shaligram B.	Vermicompost	Gates,	Cow dung,	12-13	150

	Ghangurde		Vikramgad, Thane	grasses, tree leaves		
45.	Prasad V. Khadapkar	Vermicompost	Vikramgad, Thane	Cow dung, agricultural waste, tree leaves	10-12	200
46.	Dattatray M. Chavan	Compost	Gorewadi, Vikramgad, Thane	Fish wastes, cowdung, crop residues, etc.	3	300
47.	Milan Patkar	Vermicompost	Ali, Wada, Thane	Cow dung 70 per cent, tree leaves grass, etc.	8	300
48.	Prasad M. Kshirsagar	Vermicompost	Sopan, Wada, Thane	Cow dung, agricultural wastes, rock phosphate	5-6	275
49.	Mrs. Vaishali D. Patil	FYM	Koproli, Uran, Raigad	Cow dung, agricultural wastes	4	200
50.	Moreshwar T. Shewar	Leaf compost	Pali, Sidhagad, Raigad	Tree leaves, rock phosphate, ash	4	170
51.	Rajendra Jadhav	Vermicompost	Sudhagad, Raigad	Cow dung 70 per cent, tree leaves grass, etc.	10	275
52.	Suraj A. Shinde	Vermicompost	Khopoli, Khalapur, Raigad	Cow dung, tree leaves, grasses	8	250
53.	Shivaji R. Desai	Nakshtra	Kankavli, Sindhudurg	Goat manure, fish waste, ash	10 -12	225
54.	Pankaj Dali	Ganapati Chhap organic manure	Kankawali, Sindhudurg	Boan meal, leather meal	N.A	350
55.	Pankaj Dali	Bhusanwardhak Khat	Kankawali, Sindhudurg	N.A	N.A	270
56.	Pankaj Dali	Celrich	Kankawali, Sindhudurg	City waste material	N.A	250
57.	Bajirao Zende	Sindhumishran	Hirlok, Kudal, Sindhudurg	Goat, poultry dropping, tobacco, turmeric, neem waste and fish meal	100	200
58.	Prabhu Krishi Seva Kendra	Sanwardhan	Kudal, Sindhudurg	N.A	N.A	260
59.	Bajirao J. Dhekale	Gopuri ashram	Kankawali, SIndhudurg	Cow dung, farm waste and tree	4	200

				wastes		
60.	Vikas Dhamapurkar	Mahalakshmi organic manure	Kankawali, SIndhudurg	Goat, poultry dropping, tobacco, turmeric, neem waste and fish meal, rock phosphate	30	250
61.	Vikas Dhamapurkar	Mixed manure	Kankawali, SIndhudurg	Pressmud, compost, tobacco, fish, poultry wastes, rock phosphate	10	275
62.	Chhatrapati Shahu Krishi Seva Kendra	Green meal	Kankawali, SIndhudurg	Neem cake, tobacco, fish, poultry wastes, rock phosphate	N.A	250
63.	Deogad Kharedi Vikri Kendra	Amrut vermiphos	Deogad, SIndhudurg	Organic waste, cowdung rock phosphate	N.A	350
64.	Deogad Kharedi Vikri Kendra	Sanved humiphos	Deogad, SIndhudurg	Organic waste, cowdung rock phosphate	N.A	325
65.	Deogad Kharedi Vikri Kendra	Sumitra mixture	Deogad, SIndhudurg	Organic waste, cowdung cattle feed waste	N.A	350
66.	Deogad Kharedi Vikri Kendra	Godrej Vikas	Deogad, SIndhudurg	Compost, fish meal, rock phosphate, others	N.A	396
67.	Deogad Kharedi Vikri Kendra	Biomeal	Deogad, SIndhudurg	Compost, microbial culture.	N.A	260
68.	Deogad Kharedi Vikri Kendra	Sendriya khat (I)	Deogad, SIndhudurg	Neem waste, cowdung and others	N.A	250
69.	Deogad Kharedi Vikri Kendra	Sendriya khat (II)	Deogad, SIndhudurg	Groundnut waste, cowdung and others	N.A	200
70.	Deogad Kharedi Vikri Kendra	Godrej 100%	Deogad, SIndhudurg	Organic waste compost, dung, leather wastes	N.A	350
71.	Deogad Kharedi Vikri Kendra	Castor cake	Deogad, SIndhudurg	Castor waste	N.A	250
72.	Deogad Kharedi Vikri	Narmada kudarati	Deogad, SIndhudurg	Blood meal, bone meal,	N.A	250

	Kendra			organic manure etc.		
73.	Deogad Kharedi Vikri Kendra	Geomax	Deogad, Singhudurg	Blood meal, bone meal, organic manure etc.	N.A	300
74.	Deogad Kharedi Vikri Kendra	Agromeal	Rajapur, Ratnagiri	N.A	N.A	275
75.	Deogad Kharedi Vikri Kendra	Bhumiseva	Rajapur, Ratnagiri	N.A	N.A	300
76.	Premkumar Yadati	Vasumitra	Kharepatan, Rajapur, Ratnagiri	Weeds, plant extract, etc.	30	325
77.	Yogesh Jadhav	Ormichem	Rajapur, Ratnagiri	Basic slag, cowdung and others	N.A	225
78.	Kisan Krishi Seva Kendra	Orgo	Deogad, Sindhudurg	N.A	N.A	225
79.	Rajapur Kharedi Vikri Kendra	Suphala sendriya	Rajapur, Ratnagiri	Neem cake, castor cake, poultry, tobacco wastes	N.A	300
80.	Vengurla Kharedi Vikri Kendra	Hortimeal	Vengurla, Sindhudurg	Composted material, microbial culture, rock phosphate, etc.	N.A	250
81.	Vengurla Kharedi Vikri Kendra	Govardhan	Vengurla, Sindhudurg	Cowdung, crop residue and others	N.A	250
82.	Prakash Bhangrath	Rashimeal	Shahapur, Thane	Cowdung, crop residue and others	N.A	300
83.	Prakash Bhangrath	Farmin	Shahapur, Thane	Cowdung, crop residue and others	N.A	325
84.	Prakash Bhangrath	Bhuvardhini	Shahapur, Thane	Cowdung, crop residue and others	N.A	275
85.	Prakash Bhangrath	Bhusanwardhak	Shahapur, Thane	Cowdung, crop residue and others	N.A	350
86.	Chandrakant R. More	Sendrin	Thane	Town refuse, microbial culture, bone meal, etc.	N.A	350
87.	Hitesh Shah	Uttam Sendriya	Thane	Compost, fish meal,. rock	N.A	300

				phosphate		
88.	Girish Gandhi	Brown gold	Panvel, Thane	Organic waste, dung cattle feed waste, rock phosphate.	N.A	325
89.	Sandeep S. Shinde	Paris	Panvel, Thane	City refuse, cattle feed waste, rock phosphate.	N.A	300
90.	Sachin B. Haralpatil	Bhivar organic manure	Wada, Thane	Compost, fish meal,. rock phosphate	N.A	250
91.	Madan G. Ghurat	Amrut Kumbha	Murbad, Thane	Fruit wastes, dung, tree waste etc.	N.A	325
92.	Kalyan D. Nagargoje	Neem cake	Mahad, Raigad	Neem waste, rock phosphate, ash, cowdung	N.A	325
93.	Suresh M. Salunkhe	Orgo	Mahad, Raigad	rock phosphate, ash, cowdung	N.A	280
94.	Prashant A. Rupnawar	Argo super	Mangaon, Raigad	rock phosphate, ash, cowdung	N.A	270
95.	Shivajirao Deshmukh	Super harvest	mangaon, Raigad	rock phosphate, ash, cowdung	N.A	220
96.	Shankarrao Shinde	Sarite	mangaon, Raigad	rock phosphate, ash, cowdung	N.A	330
97.	N.N. Khoja	Neem cake	Pen, Raigad	Neem waste	N.A	300
98.	Prabhakar V. Mahtre	Sendriya mixture	Pen, Raigad	Groundnut wastes	N.A	300
99.	A.H. Meman	Anomeal	Mahalsa, Raigad	N.A	N.A	350
100.	Abasaheb K. Chavan	Gomay (Vermicompost)	Srivardhan, Raigad	Cow dung, agricultural wastes	N.A	300

Note : N. A.- Not available

CHAPTER I

INTRODUCTION

Use of organic manures is well known from ancient time, but in recent years more attention is being given to them. In the practice of organic farming, incorporation of organic materials, manures and compost is easy way to increase the fertility of soil and maintain the environment eco-friendly. The importance and utility of different types of manures depend upon their physical, chemical and biological parameters.

The country has a vast potential of 873 million tones of organic resources like crop residues (273 MT), forest litter (18 MT), animal excreta or byproducts and aquatic residues (279 MT), city garbage and sewage sludge (15 MT), which can meet the total nutrient requirement of 5 to 6 million tones of nitrogen, phosphorus and potassium (Swarup and Ganeshmurty, 1998). Composting of these residues to convert them into good quality manures is one of the most efficient and hygienic methods of recycling of said residues back to the soil. In broad terms manure is biologically decayed refuse like leaves, twigs, roots, stubble, crop residues, animal wastes or byproducts etc. It leads to the production of brown and dark black coloured humidified material which is valuable in the soil as it improves soil health.

The principal requirement of manure for safe and efficient use in crop production is its degree of stability or maturity, which implies decomposed manure with high degree of humification, less phytotoxic materials and pathogens (Bernal *et al*. 1998). A review of past work revealed that adequate decomposition is essential for obtaining better quality of organic matter not only by way of crop production but also to improve soil quality and productivity (De Nobili *et al*., 1986; De Nobili and Petrussi., 1988; Inbar *et al*., 1992; Beca *et al*., 1995)

Organic manures can differ widely in their properties and characteristics. Some of these materials comprising undecomposed animal manures, green manures and sewage sludge are subject to rapid microbial decomposition i.e. mineralization in soils and tend to release their plant nutrients rapidly. This is desirable for soils which are at a high level of productivity. On the other hand, materials such as cereal straw, wood bark, composted animal manures and sewage sludge are more resistant to microbial attack. These materials would, therefore, promote more organic stability in low fertility marginal soils.

Biodegradable wastes such as straws of cereals, oilseeds, city garbage and forest litters, which have wide C : N ratio ranging from 80-110 and low content of micronutrients are normally composted by aerobic and anaerobic methods. For the preparation of the manures, organic sources such as bone meal, fish meal, leather meal, guano etc. are being used which contain considerable amount of micronutrients, typically more than 5 per cent of total N, P and K are used directly in the agriculture as a source of nutrients. There are no specific guidelines for evaluating manure quality in India, whereas other countries like USA, Canada and Europe have developed specific norms for grading of manures on the basis of their quality parameters. Manure quality depends upon the wastes characteristics as well as the process of composting used for their production. Manure quality parameters, therefore, vary widely. Generally, there are rigid quality parameters used for both compost producers and users that include minimum organic matter content, and nutrients content (N, P, K), maximum levels of trace elements, maximum levels of man – made inert which can be separated out by usual sorting process, free from human pathogens, odourless, biologically stable and better plant growth response. A major problem in developing guidelines for quality standards of compost is the different perspective between researchers, compost producers and compost users. So there is necessity to develop specific norms of quality parameters of manures which were applicable to all the users, producers and researchers.

The most critical manure quality factors depend on the planned manure and use. For most applications, plant growth response is the ultimate indicator of manure quality. Manure maturity and biological stability is applicable highly for nursery crops, sales to bagged and field crops, and medium important to fruit crops and less important to mulching operation. Manure nutrient content especially plant available nitrogen is most important for field crops, vegetable, fruit crops and less important for nursery and mulch operation. Restriction of salt content and pH is highly advisable for nursery crops and bagged crops, but is less important for vegetables, fruits and field crops and least important for mulching. Soluble salts content of matured manure should be between 2.5 to 6.0 dS m^{-1} for vegetable and plantation crops and less than 3 dS m^{-1} for potting media. Man made inert such as soil, glass, plastic is highly important for nursery. It should be less than 10% particle size of matured manure is highly important for nursery because of proper drainage requirement of nursery always improve by the particle size of more than 13 mm screen (Manna *et al*. 2004).

The present investigations are, therefore, proposed to assess the quality parameters of manures available in Konkan region of Maharashtra and to categories them in to the quality classes. The efforts will be made to develop specific norms for grading quality of manures available in Konkan region of Maharashtra State with the following objectives :

1) To know whether the manure samples from Konkan region are falling below, within or above the minimum sets of physical, chemical and biological attributes for determining the quality of manures as proposed by State Govt. of Maharashtra and Indian Institute of Soil Science (I.C.A.R.), Bhopal.
2) To correlate some of the parameters with each other such as total organic carbon and total nitrogen, total organic carbon and total phosphorus and total organic carbon and total potassium.
3) To find out correlation between/among the various methods of determination of some of the parameters like total organic carbon, total nitrogen, total phosphorus and total potassium.

CHAPTER II

REVIEW OF LITERATURE

The studies on physical, chemical and biological properties of manures prepared from a number of organic residues of plant and animal origin are undertaken by numerous researchers from the country as well as foreign countries and a lot of literature is available about the properties of these manures. The available literature is presented under the following heads:

2.1 Properties of FYM and biogas slurry

2.2 Properties of goat and sheep manure

2.3 Properties of poultry manure

2.4 Properties of fish manure

2.5 Properties of bone meal, meat meal and blood meal

2.6 Properties of compost

2.7 Properties of vermicompost

2.8 Properties of edible and non-edible oil cakes

2.9 Properties of city compost/sewage sludge compost

2.10 Standards of organic manures

2.1 Properties of FYM and biogas slurry

Swarup (1991) recorded the micronutrient content in FYM on dry weight basis. The reported values of Fe, Mn and Zn were 320 mg/kg, 125 mg/kg, 24 mg/kg, respectively. Pathak *et al*. (1992) evaluated manurial value of biogas spent slurry with dry mango leaves, wheat straw and rock phosphate. The initial nutrient content of biogas spent slurry on dry weight basis was 1.90 per cent N, 12.28 C : N ratio and 0.81 per cent P, while on the fresh weight basis 1.98, 11.18 and 0.97 per cent, respectively. After 40 days of the composting of biogas spent slurry with dry mango leaves and wheat straw the recorded nutrients values of biogas spent slurry + dry mango leaves are 2.00 per cent N, 11.32 C : N ratio and 0.80 per cent P, while biogas spent slurry + wheat straw had 1.88 per cent, 11.90 C : N ratio and 0.80 per cent P.

Patil (1993) reported that FYM consisted of 0.57 per cent total N, 0.65 per cent total phosphorus and 0.96 per cent total potassium. The micronutrients *viz*., iron, manganese, zinc and copper were 86, 28, 73 and 21 mg/kg, respectively. Shinde *et al*. (1995) stated that FYM had pH 8.05, EC 5.30 (dS m^{-1}) and total nitrogen, phosphorus and potassium were 1.44, 1.20 and 2.10 per cent, respectively. While studying the effect of FYM and vermicompost on yield of rice, Jadhav (1996) reported that FYM contained 15 per cent moisture, 37.37 per cent carbon, 0.84 per cent nitrogen, 0.72 per cent phosphorus, 0.66 per cent potassium. He also reported the biological constants like C : N and C : P ratio as 44.49 and 51.90, respectively.

Nitrogen content in FYM and rice straw on oven dry basis reported by Basumatry and Talukdar (1998) was 0.50 and 0.37 per cent, respectively. Hattab *et al*. (1998) recorded nitrogen and C : N ratio of FYM and pressmud. FYM was found to contain 0.53 per cent N and had 34 per cent C : N ratio, while pressmud was found to contain 0.72 per cent N and had 28 : 1 C : N ratio. Kundu *et al*. (1998) recorded the nitrogen content of FYM as 6.2 g/kg used in their experiment on N_2 fixation in soybean (G*lycine max*) and its contribution to soil nitrogen. Reddy and Reddy (1998) studied the chemical composition of organic manures. The recorded data revealed that the nutrient content *viz*., total nitrogen, phosphorus, potassium, zinc, copper, iron and manganese content of biogas slurry and FYM had 1.68 and 0.42 per cent, 0.98 and 0.70 per cent, 0.91 per cent and 0.73 per cent, 90.4 and 57.8 mg/kg, 66.4 and 27.6 mg/kg, 833.7 and 310.4 mg/kg and 261.9 and 198.6 mg/kg, respectively.

Singh *et al*. (1998) conducted an experiment on effect of seed inoculation and FYM on biological N fixation in soybean and nitrogen balance under soybean-wheat system on vertisols. They reported 67 per cent N on fresh weight basis in FYM. Singh *et al*. (1998) studied the nutrient composition of biogas slurry on dry weight basis. It comprised of organic carbon 35.3 per cent, total nitrogen 0.93 per cent, total phosphorus 0.45 per cent, total potassium 0.55 per cent and total zinc, iron, copper, manganese to the tune of 105, 2504, 50 and 241 mg/kg, respectively.

Gupta *et al*. (2000) reported that FYM contained 22.0, 1.12, 0.55 and 0.88 per cent organic carbon, nitrogen, phosphorus and potassium, respectively. The composition of FYM studied by Shrikanth *et al*. (2000) was as follows : organic carbon 37.4 per cent, 0.90 per cent total nitrogen, 0.40 per cent phosphorus and potassium 0.70 per cent and pH 6.90. Sharma *et al*. (2002) reported the nutrient content of FYM as 0.75 per cent nitrogen, 0.17 per cent phosphorus, 0.55 per cent potassium, 0.91 per cent calcium, 0.19 per cent magnesium, 146.6 ppm iron, 14.5 ppm zinc, 69.0 ppm manganese and 2.8 ppm copper. Arti *et al*. (2003) recorded N, P, K content of FYM as 1.0 per cent, 0.3 per cent and 0.5 per cent, respectively. Dinesh *et al*. (2003) reported organic carbon and phosphorus content in FYM was 36 per cent and 0.31 per cent, respectively.

Gupta *et al*. (2003) reported an average per cent of N, P, K in FYM as 1.12, 0.55 and 0.88, respectively, whereas in biogas slurry it was 1.40, 1.05 and 1.15 per cent, respectively. Tolanur and Badanur (2003) found that the FYM contained 0.80 per cent nitrogen, 0.41 per cent phosphorus and 0.74 per cent potassium. Karle (2004) studied the effect of organic manures on yield and quality of mango and NPK fraction in soil. He observed the nutrient contents (N, P, K) in FYM as 0.50 per cent N, 0.25 per cent P and 0.50 per cent K. Sihag *et al*. (2005) reported the chemical composition of FYM as follows : 20.20 per cent organic carbon, 0.97 per cent nitrogen, 0.40 per cent phosphorus and 1.6 per cent potassium.

2.2 Properties of goat and sheep manure

Schroeder (1980) recorded that the sheep manure had 64 per cent moisture, 1.1 per cent nitrogen, 0.3 per cent phosphorus. The sheep and goat excreta contained 0.65 per cent nitrogen, 0.5 per cent phosphorus and 0.03 per cent potassium on dry weight basis as reported by Gaur *et al*. (1984). Bhoite (1998) noted the following properties of manure prepared from goat dropping : pH 6.9, EC 1.17 (dS m^{-1}), water holding capacity 85.7 per cent, organic carbon 41.2 per cent, nitrogen 1.80 per cent, phosphorus 0.68 per cent and potassium 1.08 per cent. Lekha *et al*. (1999) registered the nutrient content of sheep manure as 2.4 per cent nitrogen, 0.9 per cent phosphorus and 2.0 per cent potash.

Gupta (2003) reported nutrient content of fresh sheep dung as follows : 0.5 to 0.7 per cent nitrogen, 0.4 to 0.6 per cent phosphorus and 0.3 to 1.0 per cent potash. Talashilkar *et al*. (2005) reported micronutrients content in goat dropping as zinc 58 ppm, copper 1.5 ppm, manganese 13 ppm and iron 370 ppm, while sheep dropping contained zinc 114 ppm, copper 2.0 ppm, manganese 25 ppm and iron 72 ppm.

2.3 Properties of poultry manure

Chemical composition of dried poultry manure reported by Shenon *et al*. (1973) is as follows : dry matter (82.3 to 96.1 %), nitrogen (2.9 to 6.2%), ash (20.7 to 49.7%), calcium (5.1 to 15.1%), available carbohydrates (2.7 to 13.9%), uric acid (2.3 to 11.4%), phosphorus (1.9 to 3.4 %), facial protein content (10.1to 14.8 %) and metabilizeable energy (640 to 1270 Kcal/kg). Gaur *et al*. (1984) reported the average nitrogen, phosphorus and potassium content of dried poultry manure from country breed as 3.03,2. 6 and 1.4 per cent, respectively. Echeandia and Menoyo (1991) conducted an experiment on poultry composting. They found that the fresh poultry excreta when blended with pine bark (50 : 50 basis) to increase C : N ratio to give adequate porosity and sponginess and improve the composting process. The mixture is accumulated in 2 meter high heap and is turned over at an interval of three days for 15 days to sterilize material to minimize volatilization of NH_3. pH attended was 9.0, CEC 80 me/100 g and nonhydrolyzable N 1.28 per cent. Gale et al. (1991) studied the effect of drying on plant nutrient content of hen manure. They observed that inorganic nitrogen (NH_4^- N) in the manure was 1.93 and 0.20 per cent by wet and dry analysis, respectively. So poultry manure sample should not be dried prior to analysis. Mean values for elements other than nitrogen (P, K, Ca, Mg and S) were not significantly different for wet and dry samples.

Cuminas *et al*. (1993) assessed potential nutrient value of composted poultry mortalities and poultry litters as a fertilizer. The same is as follows : N 40 g/kg, ash 247 g/kg, Ca 23 g/kg, Mg 5 g/kg, P 16 g/kg, Cu 143 mg/kg, Fe 2377 mg/kg, Mn 348 mg/kg, Zn 315 mg/kg and B 54 mg/kg. Sims and Wolf (1994) reported that the elemental composition of poultry waste manure from broiler and layer as follows : for broiler litter, N 4.3 per cent, NH_4 1.1 per cent, P 2.1 per cent, K 2.6 per cent, S 0.7 per cent, Ca 2.3 per cent, Mg 1.0 per cent, Cu 251 mg/kg, Mn 309 mg/kg, Zn 338 mg/kg and for layer litter, N 3.8 per cent, NH_4 0.9 per cent, P 1.6 per cent, K 1.8 per cent, Ca 3.1 per cent, Mg 0.4 per cent, Cu 473 mg/kg, B 54 mg/kg, Mn 348 mg/kg, Zn 315 mg/kg. Dosani *et al*. (1999) conducted an experiment on effect of poultry manures applied in combination with fertilizers on the yield and nutrient uptake of groundnut. They recorded the composition of poultry manure as follows : Moisture 42 per cent, organic carbon 21 per cent (Dry combustion method), nitrogen 3.79 per cent (Kjeldahl's modified sulphuric salicylic acid mixture method), phosphorus 3.09 per cent (Vanadomolybdate yellow colour method), potassium 2.12 per cent (Flame photometer), calcium 1.71 per cent, magnesium 1.04 per cent (Diacid extract by versenate titration method), sulphur 0.5 per cent (Diacid extract by colorimetric method using barium chloride as precipitating reagent), water soluble carbohydrates 1.4 per cent, CEC 135.0 c mol (p^+) kg^{-1}, micronutrients such as Zn 198 ppm, Cu 306 ppm, Mn 447.0 ppm, Fe 1978 ppm (Atomic absorption spectrophotometer). Dhopavkar (2001) revealed that per cent nitrogen, phosphorus and potassium content in poultry manure were to the tune of 3.0, 2.6 and 1.4, respectively.

Bhikane (2002) recorded the nutrient content of poultry manure used in study as 1.52 per cent nitrogen by Kjeldahl's modified sulphuric salicylic acid mixture method, 2.71 per cent phosphorus by Vanadomolybdate yellow colour method and 0.43 per cent potassium by Flame photometry. Dinesh *et al*. (2003) reported the organic carbon and phosphorus content in poultry manure on fresh weight basis as 42 per cent and 0.37 per cent, respectively. Karle (2004) studied effect of organic manures on yield and quality of mango and NPK fractions in soil. He observed the nutrient content in poultry manure as 3.0 per cent nitrogen, 2.6 per cent phosphorus and 1.4 per cent potassium. Sawant (2004) registered the nutrient composition of poultry manure, which was 1.52 per cent nitrogen, 2.71 per cent phosphorus and 0.43 per cent potassium. Sihag *et al*. (2005) reported the chemical composition of poultry manure as 26.00 per cent organic carbon, 2.62 per cent nitrogen, 2.12 per cent phosphorus and 0.54 per cent potassium.

2.4 Properties fish of manure

Hall (1909) estimated nitrogen content of fish guano from 6 to 9 per cent and phosphoric acid varying from 13 to 20 per cent of tricalcium phosphate. Indira Raja *et al*. (1958) reported that a good sample of fish manure on an average contained 7 per cent nitrogen, an equal amount of phosphoric acid and 1 per cent potash. They analyzed some of the fish manure samples for nutrient composition on per cent air dry basis *viz*., nitrogen, phosphoric acid and potash. The content of the same in fish manure was 2.2, 3.2 and 1.1 per cent, respectively in fish meal 6.9, 5.3 and 1.4 per cent, respectively in milled fish 2.4, 1.7 and 1.8 per cent, respectively and in milled fish manure it was 5.6, 4.4 and 0.8 per cent, respectively.

Mathur and Daigale (1986) examined the feasibility of preparing high quality compost by mixing fish scrap, crab scrap and sea weeds by enveloping in peat. The produced compost had pH 5.9 to 6.5, earthy in odour, dark brown in colour, granular and contained 2.7 to 3.2 per cent total nitrogen, 0.6 to 1.1 per cent NH_4-N, 0.2 to 0.5 per cent NO_3-N, 1.6 to 2.3 per cent total phosphorus, 1.2 to 1.8 per cent HCl soluble P, 0.35 to 0.70 per cent total potssium and 72 to 80 per cent organic matter. Mathur and Schnitzer (1990) studied the distribution of nitrogen in peat based composts of manure slurries and fisheries wastes. Slurries of manures from sheep, dairy cows and poultry and their composts with peat moss and composts with peat moss and composts made from fish and scarps with peat moss or brown peat were characterized for the distribution of different N forms. The total N in the composts varied from 1.09 to 3.72 per cent with the fish scrap composting being the richest. The mature composts contained 13 to 44 per cent of total N as NH_4^+ and NO_3^- irons.

Khan *et al*. (1996) reported nutrient composition of fish meals as follows : 3 to 10 per cent nitrogen, 2 to 10 per cent phosphorus and 1 to 2 per cent potassium. Bhoite (1998) analysed the nutrient content of fish waste as organic carbon 28.9 per cent, nitrogen 0.68 per cent, phosphorus 21.0 per cent, potassium 0.32 per cent. Patil *et al*. (1998) reported the nutrient composition of body parts of a fish on oven dry basis. The body parts *viz*., head, maws, skin, fin and finrays, scales, intestine, bones, tails contained per cent organic carbon, nitrogen, phosphorus, potassium, calcium and magnesium in the following order. Head contained the above mention nutrients in percentage as 43.0, 6.15, 4.22, 1.60, 2.20, 0.85, respectively, maws contained 44.6, 7.20, 4.06, 1.62, 1.86, 0.70, respectively, skin contained 41.5, 3.08, 5.02, 1.28, 3.88, 1.20, respectively, fin and finrays contained 38.8, 2.85, 6.06, 1.04, 4.48, 2.12, respectively, scale contained 39.8, 2.77, 5.84, 1.12, 4.22, 2.04, respectively, intestine contained 45.8, 7.72, 3.56, 1.75, 1.78, 0.65, respectively, bones contained 38.5, 3.92, 7.02, 0.95, 6.14, 2.52, respectively and tail contained 41.8, 4.56, 5.32, 0.98, 3.48, 2.02. They also registered the nutrient composition of fish manure prepared from waste material of twenty species of fishes from Arebian sea of Konkan. They recorded the average content of organic carbon, nitrogen, phosphorus, potassium, calcium and magnesium on per cent basis as 42.27, 5.51, 4.20, 1.34, 4.85 and 1.39, respectively.

Lekha *et al*. (1999) reported that fish meal had 2.5 per cent nitrogen, 3.4 per cent phosphorus and 0.5 per cent potassium. Patil *et al*. (2000) studied the nutrient composition of fish manure. The recorded values of nutrients in fish meal were 5.8 per cent total nitrogen, 4.5 per cent total phosphorus, 1.1 per cent total potassium, 3.8 per cent calcium, 1.0 per cent magnesium and micronutrients *viz*., zinc 17 ppm, copper 98 ppm, manganese 18 ppm and iron 2430 ppm. Gupta (2003) had mentioned the nutrient content in fish meal as follows : 4 to 10 per cent nitrogen, 3 to 9 per cent phosphorus and 0.3 to 1.5 per cent potassium. Talashilkar *et al*. (2005) reported the micronutrient content of fish meal as 480 ppm zinc, 1.5 ppm copper, 10 ppm manganese and 245 ppm iron.

2.5 Properties of bone meal, meat meal and blood meal

The nitrogen content of bone meal varied from 3.5 to 4.5 per cent, total phosphoric acid from 18 to 25 per cent, citric soluble phosphoric acids from 7 to 9 per cent and lime from 3.5 to 6.0 per cent, while steamed bone meal contained 1 to 2 per cent nitrogen (Anonymous, 1964). Hegde *et al*. (1993) reported that nutrient levels in bone meal were 2.0 to 3.5 per cent nitrogen, 20.0 to 25.0 per cent phosphorus. Bhoite (1998) recorded that bone meal had pH 7.2, EC (dS m^{-1}) 1.85, water holding capacity 81.7 per cent, organic carbon 28.9 per cent, nitrogen 0.68 per cent, phosphorus 21 per cent and potassium 0.32 per cent. Lekha *et al*. (1999) reported that bone meal contained 2.5 per cent nitrogen, 22 per cent phosphorus, 0.3 per cent potassium and 18 per cent calcium.

Sharma (2002) noted that nutrient content in meat meal was 10.5 per cent nitrogen and 2.5 per cent phosphorus. Blood meal contained 10 to 12 per cent nitrogen and 1 to 2 per cent phosphorus while horn and hoof meal contained about 13 per cent nitrogen. Gupta (2003) recorded that the raw bone meal contained 3 to 4 per cent nitrogen and 20 to 25 per cent phosphorus while steamed bone meal contained 1 to 2 per cent nitrogen and 25 to 30 per cent phosphorus. Talashilkar *et al*. (2005) registered the micronutrient content in bone meal as 18 ppm zinc, 1.0 ppm copper, 12 ppm manganese and 420 ppm iron.

2.6 Properties of compost

Nagarajan *et al*. (1985) studied the manurial value of coir pith which was inoculated with *Pleurotus* spp. and noticed that there was four fold increase in the nitrogen content from 0.26 to 1.06 per cent and six fold increase in the phosphorus content from 0.01 to 0.06 per cent. The potassium content was also increased. They also observed a two fold increase in the micronutrient content. In Zn, it increased from 7.5 to 15.80 ppm, in Cu from 3.10 to 6.20 and in Mn from 12.50 to 25.00 ppm. Swarup (1991) conducted an experiment on effect of gypsum, green manure, FYM and zinc fertilization on the zinc, iron and manganese nutrition of wetland rice on a sodic soil. He reported the micronutrient content in the green manure as 85 mg kg^{-1} Fe, 76 mg kg^{-1} Mn and 20 mg kg^{-1} Zn.

Swarup (1992) studied effect of organic amendments on the nutrition and yield of wetland rice and sodic soil reclamation. He used green manure, rice husk and wheat straw as soil amendments and the reported mineral composition of above listed amendments. The green manure contained 2.65 per cent N, 0.32 per cent P, 1.52 per cent K, 85 (mg kg^{-1}) Fe, 76 (mg kg^{-1}) Mn and 20 (mg kg^{-1}) Zn. Rice husk contained the above nutrients as 0.51 per cent, 0.66 per cent, 1.66 per cent, 115 mg kg^{-1} and 95 mg kg^{-1}, and 15 mg kg^{-1}, respectively. While wheat straw contained 0.45 per cent, 0.04 per cent, 1.58 per cent, 75 mg kg^{-1}, 59 mg kg^{-1} and 12 mg kg^{-1}, respectively.

Patil (1994) prepared compost from wheat straw and analysed for their nutrients. Its pH, EC (dS m^{-1}) and organic carbon (%) increased and reached to 7.2, 0.34 and 17, respectively. The total nitrogen, phosphorus, potassium, iron, manganese, zinc and copper were registered to be 0.54 per cent, 0.12 per cent, 1.45 per cent, 1150 mg kg^{-1}, 1220 mg kg^{-1}, 87 mg kg^{-1}, 83 mg kg^{-1} and 167.67 mg kg^{-1}, respectively.

Chattopadhyay (1997) noticed that mint residue compost had 33.33 per cent organic carbon, 1.5 per cent, 0.61 per cent and 0.78 per cent total nitrogen, phosphorus and potassium, respectively. Selviraganathan *et al*. (1997) observed that mushroom spent compost had the highest phosphorus content (0.68%) which was three times more than FYM and ten times more than coir pith. Bernal *et al*. (1998) studied the maturity and stability parameters of compost prepared with wide range of organic wastes and reported that well decomposed organic wastes showed <1.7, < 0.04 and <30 per cent water soluble carbohydrate, $NH4^{+}$-N and mineral carbon, respectively.

Hattab *et al*. (1998) recorded nitrogen content and C : N ratio of different composted manures. The data revealed that *Sesbania rostrata* contained 0.96 per cent N and had 20 : 1 C : N ratio, *Eschhornia arassipes* 0.68 per cent N and 29 : 1 C : N ratio *Ipomea cornea*, 0.83 per cent N and 32 : 1 C : N ratio raw coir waste, 0.18 per cent N and 47 : 1 C: N ratio, composted coir waste 0.72 per cent N and 36 : 1 C : N ratio. The nutrient content of different crop residues recorded by Rao and Tarfdar (1998) were as follows : Cluster bean had 452 g kg^{-1} organic carbon, 11 g kg^{-1} N, 41:1 C : N ratio, 34.2 per cent cellulose, 37.8 per cent lignin, Mung bean had 415 (g kg^{-1}), 8 (g kg^{-1}), 52:1, 29.9 per cent, 28.4 per cent, respectively, while Perl millet had 446 (g kg^{-1}), 5 (g kg^{-1}), 89 : 1, 24.7 per cent, 32.9 per cent, respectively.

Kumar and Hegde (1999) studied the nutrient composition of decomposed cashew leaf litter which had fairly good amount or organic carbon ranging from 0.7 to 1.61 per cent, low levels of total nitrogen from 0.18 to 0.25 per cent, available P_2O_5 0.13 to 0.22 and K_2O 0.29 to 0.40 per cent. The levels of micronutrients found were 0.8 to 6.0 ppm Zn, 9.7 to 39.3 ppm Fe, 0.6 to 1.6 ppm Cu and 8.4 to 21.8 ppm Mn. The nutrient value of compost could be enhanced by adjusting C: N ratio through nutrient enrichment techniques and use of suitable microbial culture.

Vermal *et al*. (1999) prepared compost from different organic materials like soybean straw, paddy straw and *kharif* weeds by different methods of aeration such as a chimney wall, with one turning and no turning. The soybean trash compost was found to contain 1.68 and 0.43 per cent total nitrogen and phosphorus, respectively and 37 mg kg^{-1} zinc. The paddy straw compost and *kharif* weed compost was found to contain 1.34, 0.60 and 1.05, 0.46 per cent total nitrogen and phosphorus, respectively and 52 and 44 mg kg^{-1} zinc, respectively. Kadalli and Nair (2000) studied the manurial value and efficiency of coir dust based enriched super compost in Bangalore. They analyzed compost made from coir dust for the major and micronutrient and the values recorded were as follows : organic carbon 31.12 per cent, nitrogen 0.91 per cent, phosphorus 2.16 per cent, potassium 0.91 per cent, calcium 2.44 per cent, magnesium 0.75 per cent, sulphur 0.31 per cent, zinc 1394 ppm, copper 69.80 ppm, iron 5809 ppm, manganese 420 ppm, cellulose 18.8 per cent, lignin 24.0 per cent, total phenols 44.1 mg/100 g, C : N ratio 34.19 and L : N ratio 26.38.

Manna *et al*. (2000) studied various chemical parameters of composts prepared from four different crop residues such as soybean straw, wheat straw, chick pea straw, mustard straw with innoculum such as cellulose decomposer (*Paecilamyces fusisporus*, *Aspergillus awamarie*), P-solubilizing bacteria (*Bacillus polymyria*, *Pseudomonas striata*) and free living N_2 fixer (*Azotobacter chrococcum*). After 120 days of composting the compost prepared from soybean straw with innoculum had 48 per cent ash, 26 per cent total organic carbon, 2.62 per cent total N, 0.32 per cent water soluble carbohydrate and 73 c mol (p^+) kg^{-1} of CEC.

The compost prepared from wheat straw had 43.3 per cent ash, 25 per cent total organic carbon, 1.83 per cent total N, 0.43 per cent water soluble carbohydrates and 101 c mol (p^+) kg^{-1} of CEC. The compost prepared from chickpea straw had 57 per cent ash, 24 per cent total organic carbon, 1.89 per cent total N, 0.3 per cent water soluble carbohydrates and 110 c mol (p^+) kg^{-1} of CEC, while the compost prepared from mustard straw had 41.7 per cent ash, 30 per cent total organic carbon, 1.57 per cent total N, 0.43 per cent water soluble carbohydrate and 59 c mol (p^+) kg^{-1} of CEC. Thus maximum total nitrogen content was registered in the compost prepared from soybean straw.

Thampan (2000) studied the average nutrient content of coir pith compost which was 1.06 per cent N, 0.06 per cent P_2O_5 and 1.20 per cent K_2O. Apart from the major nutrients the pith compost was also found to contain 0.50 per cent CaO, 0.48 per cent MgO, 0.09 per cent Fe, 25 ppm Mn, 15.80 ppm Zn and 6.20 ppm Cu. Suseeladevi *et al*. (2001) conducted an experiment on evaluation of maturity for coir dust based compost using different organic residues and microbial cultures. The coir dust used had 55.65 per cent organic carbon, 0.46 per cent nitrogen, 0.19 per cent phosphorus and 0.63 per cent potassium. It had 66.15 per cent lignin, 17.08 per cent cellulose and 309.06 mg/100 g total phenol. Its C : N ratio and L : N ratios were 120.9 and 143.7, respectively. In all these treatments urea was applied @ 2 per cent, pleurotus @ 1 kg t^{-1}, rock phosphate @ 1.25 per cent, P_2O_5, garden weeds @ 50 per cent on fresh weight basis, cow dung @ 20 per cent fresh weight basis, Fe, Zn and Mn @ 200 ppm and Cu @ 20 ppm. They reported that the compost prepared from coir dust + pleurotus + cow dung + garden weeds + green manures (sun hemp) + rock phosphate + micronutrients had CEC, C: N ratio, water soluble organic fraction and organic carbon content 69.5 c mol (p^+) kg^{-1}, 33.3, 2.24 and 13.41 per cent, respectively. While the compost prepared from pretreated coir dust + pleurotus + cow dung + garden weed + green manure (sun hemp) + rock phosphate + micronutrients had CEC, C : N ratio, water soluble organic fractions and organic carbon content to the tune of 80.9 c mol (p^+) kg^{-1}, 37.2, 1.62 and 24.2 per cent, respectively. The compost prepared from coir dust + pleurotus + cow dung + garden weeds + green manure (sun hemp) + rock phosphate had CEC, C : N ratio, water soluble organic fractions and organic carbon content 75.4 c mol (p^+) kg^{-1}, 37.5, 2.24 and 15.95, respectively, while the compost prepared from coir dust + pleurotus + cow dung + urea + rock phosphate + micronutrients had 85.0 c mol (p^+) kg^{-1}, 27.7, 0.98 and 28.80 per cent, respectively CEC, C: N ratio, water soluble organic fractions and organic carbon content.

Maheshwari (2002) prepared manure from coffee pulp waste by using selected pectinolytic culture *viz*.,*Trichoderma reesel* and *Aspergillus flavus* and yeast sludge and observed that the pH, EC (dS m^{-1}) and per cent organic carbon were in the range of 7.0 to 7.2, 1.2 to 1.6 and 23.0 to 28.7, respectively. He also reported that the reduction in organic carbon was due to utilization of organic carbon as an energy source to build up the protoplasm and release the CO_2 through the breakdown of carbon by microbes during the composting process. Ramesh Chandra (2003) studied chemical composition of some plant materials (% dry matter). He recorded the cellulose content of rice, straw, wheat straw, oat straw, barley straw, saw dust, peanut shells, cattle dung, sheep dung as 35.8, 37.8, 36.4, 40.4, 53.6, 16.8, 28.6, 18.7, respectively and hemicellulose content to the tune of 22.9, 26.9, 26.6, 25.3, 09.3, 42.2, 26.0, 18.5, respectively.

Roy and Singh (2003) studied the nutrient composition of gliricidia plants and observed that more amount of nitrogen was present in glyricidia leaves as compared to its compost. Glyricidia compost contained 2.86 per cent nitrogen and glyricidia leaves 3.18 per cent nitrogen. Dadas (2004) conducted experiments on preparation of composts from different crop residues and their characterization. The treatments consisted of different sources for the preparation of compost *viz*., weed biomass, wheat straw, sugarcane trash, jowar stubble, bajra stubble and banana pseudostem and threshing yard waste. It was observed that threshing yard waste material, wheat straw and weed biomass are good sources of composting material as revealed from their nutrient content. Their N content was 2.03, 0.66, and 1.54 per cent. P content was 0.73, 0.16, and 0.92 per cent. K content was 0.41, 0.92, 1.44 per cent and S content was 0.48, 0.31, and 0.38 per cent, respectively.

Garg *et al*. (2004) studied the status of certain trace minerals in feed and fodder in Kutch district of Gujrat. They found that wheat straw contained 4.98 ppm Cu, 24.07 ppm Zn, 56.35 ppm Mn, 550.75 ppm Fe and sorghum straw contained 6.82 ppm Cu, 34.7 ppm Zn, 74 ppm Mn and 639.5 ppm Fe. While studying the effect of organic manures on yield and quality of mango and NPK fractions in soil Karle (2004) recorded the nutrient (NPK) content of urban compost as 1.65 per cent N, 1.25 per cent P_2O_5 and 1.05 per cent K_2O.

Pawar (2004) analyzed different composts for various quality parameters such as pH, EC (dS m^{-1}), per cent organic carbon, per cent nitrogen, phosphorus, potassium, micronutrients in mg/kg as iron, manganese, zinc and copper. The sugarcane trash compost contained above nutrients to the tune of 7.6, 0.77, 13.7, 0.60, 0.19, 0.67, 0.12, 909, 91, 11.0 and 0.20, respectively. Wheat straw compost contained above mentioned nutrients 6.75, 2.03, 13.3, 0.66, 0.16, 0.92, 0.31, 101.7, 84.3, 9.83 and 1.25, respectively. Jowar stubbles compost contained 7.09, 1.13, 13.1, 0.72, 0.31, 1.36, 0.18, 1040.3, 97.7, 10.75 and 0.66, respectively.

Threshing yard waste compost contained 7.25, 2.51, 19.1, 2.03, 0.73, 0.41, 0.48, 288.3, 57.7, 8.91 and 0.58, respectively. While *Kharif* weed compost contained 7.36, 2.28, 19.2, 1.53, 0.92, 1.44, 0.38, 693.0, 69.9, 9.91 and 2.0, respectively.

Shaikh (2004) reported that the wheat straw contained 0.48 per cent N, 0.10 per cent P_2O_5, 0.76 per cent K_2O and 50.72 per cent organic carbon, while cattle dung contained these nutrients to the tune of 0.70 per cent, 1.37 per cent, 1.0 per cent and 36.75 per cent, respectively. Talashilkar *et al*. (2004) recorded the physical and chemical composition of compost. The compost was prepared by using same quality of vegetable trimmings and well decomposed, dried and powdered cow dung. The recorded values are as follows : moisture 6.04 per cent, organic carbon 22.91 per cent, total nitrogen 1.22 per cent, phosphorus 0.54 per cent, potassium 0.65 per cent. The method followed for determination of chemical properties are as organic carbon by preparing ash at 550^0 C in muffle furnace (Pipper, 1950), total nitrogen by Kjeldahl's modified sulphuric salicylic acid mixture (Jackson, 1973), total phosphorus by trimetric estimation of phosphoric acid (Sankaram, 1966) and total potassium by Flame photometer (Piper, 1950). Madhu (2005) assessed micronutrient content of different types of gliricidia composts. He recorded the values of micronutrient such as Fe, Mn, Cu, Zn and B in ppm as 6035, 318, 112, 67, 7.8, respectively in the content from gliricidia + cattle feed waste + dung slurry + *T. viride* (6035). While the compost from gliricidia + cattle feed waste + dung slurry + EM culture (6678 mg/kg) had Fe, Mn, Cu, Zn and B in ppm as 6678, 326, 119, 75, 10.4, respectively.

2.7 Properties of vermicompost

Piccone *et al*. (1987) conducted an experiment to assess the properties of compost by vermicomposting technique from pharmaceuticals wastes, sewage sludge, paper and food manufacturing wastes, sewage sludge, paper and food manufacturing wastes and their mixtures and reported that the compost prepared from various organic wastes had pH in the rage of 7.6 to 7.8 while organic carbon varied from 18.8 to 27.9 per cent and nitrogen varied from 1.1 to 3.1 per cent.

Shinde *et al*. (1992) reported that vermicompost contained more carbon and phosphorus than FYM, it had less K and micronutrients than FYM and both had comparable contents of nitrogen. Vermicompost generally had wide C : N ratio as compared to FYM. Patil (1993) reported the nutrient composition of vermicompost as 0.72 per cent total nitrogen, 0.6 per cent total phosphorus, 0.52 per cent total potassium. The total micronutrients *viz*., iron, manganese, zinc and copper were 30, 4.20, 22.82, 6.47 mg kg^{-1}, respectively.

Jadhav (1996) in experiment on effect of FYM and vermicompost on yield of rice recorded that vermicompost contained 28.5% moisture, 29.20% carbon, 2.06% nitrogen, 0.99% phosphorus, 0.53% potassium. He also reported the biological constants such as C :N ratio and C : P ratio as 14.17 and 29.50, respectively. Bhangrath (1997) conducted an experiment to study the changes in various parameters during vermicomposting by using different materials such as cow dung, cashew leaves, forest trees leaves, kitchen garbage with and without earthworm inoculation. After 150 days, he recorded per cent organic carbon, per cent nitrogen, C: N ratio, per cent P, C : P ratio, per cent K, per cent water soluble carbohydrates, per cent Ca, per cent Mg, CEC [c mol (p^+) kg^{-1}], Cu (ppm), Mn (ppm), Zn (ppm), Fe (ppm) without earthworms in the range of 16.1 to 38.0, 0.68 to 1.56, 16.8 to 26.6, 0.47 to 0.59, 34.3 to 65.3, 0.52 to 0.71, 1.37 to 1.47, 0.36 to 1.36, 0.34 to 0.51, 110 to 145, 3.85 to 7.05, 49.6 to 95.9, 13.8 to 89.9 and 580 to 1674, respectively, while the recorded data in the treatment of earthworm inoculant were in the range of 14.6 to 32.4, 0.75 to 1.67, 14.5 to 24.7, 0.50 to 0.64, 28.8 to 57.8, 0.53 to 0.82, 1.39 to 1.69, 0.38 to 1.64, 0.42 to 0.58, 112 to 147, 5.68 to 10.91, 65.4 to 126, 22.2 to 106 and 907 to 4045, respectively.

Kale (1998) reported nutrient status of vermicompost on using different organic wastes as food source as follows : organic carbon 9.15 to 17. 98 per cent, total nitrogen 0.5 to 1.5 per cent, available phosphorus 0.1 to 0.3 per cent, available potassium 0.15 to 0.56 per cent, calcium 22.7 to 70 me/100 g, copper 2 to 9.5 ppm, iron 2 to 9.3 ppm, zinc 5.7 to 11.5 ppm and available sulphur, 128 to 548 ppm. Reddy and Reddy (1998) conducted an experiment on the effect of vermicompost and other manures on the yield and nutrient uptake by soybean. They have analysed nutrient content of organic manures and given chemical composition of vermicopmpost as follows : 1.98 per cent N, 1.23 per cent P and 1.59 per cent K, total and DTPA extractable micronutrients *viz*., total Zn 132.0 mg kg^{-1}. DTPA extractable Zn 62.0 mg kg^{-1}, Cu 15.8 mg kg^{-1}, Fe 321.6 mg kg^{-1} and Mn 79.2 mg kg^{-1}.

In order to identify the best organic waste for vermicomposting an experiment was conducted by Kachhave and Jaishankar (1999) with saw dust, city waste, sugarcane trash, weed plant (*Perthenium* spp.), pressmud and slaughter house waste under two methods of composting like pit and pot methods. The total carbon content of vermicompost from all organic waste were appreciably enhanced. The total carbon content of pressmud vermicompost recorded increase of 10.2 per cent and 10.9 per cent over control in pit and pot cultures, respectively. The highest enhancement of 1.22 per cent N was recorded for slaughterhouse waste and least with can trash. The maximum levels of P and K were recorded for pressmud vermicompost and least enhancement for saw dust vermicompost. The wider C : N ratio was obtained for vermicompost prepared from cane trash while narrowest C : N ratio were found in slaughter house waste followed by city waste vermicompost.

Talashilkar *et al*. (1999) studied the changes in nutrient content in local grass, mango leaves and farm farm waste with and without two species of earthworms specie as *Eisenia foetida* and *Eudrilus eugineae*. After 150 days of decomposition they noted variation in C : N ratio, CEC [c mol (p^+) kg^{-1}] and per cent water soluble carbohydrates content in the range of 18.6 to 22.6, 113 to 141 and 1.38 to 1.64, respectively without earthworms while with the inoculation of earthworms the C : N ratio varied from 17.7 to 21.7 C.E.C. from 117 to 147 c mol (p^+) kg^{-1} and water soluble carbohydrates from 1.38 to 1.78 per cent, respectively.

Vasanthi and Kumarswamy (1999) conducted field experiments during 1994-95 and 1995-96 on red sandy clay loam soil at College of Agriculture, Madurai. The data on nutrient status showed that contents of macro and micronutrients were more by many times in composted materials compared to contents in raw material. Desirable reduction in C : N ratio was observed in enriched compost manure. Nitrogen content in vermicompost prepared from organic waste followed the following order : ipomea weed (2.99%) > banana waste (2.83%) > parthenium weed (2.99%) > sugarcane trash (2.67%) > neem leaves (2.61 %). Similarly, percentage phosphorus content in vermicompost prepared from organic waste followed in order ipomea weed (1.37%) > parthenium weed (1.20%) > banana waste (1.18%) > neem leaves (1.17%) > sugarcane trash (1.06%). The potassium content at vermicompost followed following order: ipomea weed (1.46%) > banana waste (1.32%) > parthenium weed (1.19%) > neem leaves (1.03%) > sugarcane trash (1.00%). Similarly there was appreciable increase in Ca, Mg, Fe, Mn, Zn and Cu content of vermicompost as compared to raw organic waste.

Chaudhari *et al.* (2000) recorded nutrient status of vermicompost produced from kitchen waste after 40 days. They found p^H, total organic carbon (%), total nitrogen (%), total phosphorus (%), total potassium (%), total calcium (%), total magnesium (%), total micronutrients *viz*., Fe (%), Mn (%), Zn (%) and C : N ratio were to the tune of 0.75, 10.18, 1.81, 1.12, 0.87, 2.95, 0.41, 7.73, 0.2, 1.30 and 5.62, respectively. Kadalli and Nair (2000) have given biochemical composition of raw dust and coir dust based enriched supercompost. For composting of coir dust organic additives used were raw cow dung @ 20 per cent garden weeds @ 5 per cent and sunhemp @ 5 per cent. Composting was completed in about 120 days. The organic carbon decreased from 48.72 per cent to 31.12 per cent. As compared to raw coir dust lignin and cellulose content decreased from 48.91 to 24.01 per cent and 35.51 to 18.81 per cent indicating the degradation of lignocellulose by pleurotus sajor caju, which was used as lignin degrading inoculum at the time of composting. Nitrogen content was increased from 0.47 to 0.91 per cent due to addition of sunhemp green manure. Phosphorus and potassium content increased from 0.02 to 2.16 and 0.62 to 0.91 per cent, respectively. There was considerable increase in calcium from 0.46 to 2.44 per cent and magnesium from 0.31 to 0.75 per cent. An appreciable increase in micronutrient status was observed from 53 to 1394 ppm in Zn, from 1264 to 5809 ppm in Fe, from 58.9 to 420 ppm in Mn and 14.94 to 69.80 ppm in Cu.

Rajkhowa *et al*. (2000) studied effect of vermicompost alone and in different combinations with fertilizer nitrogen on the growth and yield of green gram. The vermicompost used had 11.5 per cent organic carbon, 1.13 per cent total nitrogen, 1.3 per cent total phosphorus and 2.6 per cent potassium. Coir pith was comparatively rich in potash but low in nitrogen and phosphorus. It also contained appreciable amount of secondary and micronutrients. The material had high lignocellulose content, wider C : N ratio of 60 to 112 and the presence of tannin related phenolic compounds.

Shelke *et al*. (2001) registered the nutrient composition of vermicompost as 1.82 per cent nitrogen, 1.26 per cent phosphorus and 1.31 per cent potassium. Kumari and Kumari (2002) reported the nutrient content of vermicompost and vermicompost enriched with rock phosphate. The nutrient content in vermicompost was 1.83 per cent nitrogen, 1.39 per cent phosphorus and 2.42 per cent potassium while that in enriched vermicompost the above mentioned nutrients were in the order of 1.95 per cent, 2.15 per cent and 2.66 per cent, respectively. Tolanur and Badanur (2003) reported nutrient content in vermicompost as 1.60 per cent nitrogen, 2.20 per cent phosphorus and 0.67 per cent potassium.

Sawant (2004) registered the nitrogen, phosphorus and potassium content in vermicompost on percentage basis as 1.33, 1.25 and 1.17, respectively. Singh and Ganguly (2005) concluded that when composting is done under identical conditions either in heap or pit methods there is no variation in terms of chemical and biochemical constituents when the same raw material were used. The decomposition period was reduced by 70 days in chemically enriched compost or vermicompost as compared to conventional compost. Phosphocompost, N-enriched phosphocompost, vermicompost and phosphorus enriched vermicompost were observed to be superior in terms of all compost quality parameters and nutrient status than that of compost produced conventionally. Phosphorus content of phosphocompost, N enriched phosphocpmpost and P-enriched vermicompost was higher than conventional compost and vermicompost due to rock phosphate addition, which is a cheap mineral source of amendments for P enrichment. The nitrogen content in N enriched phosphocompost was higher due to urea addition.

Singh *et al*. (2005) reported that vermicompost on dry weight basis contained 1.0 per cent nitrogen. Talashilkar and Dosani (2005) have reviewed the nutrient value of worm cast and vermicompost prepared from different substrates using various species of earthworms. They noted wide variation in the nutrient composition to vermicompost prepared from various substrate materials. Purohit and Gehlot (2006) studied an utility of ayurvedic waste for vermicomposting the results revealed that ayurvedic waste were congenial for composting as the C : N ratio was reduced from 30 : 1 to 11 : 1. Investigations were also undertaken to standardize the substrate under controlled microenvironment for vermicomposting of ayurvedic waste with N, P and K as 2.03, 0.33 and 0.85 per cent, respectively. Biochemical composition of the same including crude protein (12.67%), crude fiber (33.4%), crude lipid (6.3%), cellulose (37.5%) and lignin (37.9%). Based on C : N ratio (11:1) and the least time taken (48 days) for compost maturity, the best treatment was selected with registered manurial content of N (3.62%), P (0.85%) and K (0.89%). In the same compost material, the biochemical constituents of crude fibre (13.9%), crude lipid (0.7%), crude protein (12.68%), lignin (28.2%) and cellulose (18.8%) were determined. Thus the best means of composting involves the use of the unsieved substrate, which must be enriched with 5% mixture of cow dung and quail manure (1:1) and later vermicomposted with *Eisenia foetida*.

2.8 Properties of edible and non-edible oil cakes

Mukharjee *et al*. (1991) reported the nutrient content of different oil cakes. The groundnut cake contained 49.4 per cent organic carbon, 7.3 per cent total nitrogen, 6.77 C : N ratio and 1.0 per cent phosphorus.

Mustard cake contained 53.1 per cent organic carbon, 4.5 per cent nitrogen, 11.80 per cent C : N ratio and 1.8 per cent phosphorus. Neem cake contained 51.2 per cent organic carbon, 2.4 per cent nitrogen, 21.33 C : N ratio and 0.8 per cent phosphorus. Mahua cake contained 51.2 per cent organic carbon, 2.4 per cent nitrogen, 21.33 C : N ratio and 0.8 per cent phosphorus. Hegde *et al*. (1993) studied the ranges of nitrogen, phosphorus and potassium content in different oil cakes such as coconut cake, groundnut cake, neem cake, pongamia cake, castor cake and sesamum cake on per cent basis. The coconut cake contained 3.0 to 3.2 per cent nitrogen, 1.7 to 2.0 per cent phosphorus and 1.7 to 2.0 per cent potassium, groundnut cake contained 4.5 to 7.0 per cent nitrogen, 1.5 per cent phosphorus and 1.30 percent potassium, neem cake contained 5 to 5.50 per cent nitrogen, 1.0 to 1.5 per cent phosphorus and 1.0 to 1.5 percent potassium, pongamia cake contained 3.9 per cent nitrogen, 0.9 per cent phosphorus and 1.2 per cent potassium, castor cake contained 4.5 to 5.5 per cent nitrogen, 1.80 per cent phosphorus and 1.0 to 1.4 per cent potassium while, sesamum cake contained 6.0 to 6.5 per cent nitrogen, 1.5 to 2.1 per cent phosphorus and 1.0 per cent potassium.

Yawalkar *et al*. (1996) reported that the amount of nitrogen varied with the type of oil cake. It varied from 2.5 per cent in mahua cake to 7.9 per cent in decorticated safflower cake. In addition to nitrogen all oil cakes contained small percentages of phosphorus i.e. 0.8 to 2.9 per cent and potash 1.2 to 2.2 per cent. Bhoite (1998) reported that neem cake had 5.8 pH, 0.95 (dS m^{-1}) EC, 84.4 per cent water holding capacity, 39.8 per cent organic carbon, 4.30 per cent nitrogen, 1.23 per cent phosphorus and 1.68 per cent potassium.

Das (1999) registered the per cent nitrogen, phosphorus and potassium content in mustard cake as 5.1 to 5.2, 1.8 to 1.9 and 1.1 to 1.2, respectively, linseed cake had 5.5 to 5.6 per cent nitrogen, 1.4 to 1.5 per cent phosphorus and 1.2 to 1.3 per cent potassium. Sesamum cake contained 6.2 to 6.3 per cent nitrogen, 2.0 to 2.1 per cent phosphorus and 1.2 to 1.3 per cent potassium. Coconut cake had 3.0 to 3.2 per cent nitrogen, 1.9 to 2.0 per cent phosphorus and 1.5 to 1.6 per cent potassium. Groundnut cake had 7.0 to 7.3 per cent nitrogen, 1.5 to 1.6 per cent phosphorus and 1.3 to 1.4 per cent potassium. Castor cake had 4.3 per cent nitrogen, 1.8 per cent phosphorus and 1.3 per cent potassium. Mahua cake had 2.5 to 2.9 per cent nitrogen, 0.8 to 0.9 per cent phosphorus and 1.8 per cent potassium and neem cake had 5.2 to 5.3 per cent nitrogen, 1.0 to 1.1 per cent phosphorus and 1.4 to 1.5 per cent potassium.

Talashilkar *et al*. (2005) reported the micronutrient content in neem cake as : 97 ppm zinc, 4.0 ppm copper, 18 ppm manganese and 119 ppm iron, karanj cake contained 117 ppm zinc, 1.5 ppm copper, 8 ppm manganese and 40 ppm iron while mahua cake contained 280 ppm zinc, 4.5 ppm copper, 3 ppm manganese and 100 ppm iron.

2.9 Properties of city compost/sewage sludge compost

Ghosh (1959) studied relationship between organic matter and nitrogen content of town compost from different cities of the country. He recorded nitrogen content in the range of 0.3 per cent to 3.13 per cent, while organic matter content was in the range of 4.6 per cent to 55.40 per cent, respectively. He also inferred that the relationship between nitrogen and organic matter content of these compost samples would be applicable to well decomposed composts and the constant m in the equation $y = mx$ may vary with the types of raw material used. The mean value of the ratio 17.7 thus obtained multiplied by nitrogen percentages gave figures which were fairly concomitant with the experimentally determined values of organic matter.

Harda and Inoko (1980) revealed that the CEC of city waste of Toyohashi city piled for 30 days after fermentation process was 46.8 c mol (p^+) kg^{-1}, city refuse of Toyohashi city piled for 60 days after fermentation process was 82.6 c mol (p^+) kg^{-1}, rice straw compost was 94.9 c mol (p^+) kg^{-1} and that of tree bark compost was 122.6 c mol (p^+) kg^{-1}.

Jankoswskin and Koc (1992) reported organic matter content of compost, sewage sludge and farm manure as 45 per cent, 12 per cent and 73 per cent, respectively. The properties of sewage sludge were studied by Bansal and Gupta (1998). The properties were as follows : pH 7.7, EC (dS m^{-1}) 1.9, organic carbon (g kg^{-1}) 186, total nitrogen 24.6 g kg^{-1}, sodium (mg kg^{-1}) 18, potassium (mg kg^{-1}) 10.6, Fe 2010, Mn 602, Ni 63, Zn 540, Cd 3.2, Pb 74, Cu 320, Cr 40 and Co 20 mg kg^{-1}. Bhattacharya *et al*. (2001) characterized municipal solid waste compost in relation to maturity, stability and heavy metal content. They noted the ranges of various parameters as follows : organic carbon 102 to 118 g kg^{-1}, Total N 8 to 11 g kg^{-1}, C : N ratio 11 to 12, ammonium nitrogen 58 to 96 mg kg^{-1}, nitrate nitrogen 1180 to 1650 mg kg^{-1}, total phosphorus 4 to 5 g kg^{-1} available potassium 2.13 to 2.15 g kg^{-1}, CEC 71.106 c mol(p^+) kg^{-1} on ash free basis, total Zn 487 to 599 ppm and total Cu 101 to 190 ppm.

Chitdeshwari *et al*. (2002) reported chemical properties of sewage biosolid as p^H (1:5) 6.70, EC (dS m^{-1}) 0.68, organic carbon 15.9 per cent, C:N ratio, 4.39, nitrogen 3.62 per cent, phosphorus 1.46 per cent, potassium 2.53 per cent, zinc 2630 ppm, iron 29200 ppm, manganese 1780 ppm, copper 2680 ppm, lead 5720 ppm, cadmium 923 ppm, chromium 2740 ppm and nickel 3460 ppm.

Desai (2003) conducted a field experiment on effect of city compost, sewage sludge and vermiwash on flower yield, nutrient uptake and keeping quality of China aster. He reported the nutrient content of sewage sludge as 3.55 per cent N, 1.41 per cent phosphorus, 1.55 per cent potassium and that of city compost as 2.07 per cent N, 1.25 per cent phosphorus and 1.30 per cent potassium. The standard analytical methods used were Kjeldahl's modified sulphuric salicylic acid mixture for total nitrogen, for phosphorus Pemberton method and flame photometer for total potassium.

2.10 Standards of organic manures

Anthonis (1994) suggested the following standards for compost maturity : (1) Minimum nutrient content : 1.0 to 3.0 per cent nitrogen, 1.5 to 3.0 per cent phosphorus and 1.0 to 1.5 per cent potassium. (2) Moisture content should not exceed 15 to 25 per cent. (3) Organic carbon should be at least 20 per cent. (4) C : N ratio : should be between 10 : 1 to 15 : 1 (5) pH should be around neutral in the range of 6.5 to 7.5. The maturity of compost can be judged by studying several indices such as biological oxygen demand, volatile fatty acid, CEC, nitrate-N, ratio of reducing sugars, C : N ratio and the germination test (Haga, 1990). For utilization point of view, nutrient content and the presence of heavy metals and/or phytotoxic substances of the compost is equally important.

According to IFOAM standards (2001), there are three criteria applicable as standards for correct composts. Compost must be cured for atleast 15 days and will not reheat to more than 20^0 C. The essential trace elements should be at a very low concentration. The solid waste should be maintained at operating conditions at 55^0 C or higher for three days to deactivate human pathogens (IIRD. 2001).

Subramaniam (2002) stated that the good quality commercially accepted compost had dark brown colour, neutral in reaction with 6.5 to 7.2 pH and its total nitrogen, phosphorus and potassium content be 2.0, 0.15 and 1.5 per cent, respectively. Ramaswamy (2004) suggested methods to evaluate maturity of compost as under : (1) Total salinity should not exceed 2 g salt/kg (expressed as NaCl) and the concentration of sodium and chloride ions should be specified in mature composts. (2) Absence transitory or permanent bio-inhibiting factors such as ammonium, water soluble aliphatic acids, amino acids, proteins and polysaccharides in the water extract of compost indicates the maturity of compost. (3) Good quality compost should contain minimum levels of toxic components and non-biodegradable materials. Compost (final produce) exceeding the concentration limits should not be used for food crops. However, it may be utilized for purposes other than growing food crops. Ministry of Environment and Forests. Municipal solid waste (management and handling) Rules under the Environment Protection Act of 1986 has made it mandatory for all municipalities to set up waste process and disposal facilities by 01/12/2003 and has also laid down standards for concentration limits of heavy metals in MSW compost, which can be used for food crops (Mohan Singh, 2004).

Sunita and Lata (2004) noted that with the starch iodine sulfide and nitrate test the maturity of compost showed that though all the four composts passed the maturity tests but C_3 was most suitable for application to soil as concluded from all the tests parameters.

CHAPTER III

MATERIALS AND METHODS

Studies were conducted on the determination of quality parameters including physical, chemical and biological parameters of the manures produced in Konkan and those used by the farmers from the Konkan region.

3.1 Materials

3.1.1 Sites of manure collection

All 100 manure samples were collected from the farmers from different villages from four districts viz. Thane, Raigad, Ratnagiri and Sindhudurg of the Konkan region of Maharashtra state, who have produced them from different organic residues available at their farm sites. Some of the manure samples were collected from the sales counters from some of the tahsils from all the four districts which are being used by the farmers from Konkan region. The details about names of the farmers or selling centers, their location, trade name of manure if any, raw material used for the preparation of manure are given in Appendix I while the locations of villages from where manure samples were collected are depicted in Fig. 3.1.

The representative manure samples were collected from the storage sites of the manure depots of the farmers while the manure samples from the sales counters were collected from the packed bags. The manure samples were collected randomly by tube hole shaped auger from five sites of the manure depots or from five bags from each of the sales centers. The collected manure samples were mixed well together and about 1 kg of each the manure samples was brought for the determination of various quality parameters after proper labelling.

3.1.2 Experimental

After bringing the manures samples in the laboratory the moisture content from each sample was immediately determined after drying in an oven at 70^0 C for 6 hours.

The manure samples were then air dried in shade, ground with the help of wooden mortar and pestle. They were then sieved through 2 mm sieve. The sieved manure samples were preserved for analysis. The particle size was estimated before grinding the manure samples. The analysis was conducted in the laboratory of the Department of Agricultural Chemistry and Soil Science, College of Agriculture, Dapoli.

The manures were classified into two or three groups on the basis of ranges for different parameters given by the State Govt. of Maharashtra and Indian Institute of Soil Science (ICAR), Bhopal for interpretation of the results (Table 3.1).

Table 3.1 Quality parameters for organic manure suggested by State Govt. of Maharashtra and Indian Institute of Soil Science (I.C.A.R.), Bhopal

Sr. No.	*Parameters*	Range given by		
		State Govt. of Maharashtra		IISS (ICAR), Bhopal
		Plant origin manure	Animal origin manure	
A)	**Physical Characteristics**			
1.	Moisture content (w/w)	25 ± 5	25 ± 5	15-25%
2.	Bulk density (g/cm^3)	0.8 ± 0.10	0.8 ± 0.10	0.7 - 0.9
3.	Inerts or sand content (g/g of compost)	-	-	< 10%
4.	Particle size (% passing through sieve)	50% particles has size must be 2 mm to 0.5 mm	50% particles has size must be 2 mm to 0.5 mm	> 90% passes through 4 mm sieve
5.	Odour	Soily	Soily	Absence of foul odor
6.	Colour	Brown to Dark black	Brown to Dark black	Dark brown to Black
B)	***Chemical characteristics***			
1.	Total organic carbon (%)	10 ± 4	10 ± 4	Minimum 16-20%
2.	Total nitrogen	-	-	Minimum 0.8%
3.	C : N ratio %	12 ± 5	12 ± 5	< 20 :1
4.	Phosphorus %	-	-	0.5 - 0.8
5.	Potassium %	-	-	1 - 2%
6.	pH	7 ± 0.5	7 ± 0.5	6.5 - 7.5
7.	E.C. dS m^{-1}	-	-	< 4

8.	Loss on ignition (%)	25 ± 5	25 ± 5	-
9.	Ash maximum (%)	55 ± 5	55 ± 5	-
C)	**Biological characteristic**			
1.	Co_2 evolution (Basal respiration)	-	-	< 15 mg Co_2 - C/100 g TOC/day

3.2 Methods

Analysis of manure samples in duplicate for different properties is carried out by following standard methods as given below in Table 3.2.

Table 3.2 : Methods used for manure analysis

Sr. No.	Property	Method	Reference
A)	**Physical properties**		
1.	Moisture content	Dry weight determination of compost manure samples after drying 70^0C for 6 hours in an oven. Moisture content (%) = 100 – total solid (%)	Manna *et al*. (2004)
2.	Bulk density	A method for packing manure in the measurement vessel (2000 cm^3) is recommended for reproducible results (Tapping method)	Manna *et al.* (2004)
3.	Particle size	Per cent (dry weight) passes through a 4 mm sieve.	Manna *et al.* (2004)
4.	Odour	Subjective	--
5.	Colour	Subjective	--
6.	Water holding capacity	By using Keen Rockzowski box	Chopra and Kanwar (1978)
B)	**Chemical properties**		
1.	pH	Lab-India pH analyzer glass electrode 1:2.5 manure – water ratio	Jackson (1973)
2.	EC	EC meter	Jackson (1973)
3.	Total Organic carbon	1) Dry combustion method (550^0 C) 2) Walkley and Black`s Wet digestion method	Piper (1950) C. A. Black (1965)
4.	Total Nitrogen	1) Colorimetric method 2) Kjeldahl`s method 3) Kjeldahl`s modified sulphuric salicylic acid mixture	Baethgen and Alley (1989) C. A. Black (1965) Jackson (1973)
5.	C: N ratio	Total organic carbon/ total nitrogen	--
6.	Total phosphorus	1) Diacid digestion 2) Triacid digestion 3) Dry ashing	Hesse (1971) Jackson (1973) Bhargava and Raghupathi (1998)

Sr. No.	Property	Method	Reference
7.	Total potassium	1) Diacid digestion 2) Triacid digestion 3) Dry ashing	Hesse (1971) Jackson (1973) Bhargava and Raghupathi (1998
8.	Calcium	By using diacid extract by versenate titration method	A. O. A. C. (1980)
9.	Magnesium	By using diacid extract by versenate titration method	A. O. A. C. (1980)
10.	Sulphur	Diacid extract of wet digestion by calorimetric method using barium chloride as precipitation reagent	Chesnin and Yein(1995)
11.	Zinc	By using diacid extract	Bhargava and Raghupathi (1998)
12.	Copper	By using diacid extract	Bhargava and Raghupathi (1998)
13.	Manganese	By using diacid extract	Bhargava and Raghupathi (1998)
14.	Iron	By using diacid extract	Bhargava and Raghupathi (1998)
15.	Boron	Diacid extract by colorimetric method using alcohol, oxalic acid and curcumin as reagents	Bhargava and Raghupathi (1998)
16.	CEC	It was carried out by replacing the exchangeable cations with 0.05 N HCl removing excess HCl treating with 1 N Barium acetate solution (pH 7) and then titrate the filtrate with 0.05 N NaOH solution using thymol blue indicator	Harada and Inoko (1980)
17.	Water Soluble Carbohydrartes	Soluble carohydrates were extracted from compost with water. The concentration of carbohydrates in the extract was determined by Spectrophotometricaly as the blue green complex which is formed when carbohydrates are heated with anthrone in sulphuric acid	Brink *et al.* (1960)
C.	**Biological properties**		
1.	CO_2 Evolution (basal respiration)	Enclose compost sample in a air tight vessel with a NaOH trap to determine CO_2 evolved during incubation for 7-10 days at 50% moisture content in compost. Add $BaCl_2$ and titrate with 0.1 N HCl	Manna *et al.* (2004)

3.2 Statistical analysis :

The statistical analysis of the data of the characters studied during the course of investigation was carried out by following the procedure outlined by Panse and Sukhatme (1967). The correlation between some of the parameters with each other such as total organic carbon and total nitrogen, total organic carbon and total phosphorus and total organic carbon and total potassium was worked out. For comparison of the difference in various methods followed for determination of total organic carbon, total nitrogen, phosphorus and potassium content from manure samples, paired 't' test was used.

CHAPTER IV

RESULTS AND DISCUSSION

The studies on quality assessment of manures from four districts of Konkan region of Maharashtra state were carried out in the laboratory of the Department of Agricultural Chemistry and Soil Science of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. One hundred manure samples collected by following standard procedure, were analysed in duplicate for different physical, chemical and biological attributes. The manure samples are divided into two to three distinct categories based on the standard values given by two different organizations such as Maharashtra State Department of Agriculture and Indian Institute of Soil Science (ICAR), Bhopal for confirming their maturity and quality. The correlation among various attributes were worked out using standard statistical procedures.

In order to find out the correlation among the various methods of determination of some of the parameters like organic carbon, total nitrogen, total phosphorus and total potassium, regression equations were also worked out. The results of the study have been presented and discussed under the following heads in this chapter.

4.1 Categorization of manures on the basis of physical properties for determination of manure quality.

4.2 Categorization of manures on the basis of chemical properties for determination of manure quality.

4.3 Categorization of manures on the basis of biological property for determination of manure quality.

4.4 Correlation between organic matter content and other chemical properties of manures.

4.5 Relationship between major nutrients and organic carbon content determined by different methods.

4.6 Comparison among the methods of determination of organic carbon and major nutrients

4.1 Categorization of manures on the basis of physical properties for determining manure quality

The various physical properties of manures such as colour, odour, particle size, moisture content, bulk density and water holding capacity of one hundred manure samples collected were determined by standard methods. The results of each of the property are reported in Appendix II and the per cent contribution of each of the category to total number of manure samples are depicted in Fig. 4.1. The range of the values of each of the property and the number of manure samples under each category are mentioned in the Table 4.1.

4.1.1 Colour

The data pertaining to colour of manures revealed that out of one hundred manure samples twenty five manure samples were observed to possess blackish brown colour while fifty two samples were black in colour which indicated that in all seventy seven per cent samples are reached to maturity while remaining twenty three per cent seen to be immature from the point of their colour.

Mathur and Daigale (1986) reported dark brown colour of mature compost prepared from mixing fish scrap, crab scrap and sea weeds. Subramaniam (2002) noted that good quality compost had dark brown colour.

4.1.2 Odour

Out of one hundred manure samples studied, twenty seven per cent manure samples possessed soily odour while four per cent manures had other than soily odour. However, sixty nine per cent samples were found to be odourless. Thus, according to the standards given by state Govt. of Maharashtra and Indian Institute of Soil Science (I.C.A.R.), Bhopal almost all the manure samples were within the standards as far as odour is concerned.

Mathur and Daigale (1986) found that compost prepared from fish scrap, crab scrap and sea weeds had earthy odour.

Table 4.1 Categorization of manures on the basis of physical properties determining manure quality

1. Colour

Sr. No.	Category	No. of samples
1.	Grey	23
2.	Dark brown	25
3.	Black	52

2. Odour

Sr. No.	Category	No. of samples
1.	Soily	27
2.	Other than soily	4
3.	Odourless	69

3. Particle size

Sr. No.	Category	No. of samples
1.	> 90 % passes through 4mm sieve	88
2.	> 90% sample did not pass through 4 mm sieve	12

4. Moisture (per cent)

Sr. No.	Category	No. of samples
1.	< 20	43
2.	20-30	28
3.	> 30	29

Range : 0.4 to 54.5

5. Bulk density (Mg m^{-3})

Sr. No.	Category	No. of samples
1.	< 0.7	70
2.	0.7-0.9	25
3.	> 0.9	05

Range : 0.32 to 1.07

6. Water holding capacity (per cent)

Sr. No.	Category	No. of samples
1.	< 50	06
2.	50-100	92
3.	> 100	02

Range : 39 to 131

4.1.3 Particle size

All the manure samples are categorized into two groups on the basis of their particle size *viz*., more than ninety per cent particles of manure samples passing through 4 mm sieve and less than ninety per cent particles of manure samples passing through 4 mm sieve. From the data presented in Table 4.1, it is seen that 88 per cent manure samples had more than ninety per cent particles passing through 4 mm sieve while remaining 12 per cent manure samples did not, which indicated that 88 per cent manure samples meet the requirement of standards suggested by Indian Institute of Soil Science, Bhopal. The particle size of manure is important from the point of nutrient availability. Finer the particle size faster is the rate of decomposition which helps for rapid availability of nutrients to the crops.

4.1.4 Moisture (per cent)

From the data on oven dry moisture content of manure samples determined by gravimetric method (Table 4.1), it is evident that moisture content of manure samples varied from 0.40 to 54.50 per cent. Out of one hundred manure samples twenty eight per cent manure samples are categorized into a group possessing 20 to 30 per cent moisture content, which is a optimum range of moisture content, according to the standards given by State Government of Maharashtra. Forty three per cent manure samples are categorized into a group possessing lower than twenty per cent moisture content. Thus, seventy one per cent manure samples are observed to be below maximum level of optimum moisture content. However, twenty nine per cent manure samples possessed excess moisture (Fig. 1).

Jadhav (1996) found contained 28.5 per cent moisture in vermicompost. Talashilkar *et al*. (2004) noted that compost prepared from crop residues had 6.04 per cent moisture.

4.1.5 Bulk density (Mg m^{-3})

The data pertaining to bulk density of manures revealed that out of one hundred manure samples, seventy per cent manure samples had less than 0.7 Mg cm^{-3} bulk density, twenty five per cent samples had bulk density between 0.7 to 0.9 Mg m^{-3}, while five per cent manure samples had bulk density more than 0.9 Mg m^{-3}. The manure samples had bulk density in the range of 0.32 to 1.07 Mg m^{-3}. Hence, ninety five per cent manure samples had lower than optimum bulk density and five per cent manure samples had bulk density higher than optimum level which was concomitant with the values suggested by State Government of Maharashtra (Anonymous, 2004) and Indian Institute of Soil Science, Bhopal (Manna *et al*., 2004).

4.1.6 Water holding capacity (per cent)

The data presented in Table 4.1 indicated that water holding capacity of manure samples was in the range of 39 per cent to 131 per cent. Ninety two per cent manure samples had water holding capacity in the range of 50 – 100 per cent, while two per cent samples had more than 100 per cent water holding capacity. However, only six per cent manure samples had less than 50 per cent water holding capacity. The reason attributed for higher water holding capacity of majority of these manure samples are to their finer size particles.

Bhoite (1998) recorded water holding capacity of bone meal, fish meal, neem cake and goat dropping to the tune of 81.7 per cent, 83.4 per cent, 84.4 per cent and 85.7 per cent, respectively.

4.2 Categorization of manures on the basis of chemical properties for determining manure quality

4.2.1 Nitrogen (per cent)

The data on distribution of manure samples under different groups on the basis of total nitrogen content and the ranges of total nitrogen content determined by colorimetric method, Kjeldahl's method and modified Kjeldahl's method are presented in Table 4.2.and Fig. 4.2. The data revealed that the total nitrogen content ranged from 0.56 to 5.28 per cent by colorimetric method, 0.78 to 4.70 per cent by Kjeldahl's method and 0.89 to 4.59 per cent by modified Kjeldahl's method.

Under colorimetric method, 40 per cent manure samples had more than two per cent total nitrogen, 55 per cent were in the range of 0.8 to 2.0 per cent, while 5 per cent had less than 0.8 per cent total nitrogen. Under Kjeldahl's method 12 per cent manure samples had more than two per cent total nitrogen, 84 per cent were in the range of 0.8 to 2.0 per cent total N and 4 per cent had less than 0.8 per cent total N. While in case of modified Kjeldahl's method, 64 per cent manures were in the range of 0.8 to 2.0 per cent and 36 per cent showed more than 2 per cent total nitrogen.

Lekha *et al*. (1999) noted that fish meal had 2.5 per cent nitrogen. Karle (2004) revealed that FYM contained 0.5 per cent nitrogen.

Talashilkar *et al*. (2004) registered that compost prepared from cow dung and vegetable trimmings had 1.22 per cent nitrogen. Sihag *et al*. (2005) found that poultry manure contained 2.62 per cent nitrogen. Sigh *et al*. (2005) reported that vermicompost contained 1.00 per cent nitrogen.

Table 4.2. Categorization of manures on the basis of chemical properties determining manure quality

1. Nitrogen (per cent)

A) Colorimetric method

Sr. No.	Category	Nos.
1.	< 0.8	05
2.	0.8-2.0	55
3.	> 2.0	40

Range : 0.56 to 5.28

B) Kjeldahl's method

Sr. No.	Category	Nos.
1.	< 0.8	04
2.	0.8-2.0	84
3.	> 2.0	12

Range : 0.78 to 4.70

C) Modified Kjeldahl's method

Sr. No.	Category	Nos.
1.	< 0.8	00
2.	0.8-2.0	64
3.	> 2.0	36

Range : 0.89 to 4.59

2. Phosphorus (per cent)

A) Diacid digestion method

Sr. No.	Category	Nos.
1.	< 0.5	03
2.	0.5-1.0	23
3.	> 1.0	74

Range : 0.27 to 18.32

B) Triacid digestion method

Sr. No.	Category	Nos.
1.	< 0.5	00
2.	0.5-1.0	15
3.	> 1.0	85

Range : 0.73 to 19.14

C) Dry ashing method

Sr. No.	Category	Nos.
1.	< 0.5	05
2.	0.5-1.0	38
3.	> 1.0	57

Range : 0.22 to 14.48

3. Potassium (per cent)

A) Diacid digestion method

Sr. No.	Category	Nos.
1.	< 1.0	63
2.	1.0 – 2.0	23
3.	> 2.0	14

Range : 0.16 to 8.28

B) Triacid digestion method

Sr. No.	Category	Nos.
1.	< 1.0	57
2.	1.0 – 2.0	28
3.	> 2.0	15

Range : 0.16 to 8.52

C) Dry ashing method

Sr. No.	Category	Nos.
1.	< 1.0	75
2.	1.0 – 2.0	18
3.	> 2.0	9

Range : 0.12 to 8.52

4. Total organic carbon (per cent)

A) Dry combustion method

Sr. No.	Category	Nos.
1.	< 6	2
2.	6.0 – 14.0	4
3.	> 14	94

Range : 4.34 to 55.97

B) Wet digestion method

Sr. No.	Category	Nos.
1.	< 6	1
2.	6.0 – 14.0	14
3.	> 14	85

Range : 4.95 to 43.65

5. Organic matter (per cent)

A) Dry combustion method

Sr. No.	Category	Nos.
1.	< 10.32	2
2.	10.32 – 24.08	4
3.	> 24.08	94

Range : 7.5 to 96.5

B) Wet digestion method

Sr. No.	Category	Nos.
1.	< 10.32	1
2.	10.32 – 24.08	14
3.	> 24.08	85

Range : 8.51 to 75.07

6. Ash (per cent)

A) Dry combustion method

Sr. No.	Category	Nos.
1.	< 50	33
2.	50-60	22
3.	> 60	45

Range : 3.5 to 92.5

B) Wet digestion method

Sr. No.	Category	Nos.
1.	< 50	11
2.	50-60	14
3.	> 60	75

Range : 23.89 to 91.49

7. C:N ratio

A) D.C. : 1 N

Sr. No.	Category	Nos.
1.	< 12	39
2.	12-17	34
3.	> 17	27

Range : 2.09 to 76.67

B) D.C. : 2 N

Sr. No.	Category	Nos.
1.	< 12	18
2.	12-17	29
3.	> 17	53

Range : 3.53 to 49.34

C) D.C. : 3 N

Sr. No.	Category	Nos.
1.	< 12	40
2.	12-17	38
3.	> 17	22

Range : 3.00 to 28.44

D) W.D. : 1 N

Sr. No.	Category	Nos.
1.	< 12	59
2.	12-17	24
3.	> 17	17

Range : 2.37 to 53.21

E) W.D. : 2 N

Sr. No.	Category	Nos.
1.	< 12	37
2.	12-17	39
3.	> 17	24

Range : 4.02 to 44.04

F) W.D. : 3 N

Sr. No.	Category	Nos.
1.	< 12	65
2.	12-17	29
3.	> 17	06

Range : 3.41 to 25.17

D.C. = Total organic carbon determined by Dry combustion method
W.D. = Total organic carbon determined by Wet digestion method
1 N = Total nitrogen determined by Colorimetric method
2 N = Total nitrogen determined by Kjeldahl's method
3 N = Total nitrogen determined by modified Kjeldahl's method

8. Calcium (per cent)

Sr. No.	Category	Nos.
1.	< 0.5	30
2.	0.5 - 1.0	24
3.	> 1.0	46

Range : 0.12 to 6.48

9. Magnesium (per cent)

Sr. No.	Category	Nos.
1.	< 0.5	13
2.	0.5 - 1.0	33
3.	> 1.0	54

Range : 0.20 to 3.56

10. Sulphur (per cent)

Sr. No.	Category	Nos.
1.	< 0.5	63
2.	0.5 - 1.0	25
3.	> 1.0	12

Range : 0.018 to 5.34

11. Zinc (mg kg-1)

Sr. No.	Category	Nos.
1.	< 500	49
2.	500 - 1000	34
3.	> 1000	17

Range : 20 to 1830

12. Manganese (mg kg^{-1})

Sr. No.	Category	Nos.
1.	< 500	41
2.	500 – 1000	52
3.	> 1000	7

Range : 116 to 1404

13. Copper (mg kg^{-1})

Sr. No.	Category	Nos.
1.	< 150	92
2.	150 – 300	4
3.	> 300	4

Range : 10 to 359

14. Iron (g kg^{-1})

Sr. No.	Category	Nos.
1.	< 1.0	7
2.	1.0 - 2.0	56
3.	> 2.0	37

Range : 0.401 to 6.309

15. Boron (mg kg^{-1})

Sr. No.	Category	Nos.
1.	< 25	18
2.	25 - 50	52
3.	> 50	30

Range : 10.40 to 95.74

16. Water soluble carbohydrate (per cent)

Sr. No.	Category	Nos.
1.	< 1.0	55
2.	1.0 - 2.0	30
3.	> 2.0	15

Range : 0.21 to 5.70

17. C.E.C. (c mol (p$^+$) kg^{-1})

Sr. No.	Category	Nos.
1.	< 65	02
2.	65 - 130	92
3.	> 130	06

Range : 62 to 139

18. pH

Sr. No.	Category	Nos.
1.	< 6.5	51
2.	6.5 – 7.5	42
3.	> 7.5	07

Range : 4.18 to 9.57

19. Electrical conductivity (dS m^{-1})

Sr. No.	Category	Nos.
1.	< 1	54
2.	1-4	43
3.	> 4	3

Range : 0.14 to 6.87

4.2.2 Phosphorus (per cent)

The data pertaining to the number of manure samples under different categories of total phosphorus content and the range values of total phosphorus content determined by different methods are presented in Table 4.2. From the data, it is revealed that the phosphorus content ranged from 0.27 to 18.32 per cent by diacid digestion method, 0.73 to 19.14 per cent by triacid digestion method and 0.22 to 14.48 per cent by dry ashing method.

Under diacid digestion method, 74 per cent manure samples had more than one per cent phosphorus, 23 per cent manures were in the range of 0.5 to 1.0 per cent while only three per cent manures had less than 0.5 per cent phosphorus content. Hence, it is inferred that 97 per cent manure samples had phosphorus higher than minimum level as per the standards given by Indian Institute of Soil Science, Bhopal. In triacid digestion method, 15 per cent manure samples were in the range of 0.5 to 1.0 per cent and 85 per cent manure samples had more than one per cent phosphorus. While under dry ashing 57 per cent manure samples had more than one per cent phosphorus, 38 per cent manures were in the range of 0.5 to 1.0 per cent and only five per cent manure samples had less than 0.5 per cent phosphorus.

The phosphorus content in vermicompost to the extent of 2.6 per cent was recorded by Rajkhowa *et al*. (2000). Tampan (2000) recorded 0.06 per cent phosphorus in coir pith compost. Tolanur and Badanur (2003) noted that vermicompost contained 1.26 per cent phosphorus. Sawant (2004) registered that poultry manure contained 2.71 per cent phosphorus, while Sihag *et al*. (2005) reported that phosphorus content in FYM was 0.40 per cent.

4.2.3 Potassium (per cent)

The data on distribution of manure samples under different groups on the basis of total potassium content determined by diacid digestion, triacid digestion and dry ashing method are presented in Table 4.2. The data showed that the total potassium content ranged from 0.16 to 8.28 per cent by diacid digestion method, 0.16 to 8.52 per cent by triacid digestion method and 0.12 to 8.52 per cent by dry ashing method.

Under diacid digestion method, 63 per cent manure samples had less than one per cent potassium, 23 per cent manures were in the range of 1.0 to 2.0 per cent and 14 per cent had more than two per cent potassium content. Under triacid digestion method, 15 per cent had more than two per cent potassium, 28 per cent were in the range of one to two per cent and 57 per cent had less than one per cent potassium content. While in case of dry ashing method, 9 per cent samples had more than two per cent potassium, 18 per cent were in the range of one to two percent and 75 per cent samples had less than one per cent potassium content.

Chitdeshwari *et al*. (2002) registered 2.53 per cent potassium content in sewage sludge. Kumari and Kumari (2002) revealed that vermicompost contained 2.42 per cent potassium. The potassium content in FYM to the tune of 0.91 per cent was recorded by Sharma *et al*. (2002). Desai (2003) noted that sewage sludge contained 1.55 per cent potassium, while Gupta (2003) found that fish meal contained potassium in the range of 0.3 to 1.5 per cent.

4.2.4 Total organic carbon (per cent)

The data on distribution of a number of manure samples under different groups of total organic carbon content and the range of values of total organic carbon content determined by dry combustion (550^{0}C) and Walkley and Black's rapid titration (Wet digestion) methods are presented in Table 4.2. The data revealed that the organic carbon content ranged from 4.34 to 55.97 per cent by dry combustion method while it ranged between 4.95 to 43.65 per cent by wet digestion method.

Under dry combustion method 94 per cent manure samples had more than 14 per cent total organic carbon, four per cent were in the range of 6 to 14 per cent, while two per cent had less than 6 per cent total organic carbon content, On the other hand, under wet digestion method 85 per cent manure samples had more than 14 per cent total organic carbon content. Four percent samples were in the range of 6 to 14 per cent and only one sample had less than 6 percent total organic carbon content. This indicated that most of the manure samples had an adequate quantity of organic carbon content as suggested by State Govt. of Maharashtra (Anonymous, 2004).

Mukharjee (1991) also found 49.4 per cent organic carbon in groundnut cake. Bhoite (1998) reported 41 per cent organic carbon in goat dropping. Chaudhari *et al*. (2000) registered 10 per cent organic carbon in poultry manure. Dinesh *et al*. (2003) noted 36 per cent organic carbon in FYM. Sihag (2005) determined 26 per cent organic carbon in poultry manure.

4.2.5 Organic matter (per cent)

The organic matter content of manure samples was in the range of 7.5 to 96.5 percent determined by dry combustion method while it was in the range of 8.51 to 75.07 per cent determined by wet digestion method. The trend in the distribution of manure samples under different categories of organic matter content is observed to be same as that observed with organic carbon content of the manures.

Jankowskin and Koc (1992) observed 45 per cent, 12 per cent and 73 per cent of organic matter content in compost, sewage sludge and FYM, respectively. Patil *et al*. (1998) noted organic matter content of fish manure prepared from different body parts of the fishes such as head, maws, skin, fin and finrays, scales, intestine, bones and tails to the tune of 73.96 per cent, 76.71 per cent, 71.38 per cent, 66.73 per cent, 68.45 per cent, 78.77 per cent, 66.22 per cent and 71.89 per cent, respectively.

Gupta (2000) found that FYM had 37 per cent organic matter. Kadalli and Nair (2000) recorded compost made from coir dust contained 53 per cent organic matter. Rajkhowa *et al*. (2000) noted that vermicompost had 19.78 per cent organic matter. Chitadeshwari *et al*. (2002) registered that sewage sludge contained 27.34 per cent organic matter.

4.2.6 Ash (per cent)

The data on ash content of manure samples determined by two methods are presented in Table 4.2, which indicated that 33 per cent samples had less than 50 per cent and 22 per cent samples were in the range of 50 to 60 per cent while 45 per cent samples had greater than 60 per cent ash content as determined by dry combustion method.

Under the wet digestion method, 11 per cent samples had less than 50 per cent ash, 14 per cent manure samples had ash content in the range of 50 to 60 per cent, while 75 per cent manure samples had more than 60 per cent ash content.

Cuminas *et al*. (1993) registered 247 g/kg ash in poultry manure. Kale (1998) found that vermicompost contained 84 per cent ash. Manna *et al*. (2000) noted that compost prepared from soybean with inoculation had 48 per cent ash, compost prepared from chickpea straw had 57 per cent ash, compost prepared from wheat straw had 43.3 per cent ash, while compost prepared from mustard straw had 41.7 per cent ash. Shrikanth *et al*. (2000) recorded that FYM contained 35.00 per cent ash. Dinesh *et al*. (2003) registered 38 per cent ash in FYM.

4.2.7 C : N ratio

The data pertaining to the number of manure samples under different categories of C : N ratio along with the range values determined by various methods of organic carbon and total N are presented in Table

4.2. It is seen from the data that C : N ratio ranged from 2.09 to 76.67 when carbon was determined by dry combustion method and nitrogen was determined by colorimetric method. Under these methods of C and N determination, 27 per cent manures had C : N ratio more than 17, while 34 per cent samples were in the range of 12 to 17 and 39 per cent manure samples had C : N ratio less than 12.

When carbon was determined by dry combustion method and nitrogen was determined by Kjeldahl’s method, C : N ratio ranged from 3.53 to 49.34. Under this combination 53 per cent manures had C : N ratio more than 17, while 29 per cent were in the range of 12 to 17 and 18 per cent had C : N ratio less than 12. The C : N ratio ranged between 3.00 to 28.44 when carbon was determined by dry combustion method and nitrogen was determined by modified Kjeldahl’s method. Forty per cent manures had C : N ratio less than 12, while 38 per cent manures were in the range of 12 to 17 and 22 per cent manures had C : N ratio greater than 17.

When carbon was determined by wet digestion method and nitrogen was determined by colorimetric method, the C : N ratio ranged between 2.37 to 53.21. Fifty nine per cent manures had less than 12 C : N ratio, while 24 per cent were in the range of 12 to 17 and 17 per cent manures had greater than 17 C : N ratio. When carbon was determined by wet digestion method and nitrogen was determined by Kjeldahl’s method C : N ratio ranged from 4.02 to 44.04. Twenty four per cent manures had C : N ratio more than 17, while 39 per cent manures were in the range of 12 to 17 and 37 per cent manure samples had less 12 per cent C : N ratio. The data revealed that the C : N ratio ranged between 3.41 to 25.17 when carbon was determined by wet digestion method and nitrogen was determined by modified Kjeldahl’s method. Sixty five per cent manures had less than 12 C : N ratio, while 29 per cent manures were having C : N ratio in the range of 12 to 17 and only 6 per cent samples had C : N ratio more than 17.

Mukharjee *et al*. (1991) reported C : N ratio of different oil cakes as follows : groundnut cake 6.77, mustard cake 11.80, neem cake 21.33 and mahua cake 21.33. Jadhav (1996) noted the C : N ratio of FYM as 45. Talashilkar *et al*. (1999) found that vermicompost prepared from different material like local grass, mango leaves and farm waste had C : N ratio in the range of 17.7 to 21.7.Bhattacharya *et al*. (2001) noted that municipal solid waste compost had C : N ratio in the range of 11-12. Purohit and Gehlot (2006) reported the C : N ratio of vermicompost prepared from Ayurvedic waste as 11 : 1.

4.2.8 Calcium (per cent)

From the data on per cent calcium content of manure samples, it is evident that calcium content of manure samples varied from 0.12 to 6.48 per cent. Out of total one hundred manure samples 24 per cent manure samples are categorized into a group possessing 0.5 to 1.0 per cent calcium, which is a optimum range of calcium content. Thirty per cent manure samples are categorized into a group possessing lower than 0.5 per cent calcium content. Thus, fifty four per cent manure samples are observed to be below maximum level of optimum calcium content. However, forty six manure samples possessed more than one per cent calcium.

Poultry manure had 2.3 per cent calcium as reported by Sim and Wolf (1994). Bhangrath (1997) recorded calcium content in the range of 0.38 to 1.64 per cent in vermicompost preapered from grass, rice straw and leaves of mango, cashew and forest trees. Dosani *et al*. (1999) noted that poultry manure contained 1.71 per cent calcium. Kadalli and Nair (2000) reported calcium content in raw dust and coir dust based enriched super compost was 0.46 and 2.44 per cent, respectively.

4.2.9 Magnesium (per cent)

The data presented in Table 4.2 indicated that magnesium content of the manure samples was in the range of 0.20 to 3.56 per cent. Thirty three per cent manure samples were categorized in the range 0.5 to 1.0 per cent which is an optimum range. Thirteen per cent manure samples had magnesium content below 0.5 per cent. Hence, 54 per cent manure samples were rated under maximum level of magnesium i.e. more than 1.0 per cent category.

Sims and Wolf (1994) noted that poultry manure contained 1.0 per cent magnesium. Chaudhari *et al*. (2000) recorded vermicompost had 0.41 per cent magnesium. Kadalli and Nair (2000) found that coir dust based compost had 0.75 per cent magnesium content. Patil *et al*. (2000) revealed that magnesium content from fish manure was 1.0 per cent. Sharma *et al*. (2002) reported that FYM had 0.19 per cent magnesium.

4.2.10 Sulphur (per cent)

Total sulphur content of one hundred manure samples varied from 0.018 to 5.34 per cent. Among all the samples tested 63 per cent manure samples were in the range of below 0.5 per cent and 25 per cent manure samples were in the range of 0.5 to 1.0 per cent. Thus, 12 per cent manure samples were found to possess total sulphur content more than 1.0 per cent. Hence, 88 per cent manure samples are categorized in less than maximum permissible limits.

Kale (1998) noted 128 to 548 ppm available sulphur in vermicompost. Dosani *et al*. (1999) registered 0.5 per cent sulphur in poultry manure. Kadalli and Nair (2000) reported that coir dust based enriched super compost contained 0.31 per cent sulphur. Dadas (2004) found that compost prepared from different materials such as weed biomass, wheat straw, sugarcane trash, jowar stubbles, bajra stubbles and banana Pseudostem comprised of 0.48 per cent sulphur.

4.2.11 Zinc (mg kg^{-1})

Total zinc content of one hundred manure samples varied from 20 to 1830 mg kg^{-1}. Among all the manure samples tested, 49 per cent manure samples were in the range of less than 500 mg kg^{-1} and 34 per cent manure samples were in the range of 500-1000 mg kg^{-1}. Thus, 83 per cent manure samples were found to possess total zinc content below maximum permissible limits (Manna *et al*., 2004). Hence, these manure samples are very safe for application in the soils of Konkan region. Further, it is observed that only 17 per cent manure samples had zinc content in the range of 1000 to 1830 mg kg^{-1}. It is suggested to use them in lower quantity to acid lateritic and calcareous medium black soils of the region. The necessary precaution may also be taken to apply some soil amendments along with such types of manures.

Patil (1994) found that wheat straw compost contained 87 mg zinc kg^{-1}of manure. Singh *et al*. (1998) observed that biogas slurry on dry weight basis contained zinc to the tune of 105 mg kg^{-1}. Dosani *et al*. (1999) observed 198 ppm zinc content in poultry manure. Vermal *et al*. (1999) noticed that zinc content in soybean trash compost, paddy straw compost and *Kharif* weeds compost was to the tune of 37, 52 and 44 mg kg^{-1}, respectively. Sharma (2000) registered that FYM contained 14.5 ppm zinc.

4.2.12 Manganese (mg kg^{-1})

Total manganese content of manure samples was in the range of 116 to 1404 mg kg^{-1}. Among the one hundred manure samples, 93 percent are observed to possess less than 1000 mg kg^{-1} of total manganese which can be rated below permissible limits as per the standards quoted by Ministry of Environment and Forestry, 2002 (Manna *et al*., 2004). Among these manure samples, 41 per cent manure samples are rated below 500 mg kg^{-1}.Only seven per cent manure samples are found to possess higher than 1000 mg kg^{-1} of the total manganese content.

Cuminas *et al*. (1993) recorded 348 mg kg^{-1} manganese in composted poultry mortalities and poultry litters. Bhangrath (1997) noticed manganese content in vermicompost prepared from different materials as 65.4 to 126.0 ppm. Kumar and Hegde (1999) observed 21.8 ppm manganese in decomposed cashew leaf litter. Chitdeshwari *et al*. (2002) found that sewage biosolids contained 1780 ppm manganese. Pawar (2004) reported manganese content in sugarcane trash compost, wheat straw compost, jowar stubble compost, threshing yard waste compost and *Kharif* weed compost to the extent of 91.0, 84.3, 97.7, 57.7 and 69.9 mg kg^{-1}, respectively.

4.2.13 Copper (mg kg^{-1})

The data presented in Table 4.2 revealed that total copper content of one hundred manure samples ranged between 10 mg kg^{-1} to 359 mg kg^{-1}. According to the standards quoted by Ministry of Environment and Forestry (Manna *et al*. 2004), 96 per cent of the manure samples registered the concentration of copper below permissible tolerable level i.e. less than 300 mg kg^{-1} of manure. Ninety two per cent of the manure samples are found to possess copper content even below fifty per cent of the tolerable limit which indicated that these manure samples were very safe for application as far as this heavy metal content of organic manure is concerned. The data also revealed that only 4 per cent of the organic manures had greater than 300 mg kg^{-1} of total copper content.

Sims and Wolf (1944) observed 251 mg kg^{-1} copper in poultry waste manure. Bansal and Gupta (1998) found that sewage sludge contained 320 ppm copper. Kale (1998) reported that the vermicompost had 2.0 to

9.5 ppm copper content. Kadalli and Nair (2000) noted that coir dust based enriched super compost had 69.80 ppm copper content. Madhu (2005) registered copper content in glyricidia, cattle feed waste, dung slurry, *T. viride* (6035) compost and glyricidia, cattle feed waste, dung slurry and EM culture (6678 mg kg^{-1}) compost as 112 and 119 ppm, respectively.

4.2.14 Iron (g kg^{-1})

From the data on total micronutrient content of manures presented in Table 4.2, it is observed that total iron content of manure samples varied from 0.40 to 6.31 g kg^{-1}. Out of one hundred manure samples, 63 per cent manure samples possessed total iron content below 2.0 g kg^{-1} which is below permissible limit as reported by Ministry of Environment and Forestry, 2002 (Manna *et al*., 2004). Among 63 per cent manure samples seven per cent manure samples were found to contain less than 1.0 g kg^{-1} iron content.

Swarup (1992) observed that green manure contained 76 mg kg^{-1} iron. Patil (1993) recorded 86 ppm iron in FYM. Reddy and Reddy reported that FYM and biogas slurry had 310.4 ppm and 833.7 ppm iron, respectively. Chaudhari *et al*. (2000) found that vermicompost produced from kitchen waste had 7.7 per cent iron. Talashilkar *et al*. (2005) revealed that iron content in neem cake, goat dropping, fish meal, bone meal was to the tune of 40, 72, 245 and 420 ppm, respectively.

4.2.15 Boron (mg kg^{-1})

The total boron content of manure samples was observed to be in the range of 10.40 to 95.74 mg kg^{-1}. Out of 100 manure samples, 18 per cent manure samples rated below 25 mg kg^{-1} of boron, 52 per cent manure samples rated between 25 to 50 mg kg^{-1} while 30 per cent samples had greater than 50 mg kg^{-1} of total boron. Most of the organic manures collected from Konkan region of Maharashtra were observed to be good source of boron.

Cuminas *et al*. (1993) observed that boron content in poultry manure was 54 mg kg^{-1}. Madhu (2005) noted that boron content in glyricidia compost prepared from glyricidia, cattle feed waste, dung slurry and *T. viride* (6035) and glyricidia, cattle feed waste, dung slurry and EM culture (6678 mg kg^{-1}) was 7.8 and 10.4 ppm, respectively.

4.2.16 Water soluble carbohydrates (per cent)

The data pertaining to water soluble carbohydrates of manures revealed that out of one hundred manure samples, fifty five per cent manure samples had less than 1.0 per cent water soluble carbohydrates, while fifteen per cent manure sample had water soluble carbohydrates more than 2.0 per cent, while 30 per cent manure samples had water soluble carbohydrates in between 1.0 to 2.0 per cent. The range of water soluble carbohydrates was 0.21 to 5.70 per cent in all the manures.

Bhangrath (1997) noted that water soluble carbohydrate content of vermicompost was in the range of 1.39 to 1.69 per cent. Dosani *et al*. (1999) reported that poultry manure contained 1.4 per cent water soluble carbohydrate. Manna *et al*. (2000) recorded water soluble carbohydrates in the composts prepared from soybean straw, wheat straw, chickpea straw and mustard straw as 0.32, 0.43, 0.30 and 0.43 per cent, respectively.

4.2.17 Cation exchange capacity (c mol (p^+) kg^{-1})

The data on cation exchange capacity of manure samples which is an important chemical property of manures from the point of better degree of humification and nutrient availability to crops is given in Table 4.2. The CEC of all the manures ranged between 62 to 139 c mol (p^+) kg^{-1}. Out of hundred manure samples 98 per cent manure samples were in the range of 65 to 139 c mol (p^+) kg^{-1} which indicated better decomposition of said manures from the point of higher nutrient availability and better retention of nutrients in the soil. Only two per cent samples possessed lower than 65 c mol (p^+) kg^{-1} CEC values which need some more period for decomposition.

Harda and Inoko (1980) noted the CEC of city waste (Toyohashi city piled for 30 days after fermentation process), city refuse (Toyohashi city piled for 60 days after fermentation process), rice straw compost and tree bark compost to the tune of 46.8 c mol (p^+) kg^{-1}, 82.6 c mol (p^+) kg^{-1}, 94.9 c mol (p^+) kg^{-1} and 122.6 c mol (p^+) kg^{-1}, respectively. Dosani *et al*. (1999) revealed that CEC of poultry manure was 135.0 c mol (p^+) kg^{-1}. Talashilkar *et al*. (1999) reported vermicompost prepared from local grass, mango leaves and farm waste had CEC in the range of 117 to 147 c mol (p^+) kg^{-1}. Manna *et al*. (2000) observed CEC of different composts prepared from soybean straw, wheat straw, chickpea straw, mustard straw with inoculums had 73 c mol (p^+) kg^{-1}, 101 c mol (p^+) kg^{-1}, 110 c mol (p^+) kg^{-1} and 59 c mol (p^+) kg^{-1}, respectively. Suseeladevi *et al*. (2001) reported compost prepared from coir dust and pleurotus, cow dung , garden weeds, green manures, rock phosphate and micronutrients had CEC 69.5 c mol (p^+) kg^{-1}, while the compost prepared from pretreated coir dust and pleurotus, cow dung , garden weeds, green manures, rock phosphate and micronutrients had CEC to the extent of 80.9 c mol (p^+) kg^{-1}.

4.2.18 pH

The pH of all the manure samples was in the range of 4.18 to 9.57. Forty two manure samples were in the neutral pH range of 6.5 to 7.5, however, fifty one per cent samples were in the acidic pH range of 4.18 to 6.50. Seven per cent are categorized in alkaline pH range of 7.50 to 9.57, which may perhaps be due to the presence of higher salt content in comparison to the manure samples possessing acidic and neutral reaction.

Piccone *et al*. (1987) noted that vermicompost had 7.6 pH. Shinde *et al*. (1995) recorded that FYM had pH 8.05. Chaudhari *et al*. (2000) recorded pH to the tune of 7.5 of the vermicompost prepared by them. Chitdeshwari *et al*. (2002) found sewage biosolids had pH (1:5) 6.70. Maheshwari (2002) observed that coffee pulp compost had 7.0 pH. Subramaniam (2002) stated that good quality compost had pH between 6.5 to 7.2.

4.2.19 Electrical conductivity (dS m^{-1})

The data on electrical conductivity of manure samples revealed that out of total one hundred samples only 3 per cent manure samples possessed greater than 4 dS m^{-1} electrical conductivity, which indicated that 97 per cent samples collected from the Konkan region are safe to use in manurial schedule as per the compost quality characters reported by IISS. Bhopal (Manna *et al*. 2004). Fifty four manure samples possessed very low salt content as their EC values were below 1 dS m^{-1}. The electrical conductivity of all the manure samples was in the rage of 0.14 to 6.87 dS m^{-1}. Patil (1994) found that wheat straw compost had 0.34 dS m^{-1} EC. The sewage sludge had EC 1.9 dS m^{-1} as recorded by Bansal and Gupta (1998). Bhoite (1998) recorded EC of bone meal, fish wastes, neem cake and goat dropping to the tune of 1.85 dS m^{-1}, 1.58 dS m^{-1}, 0.95 dS m^{-1} and 1.17 dS m^{-1}, respectively. While Chitdeshwari *et al*. (2002) reported that sewage biosolid had EC 0.68 dS m^{-1}. Pawar (2004) registered EC of different composts *viz*., sugar cane trash compost, wheat straw compost, jowar stubble compost, threshing yard waste compost and *Kharif* weed compost had 0.77 dS m^{-1}, 2.03 dS m^{-1}, 1.13 dS m^{-1}, 2.51 dS m^{-1} and 2.28 dS m^{-1}, respectively.

4.3 Categorization of manures on the basis of biological property determining manure quality

CO_2 evolution

All the manure samples are categorized into two groups on the basis of their CO_2 evolution as the basal respiration *viz*., less than 15 mg CO_2 – C / 100 g TOC / day and more than 15 mg CO_2 – C /100 g TOC / day. From the data presented in Table 4.3, it is seen that 83 per cent manure samples had less than 15 mg CO_2 – C /100 g TOC/day while remaining 17 per cent manure samples had more than 15 mg CO_2 – C / 100 g TOC/day. The CO_2 evolution was in the range of 2.86 to 16.50 mg CO_2 – C / 100 g TOC / day (Fig. 4.3).

4.3 Categorization of manures on the basis of biological property determining manure quality

1. CO_2 evolution (mg CO_2 – C /100g TOC/day)

Sr. No.	Category	Nos.
1.	< 15	83
2.	> 15	17

Range : 2.86 to 16.5

4.4 Correlation between organic matter content and other chemical properties of manures.

One hundred manure samples having organic matter content in the range of 7.5 to 96.5 per cent were also analyzed for major and minor nutrients and some other chemical properties. In order to understand the relationship between organic matter content of manures and their other chemical parameters, simple correlation coefficients were worked out. The data regarding their correlation coefficients are recorded in Table 4.4 and depicted in fig. 4.4. It is seen from the data that nitrogen content of manures

4.4 Correlation coefficients (r) of the organic matter with macro and micro nutrient contents and other chemical properties of manures

Sr. No.	Property	Organic matter by Dry combustion	Organic matter by Wet digestion
1.	Nitrogen by Colorimetric method	0.268**	0.241*
2.	Nitrogen by Kjeldahl's method	0.506**	0.356**
3.	Nitrogen by Modified Kjeldahl's method	0.463**	0.411**
4.	Phosphorus by Diacid digestion	-0.167	-0.131
5.	Phosphorus by Triacid digestion	-0.172	-0.153
6.	Phosphorus by Dry ashing	-0.120	-0.090
7.	Potassium by Diacid digestion	0.169	0.123
8.	Potassium by Triacid digestion	0.160	0.090
9.	Potassium by Dry ashing	0.084	0.066
10.	Calcium	-0.262	-0.185
11.	Magnesium	-0.322	-0.290
12.	Sulphur	-0.105	-0.173
13.	Zinc	0.007	0.142
14.	Manganese	-0.105	-0.105
15.	Copper	-0.210	-0.198
16.	Iron	-0.245	-0.266
17.	Boron	0.111	0.108
18.	Water soluble carbohydrates	0.496**	0.487**
19.	Cation exchange capacity	0.309**	0.260**

Note : * Significant at 5%, ** Significant at 1%

three methods such as colorimetric, Kjeldahl's method and modified Kjeldahl's method had significant positive correlation with their organic matter content determined by dry combustion as well as wet digestion methods. This signified the importance of organic matter in contribution of nitrogen from manures when applied to crop. Ghosh (1959) also studied correlation between the organic matter and nitrogen content values of town compost from different municipalities of Bihar and reported significant positive correlation between the organic matter content and nitrogen.

No significant correlation of organic matter content of manures determined by dry combustion as well as wet digestion methods was observed with the phosphorus content of manures determined by three analytical methods such as diacid digestion method, triacid digestion method and dry ashing method. The organic matter content of manures determined by two methods such as dry combustion and wet digestion methods did not exhibit any significant relation with total potassium content of the manures determined by all the methods such as diacid digestion, triacid digestion and dry ashing methods.

The data pertaining to correlation coefficients between organic matter content and other major nutrients such as calcium, magnesium, sulphur and minor nutrients such as zinc, manganese, copper, iron and boron revealed that there was no significant relationship between these chemical parameters. A significantly positive correlation of organic matter content of organic manures was noted with the cation exchange capacity and water soluble carbohydrate content of the manure samples when organic matter content was determined by dry combustion and wet digestion methods. These showed that the increasing proportion of organic matter in the organic manures must have increased the cation exchange capacity of manures.

The increase in the organic matter content of the said manure samples had also contributed for increasing concentration of water soluble carbohydrates.

4.5 Relationship between major nutrients and organic carbon content determined by different methods

The relationship between major nutrients content of manures such as nitrogen, phosphorus and potassium and organic carbon content determined by two methods are described with regression equations as under and depicted graphically in Fig. 4.4 to 4.6.

4.5.1 Relationship between nitrogen and organic carbon content determined by different methods

The regression equations of total nitrogen content determined by colorimetric method, Kjeldahl's method and modified Kjeldahl's method with total organic carbon content determined by dry combustion and wet digestion methods are given below:

$$Y = 1.3867 + 0.0211\ X_1$$

$$R^2 = 0.0719,\ SE(b) = 0.0076$$

Where,

Y = Total nitrogen by colorimetric method

X_1 = Total organic carbon by dry combustion method

It is seen from the above equation that the calculated average per cent nitrogen by colorimetric method was 1.386 and with every per cent increase in total organic carbon determined by dry combustion method caused an increase in nitrogen content by 0.0211 per cent. The 7.19 per cent variation in nitrogen by colorimetric method is attributed to total organic carbon by dry combustion method, remaining 92.81 per cent variation is due to other factors.

$$Y = 0.817 + 0.0274\ X_1$$

$$R^2 = 0.2566,\ S.E.(b) = 0.0047$$

Where,

Y = Total nitrogen by Kjeldahl's method

X_1 = Total organic carbon by dry combustion method

It is clear from this equation that the calculated average per cent nitrogen by Kjeldahl's method was 0.8175 and with every per cent increase in total organic carbon determined by dry combustion method caused an increase in nitrogen content by 0.0274 per cent. The variation in nitrogen content to the extent of 25.63 per cent by Kjeldahl's method is attributed to total organic carbon by dry combustion method, while the remaining 74.37 per cent variation is due to other factors.

$$Y = 1.3292 + 0.0214\ X_1$$

$$R^2 = 0.2151,\ S.E.\ (b) = 0.0041$$

Where,

Y = Total nitrogen by modified Kjeldahl's method

X_1 = Total organic carbon by dry combustion method

This equation revealed that the calculated average per cent nitrogen by modified Kjeldahl's method was 1.3292 and with every per cent increase in total organic carbon determined by dry combustion method resulted in an increase in nitrogen content by 0.0214 per cent. The 21.51 per cent variation in nitrogen by modified Kjeldahl's method is attributed to total organic carbon by dry combustion method and the remaining 78.49 per cent variation is due to other factors.

$$Y = 1.3960 + 0.0262 X_2$$

$$R^2 = 0.0581, \text{S.E.(b)} = 0.0106$$

Where,

Y = Total nitrogen by colorimetric method

X_2 = Total organic carbon by wet digestion method

From this equation it is seen that the calculated average per cent nitrogen by colorimetric method was 1.3960 and with every per cent increase in total organic carbon determined by wet digestion method caused an increase in nitrogen content by 0.0262 per cent. The variation to the extent of 5.81 per cent in nitrogen by colorimetric method is attributed to total organic carbon by wet digestion method, remaining 94.19 per cent variation is due to other factors.

$$Y = 0.9796 + 0.267 X_2$$

$$R^2 = 0.1275, \text{S.E. (b)} = 0.0070$$

Where,

Y = Total nitrogen by Kjeldahl’s method

X_2 = Total organic carbon by wet digestion method

It is clear from this equation that the calculated average per cent nitrogen by Kjeldahl’s method was 0.9796 and with every per cent increase in total organic carbon determined by wet digestion method has resulted in an increase in nitrogen content by 0.0267 per cent. The 12.75

per cent variation in nitrogen by Kjeldahl's method is attributed to total organic carbon by wet digestion method while the remaining 87.25 per cent variation is due to other, factors

$$Y = 1.3449 + 0.0262\ X_2$$

$$R^2 = 0.1696,\ S.E.\ (b) = 0.0058$$

Where,

Y = Total nitrogen by modified Kjeldahl's method

X_2 = Total organic carbon by wet digestion method

It is clear from this equation that the calculated average per cent nitrogen modified Kjeldahl's method was 1.3449 and every per cent increase in total organic carbon determined by wet digestion method caused an increase in nitrogen content by 0.0262 per cent. The variation in nitrogen determined by modified Kjeldahl's to the extent of 16.96 per cent is attributed to total organic carbon by wet digestion method while the remaining 83.04 per cent variation is due to other factors.

4.5.2 Relationship between phosphorus and organic carbon determined by different methods

The regression equations of total phosphorus determined by three methods with total organic carbon content determined by dry combustion and wet digestion methods are mentioned and described as below:

$$Y = 4.1736 - 0.0571\ X_1$$

$$R^2 = 0.0301,\ S.E.\ (b) = 0.0327$$

Where,

Y = Total phosphorus by diacid digestion method

X_1 = Total organic carbon by dry combustion method

From this equation it is found that the calculated average per cent phosphorus by diacid digestion method was 4.1736 and with every per cent increase in total organic carbon determined by dry combustion method, there was decrease in phosphorus content by 0.571 per cent. The 3.01 per cent variation in phosphorus by diacid digestion method is attributed to total organic carbon by dry combustion method, remaining 96.99 per cent variation is because of other factors.

$$Y = 4.0518 – 0.0517\ X_1$$

$$R^2 = 0.0319,\ S.E.\ (b) = 0.0287$$

Where,

Y = Total phosphorus by triacid digestion method

X_1 = Total organic carbon by dry combustion method

It is clear from this equation that the calculated average per cent phosphorus by triacid digestion method was 4.0518 and with every per cent increase in total organic carbon determined by dry combustion method there was decrease in phosphorus content by 0.0517 per cent. The variation in phosphorus to 3.19 per cent by triacid digestion method is attributed to total organic carbon by dry combustion method, remaining 96.81 per cent variation is due to other factors.

$$Y = 3.554 – 0.0538\ X_1$$

$$R^2 = 0.0428,\ S.E.\ (b) = 0.0256$$

Where,

Y = Total phosphorus by dry ashing method

X_1 = Total organic carbon by dry combustion method

It clear from this equation that the calculated average per cent phosphorus by dry ashing method was 3.554 and with every per cent increase in total organic carbon determined by dry combustion method caused decrease in phosphorus content by 0.538 per cent. The 4.28 per cent variation in phosphorus by dry ashing method is attributed to total organic carbon by dry combustion method, remaining 95.73 per cent variation is due to other factors.

$$Y = 3.3131 - 0.03313\ X_2$$

$$R^2 = 0.0045,\ S.E.\ (b) = 0.0496$$

Where,

Y = Total phosphorus by diacid digestion method

X_2 = Total organic carbon by wet digestion method

It is clear from this equation that the calculated average per cent phosphorus by diacid digestion method was 3.3131 and with every per cent increase in total organic carbon by wet digestion method caused decrease in phosphorus content by 0.0331 per cent. The variation in phosphorus content to the tune of 0.45 per cent determined by diacid digestion method is attributed to total organic carbon by wet digestion method and the remaining 99.55 per cent variation is due to other factors.

$$Y = 3.954 - 0.0606\ X_2$$

$$R^2 = 0.0235,\ S.E.\ (b) = 0.0394$$

Where,

Y = Total phosphorus by triacid digestion method

X_2 = Total organic carbon by wet digestion method

The calculated average per cent phosphorus by triacid digestion method was 3.954 and with every per cent increase in total organic carbon determined by wet digestion method caused decrease in phosphorus content by 0.0606 per cent as revealed from above equation. The 2.35 per cent variation in phosphorus by triacid digestion method is attributed to total organic carbon by wet digestion method remaining variation is due to other factors.

$$Y = 2.448 – 0.0237\ X_2$$

$$R^2 = 0.0082,\ S.E.\ (b) = 0.0263$$

Where,

Y = Total phosphorus by dry ashing method

X_2 = Total organic carbon by wet digestion method

From this equation, it is seen that the calculated average per cent phosphorus by dry ashing method was 2.448 and with every per cent increase in total organic carbon determined by wet digestion method caused decrease in phosphorus content by 0.0237 per cent. The 0.82 per cent variation in phosphorus by dry ashing method is attributed to total organic carbon by wet digestion method, remaining 99.18 per cent variation is due to other factors.

4.5.3 Relationship between potassium and organic carbon determined by different methods

The regression equation of total potassium content determined by diacid digestion, triacid digestion and dry ashing methods with total organic carbon content determined by dry combustion and wet digestion methods are mentioned and presented as below:

$$Y = 0.634 + 0.0180\ X_1$$

$$R^2 = 0.0279,\ S.E.\ (b) = 0.0107$$

Where,

Y = Total potassium by diacid digestion method

X_1 = Total organic carbon by dry combustion method

This equation revealed that the calculated average per cent potassium by diacid digestion method was 0.634 and with every per cent increase in total organic carbon determined by dry combustion method, there was decreased in phosphorus content by 0.0180 per cent. The variation to the extent of 2.79 per cent in potassium by diacid digestion method is attributed to total organic carbon determined by dry combustion method, remaining 97.21 per cent variation is because of other factors.

$$Y = 0.7680 + 0.0185\ X_1$$

$$R^2 = 0.0248,\ S.E.\ (b) = 0.01173$$

Where,

Y = Total potassium by triacid digestion method

X_1 = Total organic carbon by dry combustion method

It is clear from this equation that the calculated average per cent of potassium content determined by triacid digestion method was 0.7680 and with every per cent increase in total organic carbon determined by dry combustion method caused an increase in potassium content by 0.0185 per cent. The 2.48 per cent variation in potassium by triacid digestion method is due to total organic carbon determined by dry combustion method, while remaining 97.52 per cent variation is because of other factors.

$$Y = 0.7307 + 0.0084\ X_1$$

$$R^2 = 0.0066,\ S.E.\ (b) = 0.0103$$

Where,

Y = Total potassium by dry ashing method

X_1 = Total organic carbon by dry combustion method

It is clear from this equation that the calculated average per cent of potassium content determined by dry ashing method was 0.7307 and with every per cent increase in total organic carbon determined by dry combustion method caused an increase in potassium content by 0.0084 per cent. The variation in potassium to the extent of 0.66 per cent by dry ashing method is attributed to total organic carbon determined by dry combustion method and the remaining 99.34 per cent variation is owing to other factors.

$$Y = 0.7315 + 0.0181\ X_2$$

$$R^2 = 0.0151,\ S.E.\ (b) = 0.0147$$

Where,

Y = Total potassium by diacid digestion method

X_2 = Total organic carbon by wet digestion method

It is clear from this equation that the calculated average per cent of potassium by diacid digestion method was 0.7315 and with every per cent increase in total organic carbon determined by wet digestion method caused an increase in potassium content by 0.0181 per cent. The 1.51 per cent variation in potassium by diacid digestion method is attributed to total organic carbon determined by wet digestion method and the remaining 98.49 per cent variation is due to other factors.

$$Y = 0.9511 + 0.145\ X_2$$

$$R^2 = 0.0081,\ S.E.\ (b) = 0.016$$

Where,

Y = Total potassium by triacid digestion method

X_2 = Total organic carbon by wet digestion method

It is clear from this equation that the calculated average per cent of potassium by triacid digestion method was 0.9511 and with every per cent increase in total organic carbon determined by wet digestion method caused an increase in potassium content by 0.145 per cent. The variation in potassium content to the extent of 0.81 per cent by triacid digestion method is attributed to total organic carbon determined by wet digestion method and the remaining 99.19 per cent variation is because of other factors.

$$Y = 0.7573 + 0.0094\ X_2$$

$$R^2 = 0.0084,\ S.E.\ (b) = 0.0142$$

Where,

Y = Total potassium by dry ashing method

X_2 = Total organic carbon by wet digestion method

The above equation revealed that the calculated average per cent of potassium by dry ashing method was 0.7573 and with every per cent increase in total organic carbon determined by wet digestion method caused an increase in potassium content by 0.0094 per cent. The variation in potassium content by dry ashing method to 0.44 per cent is attributed to total organic carbon determined by wet digestion method while the remaining 99.56 per cent variation is because of other factors.

4.6 Comparison among the methods of determination of organic carbon and major nutrients

In order to compare the methods used for the determination of organic carbon, total nitrogen, total phosphorus and total potassium content of hundred manure samples, the data presented in Appendix III were subjected to simple paired ‘t’ test and the data of paired‘t’ test values are presented in Table 4.5. The analysis of the data revealed that the values of total organic carbon obtained by dry combustion method (25.76%) and wet digestion method (20.41%) had significant difference with each other (t_{cal} 7.996). Hence, these two methods were quite different from each other.

Similarly, the values of total nitrogen content of manure samples recorded in I method i.e. colorimetric method (1.93%) had close agreement with the III method i.e. modified Kjeldahl’s method (1.87%) as noted from non-significant paired ‘t’ test value (t_{cal} 0.6419). It is, therefore, inferred that these methods are statistically at par with each other. The comparison of I method i.e. colorimetric (1.93%) with II method i.e. Kjeldahl’s method (1.52%) and comparison of II method i.e. Kjeldahl’s method (1.52%) with that of III method i.e. modified Kjeldahl’s method (1.87%) of nitrogen estimation revealed that there was quite difference between I and II methods (t_{cal} 5.59) and II and III methods (t_{cal} 8.15) as the paired ‘t’ test values are observed to be significant.

As regards to comparison among the methods of phosphorus determination, the I method i.e. diacid digestion (2.69%) and II method i.e. triacid digestion (1.71%) used for the determination of total phosphorus content of manure samples, there was a close agreement between these two methods as a paired ‘t’ test value is observed to be non-significant

(t_{cal} 0.229). However significant paired 't' test value were registered between I method i.e. diacid digestion (2.69%) with III method i.e. dry ashing (2.16%) and II method i.e. triacid digestion (2.71%) and III method i.e. dry ashing (2.16%) which revealed that there was no agreement between I and III methods (t_{cal} 2.69) and II and III methods (t_{cal} 2.71) of phosphorus estimation.

From perusal of data, it is observed that the values of potassium content in manures by I method i.e. diacid digestion (1.10%) with II method i.e. triacid digestion (1.24%) and I method i.e. diacid digestion (1.10%) with III method i.e. dry ashing (0.94%) and II method i.e. triacid digestion (1.24%) with III method i.e. dry ashing (0.94%) significantly differed from each other as paired 't' test values are significant, t_{cal} are 4.92, 3.60 and 5.96, respectively.

From the foregoing discussion, it is evident that 77 per cent manure samples were reached to dark brown to black colour. Less than 0.9 Mg m^{-3} bulk density was registered in 95 per cent manures and 94 per cent manure samples had more than 50 per cent water holding capacity, which are the indicators of compost maturity. These results are in agreement with the standards suggested by Anthonis (1994) and Subramanian (2004). Ninety two per cent manure samples possessed more than 65 c mol (p^+) kg^{-1} of cation exchange capacity values which also revealed that the said manures are reached to stability from the point of decomposition process (Harda and Inoko, 1980).

Total N content of the manures ranged from 0.56 to 5.28 per cent by colorimetric method, from 0.78 to 4.70 per cent by Kjeldahl's method and from 0.89 to 4.59 per cent by modified Kjeldahl's method. More than lower limit of optimum range of nitrogen, phosphorus and potassium content was noted in 95, 97 and 43 per cent manure samples, respectively.

Table 4.5 Simple paired 't' test values observed for the methods of determination of organic carbon, total nitrogen, total phosphorus and total potassium

Sr. No.	Property	Mean values	t_{cal}
1.	Organic carbon by I method (Dry combustion) and by II method (Wet digestion)	25.76 & 20.40	7.996*
2.	Total nitrogen by I method (Colorimetric method) and by II method (Kjeldahl's method)	1.93 & 1.52	5.591*
3.	Total nitrogen by I method (Colorimetric method) and by III method (modified Kheldahl's method)	1.93 & 1.87	0.6419
4.	Total nitrogen by II method (Kjeldahl's method) and by III method (modified Kjeldahl's method)	1.52 & 1.87	8.158*
5.	Total phosphorus by I method (Diacid digestion method) and by II method (triacid digestion method)	2.69 & 2.71	0.229
6.	Total phosphorus by II method (triacid digestion method) and by III method (Dry ashing method)	2.69 & 2.16	4.6471*
7.	Total phoshorus by II method (triacid digestion method) and by III method (Dry ashing method)	2.71 & 2.16	5.994*
8.	Total potassium by I method (Diacid digestion method) and by II method (triacid digestion method)	1.10 & 1.24	4.928*
9.	Total potassium by I method (Diacid digestion method) and by III method (Dry ashing method)	1.10 & 0.94	3.609*
10.	Total potassium by II method (Triacid digestion method) and by III method (Dry ashing method)	1.24 & 0.94	5.968*

Note : *Significant at 5%

Similarly, higher than 0.5 per cent calcium, magnesium and sulphur content was recorded in 70, 87 and 37 per cent manure samples, respectively. Fifty one and fifty nine per cent manure samples had more than 500 mg kg^{-1} of zinc and manganese content, respectively while 8 per cent manure samples had more than 150 mg kg^{-1} of copper content and 93 per cent manure samples had more than 1.0 g kg^{-1} of iron content which indicated that the organic manures being used by the farmers from Konkan region are good source of micronutrients too.

The data on electrical conductivity values also revealed that 97 per cent manure samples are safe to use as their salt content is below permissible limits.

From the nutrient composition of manures it is inferred that the farmers must have used nutrient rich plant and animal origin raw materials for the preparation of manures. Some of the manure samples collected from branded bags from commercial units had very high nitrogen, phosphorus and potassium content. The reasons attributed to this are blending of organic residues with rock phosphate, bone meal, leather wastes, neem cake and inorganic sources of nutrients. The said enrichment techniques including use of microbial culture as low cost technology were also suggested by Gaur *et al*. (1984) and Gaur and Singh (1995).

From the correlation studies, it is evident that nitrogen content of manures determined by all the methods had significantly positive correlation with their organic matter content determined by both the methods i.e. dry combustion and wet digestion methods. Ghosh (1959) also found significant positive correlation between organic matter and nitrogen content. A significant positive correlation of organic matter content of manures was noted with cation exchange capacity and their water soluble carbohydrates content. This focuses on the better humification of manures, prepared in Konkan region of Maharashtra State. The results obtained in this investigation are in conformity with those obtained by Manna *et al*. (2000).

When the comparison was made among the methods of determination of organic carbon and major nutrients such as nitrogen, phosphorus and potassium by following paired ‘t’ test values, it was noted that only total nitrogen content of manure samples determined by colorimetric method had close agreement with modified Kjeldahl’s method. The diacid digestion and triacid digestion methods used for determination of total phosphorus content of manures also showed close agreement with each other. However, such a close agreement with other methods was not noticed. Therefore, it is suggested to develop different categories for different methods used for analysis.

CHAPTER V

SUMMARY

The present investigations on studies on quality assessment of manures from Konkan region of Maharashtra State were carried out in the Department of Agricultural Chemistry and Soil Science of Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli. One hundred manure samples were collected and analyzed for 26 physical, chemical and biological attributes. For comparing their values with the standard values given by State Department of Agriculture and Indian Institute of Soil Science (I.C.A.R.), these manures are categorized into different groups. The relationship among various properties and correlation among the methods of some of the parameters have been worked out in the form of correlation coefficients and simple paired ‘t’ tests. The salient features emanating from the studies are summarized as below.

5.1 Categorization of manures on the basis of physical properties

5.1.1 Out of one hundred manures examined, seventy seven per cent manures were found to possess dark brown to black colour. Similarly sixty nine per cent manures were odourless, therefore, indicating that the most of the manures are stable from the point of compost maturity.

5.1.2 From one hundred manure samples, less than 20 per cent moisture was registered in 43 per cent manure samples, while 28 per cent manures were in the range of 20 to 30 per cent moisture

5.1.3 An optimum bulk density in the range of 0.7 to 0.9 Mg m^{-3} was recorded in 25 per cent manures among all the manures tested in the studies

5.1.4 More than fifty per cent water holding capacity was noticed in 94 per cent samples, out of one hundred manures analysed

5.2 Categorization of manures on the basis of chemical properties

5.2.1 Total nitrogen content of all manures ranged from 0.56 to 5.28, 0.78 to 4.70 and 0.89 to 4.59 per cent, when nitrogen content in manures was determined by colorimetric method, Kjeldahl's method and modified Kjeldahl's method, respectively. Fairly high quantity of nitrogen in the range of 0.8 to 2.0 per cent was recorded in 55 per cent, 84 per cent and 64 per cent manure samples, respectively with the said methods.

5.2.2 The phosphorus content in manures determined by diacid digestion method, triacid digestion method and dry ashing method, ranged from 0.27 to 18.32, 0.73 to 19.14 and 0.22 to 14.48 per cent, respectively. More than one per cent phosphorus content was recorded in 74 per cent, 85 per cent and 57 per cent manure samples determined by diacid digestion, triacid digestion and dry ashing methods, respectively.

5.2.3 The potassium content in manures determined by diacid digestion, triacid digestion and dry ashing methods varied from 0.16 to 8.28, 0.16 to 8.52 and 0.12 to 8.52 per cent, respectively with 23 per cent, 28 per cent and 18 per cent samples containing potassium in the range of 1.0 to 2.0 per cent, respectively which is categorized under optimum group.

5.2.4. The total organic carbon content of one hundred manure samples was in the range of 4.34 to 55.97 per cent when determined by dry combustion method and in the range of 4.95 to 43.65 per cent when determined by wet digestion method. More than 14 per cent organic carbon content was noticed in 94 per cent manure samples under dry combustion method while it was in 84 per cent manure samples when determined by wet digestion method.

5.2.5 The organic matter content was in the range of 7.5 to 96.5 and 8.51 to 75.07 per cent when determined by dry combustion method and wet digestion method, respectively.

5.2.6 The ash content of one hundred manure samples was in the range of 3.5 to 92.5 per cent when determined by dry combustion method and in the range of 23.89 to 91.49 per cent, when determined by wet digestion method. The optimum ash content in the range of 50 to 60 per cent was noted in 22 per cent manure samples under dry combustion method while it was in 14 per cent manure samples when determined by wet digestion method.

5.2.7 Among 100 manure samples, 24 per cent, 39 per cent and 29 per cent manures had C : N ratio in the range of 12 to 17 when organic carbon was determined by wet digestion method and nitrogen by colorimetric method, Kjeldahl's and modified Kjeldahl's method, respectively.

5.2.8 Calcium and magnesium content of the manure samples in the range of 0.5 to 1.0 per cent was recorded in 24 per cent and 33 per cent manure samples, respectively. Similarly 25 per cent manure samples were found to possess total sulphur in the range of 0.5 to 1.0 per cent.

5.2.9 As regards to micronutrient content of one hundred manures, it is noted that 34 per cent manures had zinc in the range of 500 to 1000 mg kg^{-1}, while 93 and 96 per cent manure samples were found to possess less than 1000 mg kg^{-1} and 300 mg kg^{-1}

manganese and copper content, respectively. The total iron content in range of 1.0 to 2.0 g kg^{-1} was registered in 56 per cent manure samples. The boron content in the range of 25 to 50 mg kg^{-1} was recorded in 52 per cent manure samples.

5.2.10 Out of one hundred manure samples 30 per cent were found to possess water soluble carbohydrates in the range of 1.0 to 2.0 per cent, while 15 per cent manure had more than 2 per cent water soluble carbohydrates.

5.2.11 The cation exchange capacity in the range of 65 to 130 c mol (p^+) kg^{-1} was recorded in 92 per cent manure samples.

5.2.12 Fourty two per cent manure samples were found to be in the neutral pH range while fifty one per cent manures were acidic in reaction i.e. having pH in the range of 4.18 to 6.50.

5.2.13 Out of hundred manures, 97 per cent manures had electrical conductivity less than 4 dS m^{-1} indicating their salt content below tolerable limit.

5.3 Categorization of manures on the basis of biological property

Eighty three per cent manure samples had less than 15 mg CO_2-C/100g TOC content while remaining 17 per cent were found to have more than 15 mg CO_2-C/100 g TOC.

5.4 Correlation between organic matter content and other chemical properties of manures

5.4.1 Nitrogen content of manures determined by three methods such as colorimetric, Kjeldahl's and modified Kjeldahl's method had significant positive correlation with their organic matter content determined by dry combustion as well as wet digestion methods.

5.4.2 There was no significant correlation of organic matter content of manures with their total phosphorus, potassium, calcium, magnesium, sulphur, zinc, manganese, copper, iron and boron content.

5.4.3 A significant positive correlation of organic matter content of organic manures was noted with the cation exchange capacity and water soluble carbohydrates content of the manure samples when organic matter content was determined by dry combustion as well as wet digestion methods.

5.5 Relationship between major nutrients and organic carbon content determined by different methods

The regression equations developed for determining the relationship between major nutrients such as nitrogen, phosphorus, potassium and organic carbon revealed that there was significantly positive relationship between total nitrogen content determined by all the three methods with that of total organic carbon determined by two methods.

5.6 Comparison among the methods of determination of organic carbon and major nutrients

5.6.1 Total nitrogen content of manure samples determined by colorimetric method had close agreement with modified Kjeldahl's method as noted from non-significant paired 't' test value.

5.6.2 Similarly the diacid digestion and triacid digestion methods used for determination of total phosphorus content of manures had close agreement with each other as paired 't' test value is observed to be non-significant.

CONCLUSION

Most of the manures produced and being sold in Konkan region are observed to be stable from the point of compost maturity. Most of them had higher water holding capacity. Many of these manures are fairly rich in macro as well as micro nutrient contents. They are safe for field application as their electrical conductivity values are observed to be below tolerable limits.

The quality of manures depends upon the characteristics of decomposable materials and the process adopted for compost making. It is, therefore, suggested to follow appropriate steps while preparing compost from organic residues of plant and animal origins.

Since, the equal values of organic carbon, total nitrogen, phosphorus and potassium were not obtained with different analytical methods, it is suggested to develop different categories for different methods used for analysis.

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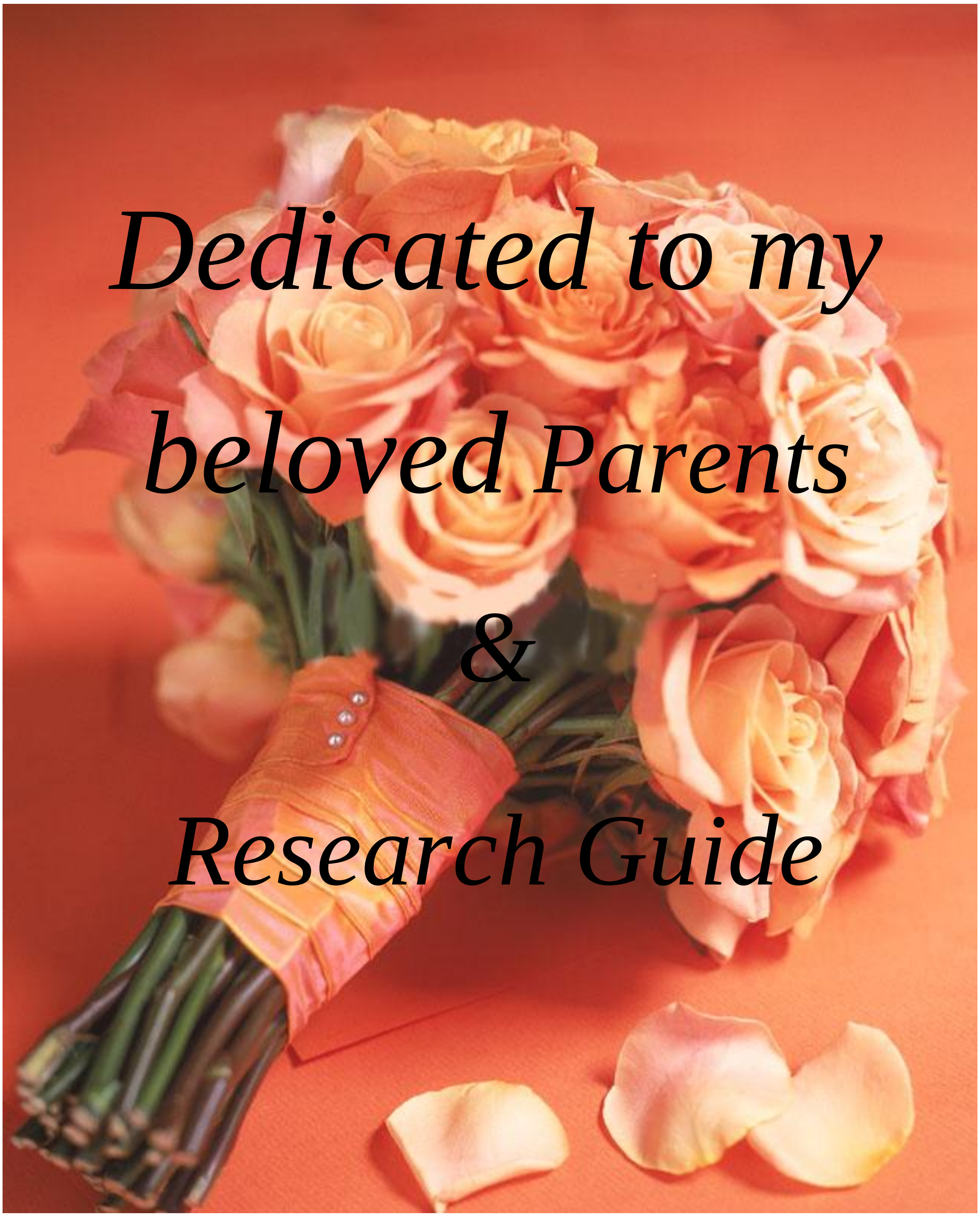
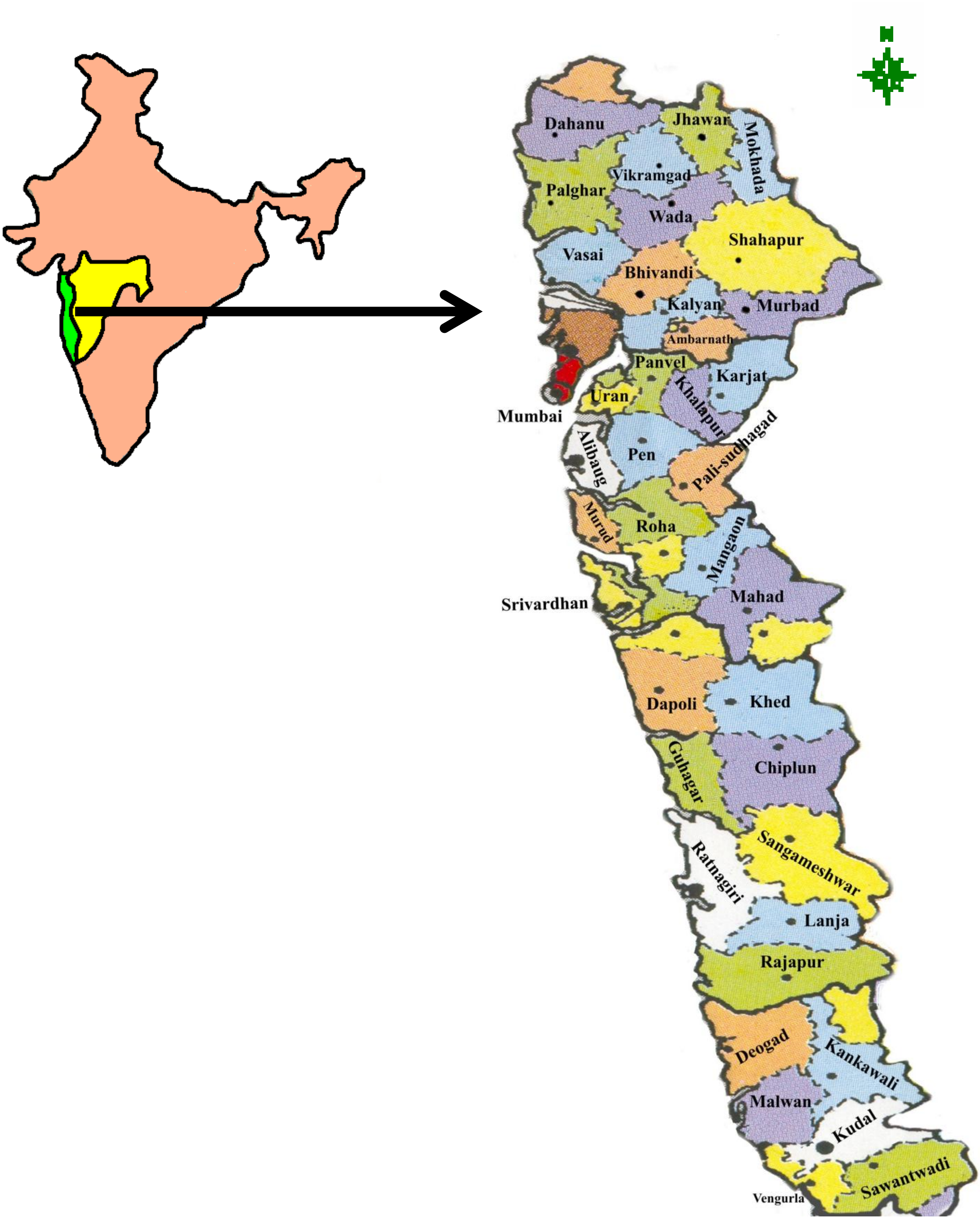

Dedicated to my
beloved Parents
&
Research Guide

Fig. 3.1 Locations showing sites of collection of manure samples



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