

PREPARATION OF ORGANIC FERTILIZERS USING FOR CROP CULTIVATION

Aung Aung¹, Aye Aye Lwin², Thi Thi Aye³

Abstract

Organic fertilizers prepared from organic wastes can reduce cost in agricultural sectors and increase soil fertility. This research work concerns with studies for the preparation of organic fertilizers from rice straw, chicken manure and neem leaves, its application for crop cultivation and studies the effect of fertilizer on soil fertility. Rice straw from farmer field, neem leaves from Kun Chan Village in Taungdwingyi Township and chicken manure from Pyay Township were collected. The organic fertilizers were prepared by five different weight ratios (100kg :100kg :100kg), (rice straw, chicken manure, neem leaves) for OF-1(organic fertilizer 1), (200kg : 75kg : 25kg) for OF-2 , (200kg : 25kg : 75kg) for OF-3, (250kg : 30kg : 20kg) for OF-4, and (250kg : 20kg : 30kg) for OF-5. These different fertilizers were prepared by compost heap method. The physicochemical properties and, content of macronutrients and micronutrients were determined by EDXRF, AAS and other modern and conventional methods. It was found that OF-1 contains (2.17%N, 1.523%P₂O₅, 1.663%K₂O), OF-2 (1.70%N, 0.825%P₂O₅, 1.478%K₂O), OF-3 (1.729%N, 0.689%P₂O₅, 1.372%K₂O), OF-4 (1.563%N, 0.913%P₂O₅, 1.346%K₂O), OF-5 (1.241% N, 0.849%P₂O₅, 1.056%K₂O).From EDXRF result, the amount of Ca, K and Si are higher than other elements in five different ratios of organic fertilizers. It was found that, these organic fertilizers contain Ca%, Mg%, Zn%, Cu%, Mn% and Fe% by AAS measurement. According to these results, it was found that OF-1was rich in macronutrients. So OF-1 was chosen to use for crop cultivation and improving the soil fertility. The rice straw based organic fertilizers should be used as effective fertilizer for agricultural section and for reducing the use of chemical fertilizer which can damage the soil fertility.

Keywords: rice straw, chicken manure, neem leaves, organic fertilizers, physicochemical properties, macronutrients, micronutrients

¹ 2 PhD, Candidate, Assistant Lecturer, Department of Chemistry, Pyay University

² Associate professor, Department of Chemistry, Yenangyang Degree College

³ Associate professor, Department of Chemistry, University of Yangon

Introduction

Fertilizer is any organic or inorganic materials of natural or synthetic origin that is added to a soil to supply one or more plants nutrients essential to the growth of plants (Mi Mi Hlaing, 2011). Fertilizer is substance containing some or all of a range of about 20 chemical elements necessary for healthy plant growth, used to compensate for the deficiencies of poor or depleted soil (Aduand Zubairu, 2013). Fertilizers are broadly divided into organic fertilizers (composed of organic matter of plant or animal) or inorganic fertilizers (composed of synthetic chemical and minerals).

Our environment is a houseful of various nutrients which plants require for normal growth and development. Organic wastes or organic fertilizers, many of which are rich in nutrients and organic matter, can be used to replenish soils. Organic fertilizers come from plant and animal sources. These fertilizers have a slower release of nutrients as they need to be decomposed by soil microorganisms. They are easy on plant roots but take longer to become effective. Organic fertilizers are naturally occurring fertilizers (e.g, compost, manure). Organic fertilizers essential for maintaining the soil health (Tha zin Nyo, 2009). Cow dung and chicken manure are excellent source of soil organic matter as well as phosphorus and potassium. Microorganisms in the soil decompose organic material making its elements available for use by plants (Theingi Shwe, 2007).

Rice is one of the major crops grown throughout the world. Rice straw are an agricultural residue abundantly available in rice producing countries. Rice straw can be converted to fertilizer throughout the process of composting. Components of rice straw are mainly cellulose and hemicellulose encrusted by lignin, in addition to a small amount of protein, which makes it high in C/N ratio. Rice straw compost will be good carrier materials for the inoculants. The biodegradation of such materials to simple sugars provide energy sources for heterotrophic microorganisms such as P- solubilizing and nitrogen fixing bacteria. Rice straw is rich in nitrogen, potassium and silicon (Thida Min, 2005).

Chicken manure provides nitrogen, phosphorus and potassium for plants. Chicken manure is a good source of organic material for composting. Chicken manure is very high in nitrogen and a very desirable fertilizer for

gardens and farms. Chicken manure may be applied to the soil fresh and growth of plants. Chicken manure is an important soil conditioner, and it increases the soil moisture, holding and nutrient holding capacities(Sunarlim, Sahwan and Schuchardt, 1999).

Neem leaves are cheap and useful fertilizer. Neem leaves improve efficiency of fertilizer utilization in crop production by gradual release of nitrogen to crops(Sumaila, 2012).Neem leaves have an adequate quantity of NPK in organic form for plant growth. Neem leaves are 100 % natural fertilizer (Emmanuel, 2013). Rice straw, chicken manure and neem leaves enhance for application to crops and soil as a fertilizing resource, were used as material for biodegradation.

Materials and Methods

Collection of Rice Straw, Chicken Manure, Neem Leaves

The rice straw sample and neem leaves sample were collected from Kun Chan Village in Taungdwingyi Township. The chicken manure sample was collected from Pyay Township. These samples were dried in air, ground and sieved into 80 mesh size and stored in air tight plastic bags.

Preparation of Organic Fertilizers

Five piles were prepared by plastic sheets and the size of each pile was 1.5 m wide, 1.5 m long and 1.5 m high. The prepared organic fertilizers were made by five different ratios. The different types of organic fertilizers (rice straw, chicken manure, neem leaves) were OF-1 (100kg: 100kg: 100kg), OF-2 (200kg: 75kg: 25kg), OF-3 (200kg: 25kg:75kg), OF-4(250kg: 30kg :20kg), OF-5 (250kg : 20kg : 30kg). Organic fertilizers were prepared by compost heap layer method. Firstly, dry plant materials (strong rice straw) were loosely spread on the bottom of the piles which were used for the foundation layers. The compost heap was made by the three basic layers (first layer, second layer, third layer). First layer was made by rice straw materials. This layer was 25cm thick of the sides. Then, water was sprinkled over this layer. This layer should be moist but not soaked. The second layer was made by neem leaves (green) plant materials. This layer was added on the first layer. The second

layer was 25 cm thick. The third layer was made by chicken manure with 10 cm thick. These three layers were added to the pile in the sequence, first layer, second layer, third layer, until the piles were full of compost making materials. The top of piles were covered with plastic sheets.

After one month, white fungi were appeared on the surface. And then, the piles were turned over. After 3 months, compost making material became black colour and odourless smell. And then, organic fertilizers were obtained.

Study on Physicochemical Properties of Organic Fertilizers

Chemical analyses such as pH, moisture, Organic matter, Total N, P₂O₅, K₂O, Total Ca and Mg, S, Mn, Fe, Zn, Cu and relative composition of elements were carried out on the collected samples and organic fertilizers. The pH was determined by pH meter. Moisture was determined by oven dry method and organic matter was determined by Walkey and Black' titration method. Total N, P₂O₅ and K₂O were determined by Kjeldahl digestion method, visible spectrophotometric method and atomic absorption spectrometric method respectively. Ca, Mg, Mn, Fe, Zn and Cu were also determined by atomic absorption spectrometric method. Total S was determined by turbidity method. Relative composition of elements was determined by energy dispersive -X- ray fluorescence spectrometric method.

Results and Discussion

Total N, P₂O₅ and K₂O Contents of Rice Straw, Neem Leaves and Chicken Manure

Table 1 shows the composition of nitrogen content in rice straw, chicken manure and neem leaves samples. In the present research, total N of fertilizers contains 0.799%, 0.817% and 3.118 % for rice straw, chicken manure and neem leaves samples. As mentioned above, neem leaves sample was observed to show higher amounts of nitrogen.

Table 1 shows the composition of P₂O₅ content in rice straw, chicken manure and neem leaves samples. In this experiment, the amount of P₂O₅ in rice straw, chicken manure and neem leaves samples were found to be 0.107%,

2.052% and 0.379%. It can be seen that chicken manure sample was higher in amount of P_2O_5 than rice straw and neem leaves samples. Table 1 shows the composition of K_2O content in three samples. In this work, the amount of potassium in neem leaves sample was higher than rice straw and chicken manure samples.

Table 1: Total N, P_2O_5 and K_2O Contents of Rice Straw, Chicken Manure and Neem Leaves samples

No.	Sample	Total N (%)	P_2O_5 (%)	K_2O (%)
1	Rice straw	0.799	0.107	0.264
2	Chicken manure	0.817	2.052	0.475
3	Neem leaves	3.118	0.379	1.162

Temperature of Compost During Composting Process

Table 2 shows temperature of prepared compost (OF-1, OF-2 OF-3, OF-4 and OF-5) during composting process. Decomposition of organic wastes produces heat. Compost needs to be kept hot and moist because the plant and animals materials can be broken down quickly and thoroughly. The temperature was measured at (10 am) daily. On one day, the temperature was nearly 32°C and the temperature gradually increased ($\sim 50^\circ\text{C}$) within at 29 days. And then, the temperature slightly decreased. After 31 days, the temperature gradually increased and reached its optimum ($\sim 54^\circ\text{C}$) within 55 to 60 days. The temperature gradually dropped to reached 26°C after 84 days. The compost process was finished when the colour of material turned dark. When the temperature reached 26°C , the dark colour was found. Therefore the compost process was taken between 26°C to 54°C .

Table 2: Temperature of Compost during Composting Process

Day	Temperature °C					Day	Temperature °C					Day	Temperature °C				
	OF-1	OF-2	OF-3	OF-4	OF-5		OF-1	OF-2	OF-3	OF-4	OF-5		OF-1	OF-2	OF-3	OF-4	OF-5
1	32	32	31	31	32	31	43	42	43	43	42	61	50	51	54	52	52
2	32	33	31	32	32	32	44	42	43	43	42	62	50	51	50	52	50
3	32	33	32	32	33	33	44	44	43	43	42	63	50	51	50	49	50
4	35	33	33	32	33	34	44	44	44	44	43	64	49	48	50	49	47
5	35	35	33	32	34	35	44	44	44	44	43	65	47	48	50	49	47
6	35	35	33	35	35	36	44	44	44	44	43	66	47	44	50	48	47
7	35	36	34	35	36	37	46	45	45	44	43	67	40	44	46	48	47
8	35	36	34	35	36	38	46	45	45	44	43	68	40	42	46	45	43
9	35	36	36	35	36	39	46	45	47	44	45	69	40	42	46	45	43
10	37	37	36	36	36	40	46	45	47	46	45	70	39	40	41	45	43
11	37	37	36	38	36	41	46	46	47	46	45	71	39	40	41	39	41
12	37	37	36	38	37	42	46	46	47	46	45	72	39	40	41	39	41
13	37	37	36	38	37	43	46	47	47	48	45	73	35	34	33	33	36
14	37	37	36	38	38	44	46	47	47	48	46	74	35	34	33	33	36
15	37	38	37	38	39	45	47	47	49	48	46	75	32	34	33	33	32
16	37	38	37	39	39	46	47	47	49	48	47	76	32	34	33	30	32
17	37	38	37	39	39	47	47	47	49	49	47	77	28	27	27	30	29
18	38	38	37	39	39	48	49	48	49	49	49	78	28	27	27	27	27
19	38	38	38	39	39	49	49	48	49	50	49	79	28	27	27	27	27
20	39	38	38	39	39	50	49	49	50	50	49	80	28	27	27	26	27
21	39	38	38	39	39	51	49	50	50	51	49	81	26	27	27	26	26
22	39	38	38	40	39	52	49	50	50	51	50	82	26	26	27	26	26
23	39	38	38	40	41	53	49	50	50	51	50	83	26	26	27	26	26
24	39	39	38	40	41	54	50	50	51	51	50	84	26	26	26	26	26
25	41	39	41	42	41	55	54	53	53	54	54	85	26	26	26	26	26
26	48	40	41	42	41	56	54	53	53	54	54	86	26	26	26	26	26
27	48	49	50	47	47	57	54	54	53	54	54	87	26	26	26	26	26
28	48	49	50	47	47	58	54	54	54	54	52	88	26	26	26	26	26
29	43	40	50	42	47	59	53	54	54	54	52	89	26	26	26	26	26
30	43	42	43	42	41	60	53	51	54	52	52	90	26	26	26	26	26

C/N Ratios of Organic Fertilizers

The C/N ratios in five different ratios of organic fertilizers are shown in Table 3. The C/N ratio of OF-3 was higher than other organic fertilizers. OF-2 and OF-4 were nearly the same amount of C/N ratio. The C/N ratio of (~ 10 to 15) is suitable for crop cultivation and soil fertility.

Table 3: C/N Ratio of Organic Fertilizers

Fertilizers	Organic matter (%)	Organic carbon (%)	Total N(%)	C/N ratio
OF-1	35.629	21.246	2.17	9.523
OF-2	36.766	21.325	1.70	12.543
OF-3	40.09	23.254	1.729	13.448
OF-4	32.859	19.059	1.563	12.19
OF-5	28.19	16.241	1.241	13.175

OF-1= rice straw+chicken manure+ neem leaves (100kg:100kg:100kg)

OF-2= rice straw+ chicken manure+ neem leaves (200kg:75kg:25kg)

OF-3= rice straw+ chicken manure+ neem leaves (200kg:25kg:75kg)

OF-4= rice straw+ chicken manure+ neem leaves (250kg:30kg:20kg)

OF-5= rice straw+ chicken manure+ neem leaves (250kg:20kg:30kg)

pH and Moisture Contents of Organic Fertilizers

Table 4 shows contents of pH and moisture of organic fertilizers. The pH values were slightly acidic as well as alkaline (pH 6.42 to 7.41). The (pH 5.8 to 7.5) are suitable for the plant growth. The moisture contents of OF-5 was higher than other organic fertilizers.

Table 4: pH and Moisture Contents of Organic Fertilizers

Fertilizers	pH	Moisture (%)
OF-1	6.42	6.539
OF-2	6.92	11.573
OF-3	7.41	6.940
OF-4	7.15	8.228
OF-5	7.22	12.648

Relative Abundance of Element in Organic Fertilizers by EDXRF

The presence of silicon, calcium, potassium, iron, sulphur, phosphorous, titanium, manganese, zinc, strontium, copper, chromium, bromine, rubidium, zirconium, vanadium, aluminum and palladium are shown in Figures 1,2,3,4,5 and Table 5. Each spectrum indicated that the relevant elements are shift present in organic fertilizers. The amount of silicon, calcium and potassium were higher than other elements in these organic fertilizers.

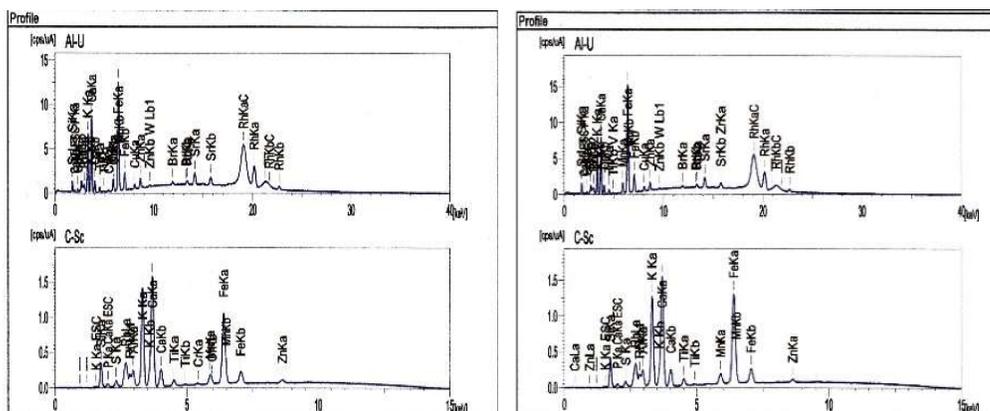


Figure 1: EDXRF Spectrum of OF-1 **Figure 2:** EDXRF Spectrum of OF-2

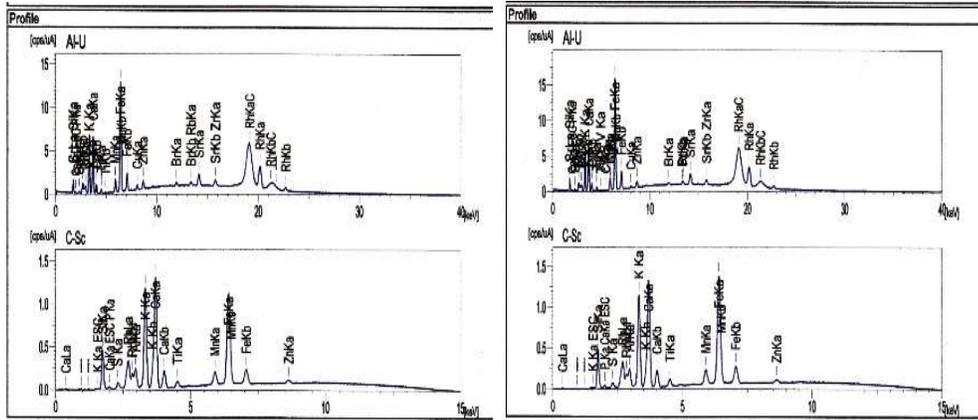


Figure 3: EDXRF Spectrum of OF-3 Figure 4: EDXRF Spectrum of OF-4

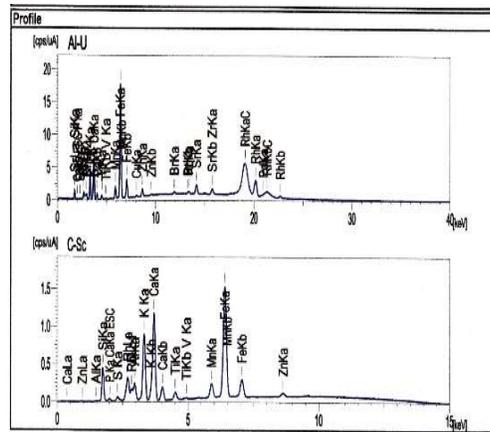


Figure 5: EDXRF Spectrum of OF-5

Table 5: Relative Abundance of Elements in Organic Fertilizers by EDXRF

No.	Elements	OF-1 (%)	OF-2 (%)	OF-3 (%)	OF-4 (%)	OF-5 (%)
1	Si	30.304	36.476	41.408	41.408	44.252
2	Ca	29.117	26.557	23.293	22.665	19.139
3	K	23.994	20.559	20.912	19.688	15.724
4	Fe	7.986	8.785	7.455	8.805	9.394
5	S	2.476	2.072	2.291	1.946	1.803
6	P	2.378	2.056	1.489	1.43	1.729
7	Ti	1.312	1.224	0.965	1.125	1.215
8	Mn	1.145	1.068	1.16	1.253	1.341
9	Zn	0.41	0.379	0.327	0.324	0.376
10	Sr	0.296	0.279	0.257	0.29	0.259
11	Cu	0.203	0.235	0.177	0.093	0.075
12	Cr	0.193	-	-	0.088	-
13	Br	0.096	0.075	0.092	0.083	0.076
14	Rb	0.08	0.08	0.075	0.081	0.066
15	Zr	-	0.104	0.098	0.095	0.121
16	V	-	0.052	-	0.043	0.049
17	Al	-	-	-	-	3.96
18	Pd	-	-	-	-	0.419

Macronutrients and Micronutrients in Prepared Organic Fertilizers

Table6 shows the macronutrients and micronutrients in prepared organic fertilizers. In macronutrients, the total N, P₂O₅, K₂O and S contents of OF-1 were higher than those of other organic fertilizers. The Ca content of OF-3 and Mg content OF-4 were higher than those of other organic fertilizers. In micronutrients, Fe content of OF-1 was higher than those of other organic fertilizers. Mn and Zn contents of OF-5 were higher than those of other organic fertilizers. Cu content of OF-2 was higher than those of other organic fertilizers.

Table 6: Macronutrients and Micronutrients in Prepared Organic Fertilizers

Macronutrients	Organic Fertilizers				
	OF-1	OF-2	OF-3	OF-4	OF-5
N(%)	2.170	1.700	1.729	1.563	1.241
P ₂ O ₅ (%)	1.523	0.825	0.689	0.913	0.849
K ₂ O(%)	1.663	1.478	1.372	1.346	1.056
Ca(%)	1.695	2.202	5.100	1.312	3.359
Mg(%)	0.122	0.080	0.038	0.367	0.068
S(%)	0.175	0.162	0.162	0.171	0.166
Micronutrients					
Fe (ppm)	1.203	0.019	0.810	0.562	1.07
Mn(ppm)	0.422	1.102	0.754	0.183	1.201
Zn(ppm)	3.468	3.455	3.752	3.035	5.543
Cu(ppm)	0.280	0.304	0.247	0.138	0.181

Conclusion

In the present work, the selected agricultural wastes (rice straw, chicken manure, neem leaves) were recycled to use as organic fertilizers. During composting process, temperature of prepared organic fertilizers (OF-1, OF-2, OF-3, OF-4, OF-5) ranged from 26°C to 54°C. The moisture content, the pH values, the total organic matter, the total organic carbon and the C/N ratio ranged from 6.539 to 12.648, 6.42 to 7.41, 28.19 to 40.09, 16.241 to 23.254, and 9.523 to 13.448 respectively. According to EDXRF results, the amount of Ca, K and Si are higher than other elements in organic fertilizers. Micronutrients Fe, Mn, Zn and Cu contained in all prepared organic fertilizers. Macronutrients N, P₂O₅, K₂O, Mg and S of OF-1 are higher than OF-2, OF-3, OF-4, OF-5. Primary macronutrients are N, P₂O₅ and K₂O.

Therefore, the prepared organic fertilizers should be used in cultivation of crops and improving the soil fertility.

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