Production of Bio Fertilizer From Rice Waste, Cow Dung and Timber Sawdust (Daniela Oliveira)

Oladejo, Oladipupo.S and Fasan Ayorinde.B

Abstract- Organic residues-wastes from human, animal, agricultural and industrial establishments, posing serious environmental and health problems can be managed besides storage, through production of compost. Raw organic materials such as rice waste, cow dung, and iya timber sawdust that enhance suitability for application to the soil as a fertilizing resource, were used as material for biodegradation.

1kg of cooked rice waste and cow dung each, with 3kg of sawdust were placed in container to form sample A, B, and C respectively. Rice waste was mixed with sawdust to form sample D in ratio1:3; sample E (cow dung and sawdust) of ratio 1:3 and sample F (rice waste, cow dung and sawdust) of ratio 1:1:3 respectively. All samples were grinded to increase the surface area and sieved through sieve No 20 (1mm aperture). Each sample was agitated with 5litres of distilled water inside container as a composter. The biodegradation was aerobic for 28days.

The microbial population of samples A-F were, respectively, 0mpn/gr, 80,000mpn/gr, 16,000mpn/gr, 55,000mpn/gr, and 51,000mpn/gr. Samples C, D, E, and F had moisture content of 74.94%, 75.44%, 66.67% and 69.48% at day 28 hence, while samples A and B maintained moisture content of 93.42% and 86.92% at day 28. Values of Nitrogen N, Phosphorous P, and Potasium K, in composted Samples D, E, and F were: N (19340mg/L, 19670mg/L, 19480mg/L) P (6180mg/L, 6590mg/L, 6630mg/L) and K (1403.2mg/L, 1329.6mg/L, and 1364.4mg/L). These were lesser than that of NPK fertilizer values of 10,000mg/L, 20,000mg/L and 10,000mg/L respectively, making the composted organic wastes (bio fertilizer) produced to be environmentally friendly.

This research established the possibility of recycling waste generated from leftover of cooked rice from different eateries and household, cow dung from cattle farms, and sawdust from sawmills.

Keywords: *Compost, rice waste, cow dung, sawdust.*

I. Introduction

Composting is generally defined as the biological oxidative decomposition of organic constituents in wastes under controlled conditions which allow development of aerobic micro- organisms that convert biodegradable organic matter into a final product sufficiently stable for storage and application without adverse environmental effects [1], [2]. The main products of aerobic composting are CO_2, H_2O, mineral ions and humus [14]. Also the process destroys pathogens, converts nitrogen from unstable ammonia to stable organic forms and reduces the volume of waste [7], [9], [12], [14]

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One of the major reasons of carrying out the experiment is that there is high rate of food waste from eateries and houses (rice waste), cow dung from cattle farm, and sawdust at various sawmill that have become nuisance to the environment [4], [5], [10], [13]. One of the ways of getting rid of these is to convert them to a useful material that can be of help to the plant. Also, bio fertilizer improves the quality of soil for more productivity; because they contain natural components which improve plant growth and do not cause any damage to plant. In case of chemical fertilizers the soil loses its natural balance and that in turn leaves a harmful effect on the environment.

Moreover, bio fertilizers contain microorganisms that help plants to grow by increasing the quantity of nutrients. Since these fertilizers contain living microorganisms, it increases or promotes the supply of important nutrients crucial for the overall productivity of the soil. An increasing number of farmers and agriculturists are turning to the use of bio fertilizers as these are gentler on the soil as against chemical fertilizers.

Another benefit of carrying out this research work is that bio fertilizers have the ability to symbiotically relate to the roots of plants. These living microorganisms help to transform complicated organic material into basic compound, helping the plant to grow and nurture in a natural way [8] .The effects of bio fertilizers on crops and soil can be felt for a long time. The use of such fertilizers enables the soil to remain fertile and ready for increase in crop productivity.

Studies on environmental science have also indicated that bio fertilizers could help to reduce the negative impact of global warming. Bio fertilizers are gaining increasing importance of their sustainable and holistic approach to maintain the purity of the soil and enhance crop productivity.

II. Methodology

Prior to laboratory work, location, magnitude, type of food wastes and method of disposal were considered. Survey was carried out to determine method of disposing cow dung and sawdust at various cattle farm and sawmill respectively.

Leftover of cooked rice was collected from kitchens outside the campus. Also, fresh cow dung was collected from cattle farm around LAUTECH environment, Ogbomoso, Oyo state. The waste samples were stored in black sealed polythene bags to conserve the moisture.

Sawdust was collected from Anuoluwapo sawmill, Yoaco area Ogbomoso. The organic wastes were mixed as stated below. These were decomposed with the help of microorganisms for 28 days at 37^0C in composters. Microbial decomposition enhances the degradation of food wastes and cow dung, hence increases the total nitrogen and germination rate of plants and improves the quality of bio fertilizer.

Six samples of biodegradable organic matter were made, each sample having the same amounts of food waste, cow dung and sawdust as follows:

(a) Sample A: 1kg of food waste (rice waste) +5litres of distilled water.

(b) Sample B: 1kg of cow dung +5 litres of distilled water

(c) Sample C: 3kg of sawdust + 5 litres of distilled water

(d) Sample D: 1kg of food waste (cooked rice) + 3kg of sawdust + 5litres of portable water to achieve optimum moisture content

(e) Sample E: 1kg of cow dung + 3kg of sawdust + 5litres of portable water.

(f) Sample F: 1kg of food waste (the same mixture and ratios as sample 1) + 1kg of cow dung + 3kg of sawdust + 5litres of portable water.

Samples were grinded to increase the surface area and allow passing through 20-mesh Sieve (1mm diameter screen. Each sample was agitated with 5 liters of distilled water, and this took place inside waste bin as a composter. The decomposition was aerobic for 28 days and microorganisms which were present enhance the degradation of the total sample, hence increase the total nitrogen, and germination rate of plants and this improves the quality of bio fertilizer.

On weekly basis, sample fractions of organic matters were taken and physical, chemical, and biological properties were determined [3], [6]. During the composting process, temperature, electrical conductivity and total dissolved solid of organic matters were measured. The chemical properties of the compost were monitored, including Carbon to Nitrogen ratio. Total carbon content of samples was determined through combustion using an Oven at 750C for 2h. Total nitrogen analysis was performed by kjeldahl method. Samples were digested by 5ml of nitric acid (HNO_3) and 15ml of hydrochloric acid (HCl) to obtain the following heavy metals Zn, Mg, Fe, Cu and other trace elements which later analysed by spectrophotometer. Indicator and pathogenic microorganisms including coliforms, salmonellae were determined at the beginning and end of the composting process.

III. Results and Discussion

A. Results

Results of physical, chemical and microbiological parameters of raw materials for production of bio fertilizer are shown below:

TABLE 1

RESULTS OF TEMPERATURE (^{0}C) PARAMETERS OF RAW MATERIALS FOR THE PREPARATION OF BIO FERTILIZER

Days	A	B	C	D	E	F
1	32.70	31.20	32.20	32.70	33.40	37.00
7	28.60	30.00	29.70	29.90	29.00	30.00
14	31.50	30.70	31.10	30.09	31.70	31.50
21	30.40	29.10	30.40	30.20	30.40	30.20
28	32.20	31.00	31.80	32.70	33.10	33.00

A = rice waste, B = cow dung, C = sawdust, D = rice waste + sawdust, E = cow dung+ sawdust, F = rice waste+ cow dung+ sawdust

TABLE 2

RESULTS OF ELECTRICAL CONDUCTIVITY PARAMETERS OF RAW MATERIALS FOR THE PREPARATION OF BIO FERTILIZER

Days	A	B	C	D	E	F
1	29.60	15.20	15.00	12.30	6.500	11.20
7	30.70	36.00	1.600	13.50	7.200	14.40
14	41.70	16.60	2.400	14.70	7.000	19.70
21	34.50	22.70	2.900	12.90	7.400	17.40
28	38.80	13.00	2.300	15.40	9.500	23.30

TABLE 3

RESULTS OF pH PARAMETERS OF RAW MATERIALS FOR THE PREPARATION OF BIO FERTILIZER

Days	A	B	C	D	E	F
1	5.80	9.50	7.80	7.60	10.30	9.40
7	4.00	7.20	8.60	6.00	9.90	9.50
14	4.40	8.30	8.00	7.60	10.60	10.20
21	4.50	8.90	9.20	9.10	10.20	10.00
28	4.50	8.90	8.90	9.60	10.20	10.00

TABLE 4
RESULTS OF TOTAL ORGANIC CARBON OF RAW MATERIALS FOR THE PREPARATION OF BIO FERTILIZER

Days	A	B	C	D	E	F
1	8260	6780	82600	93600	106900	98700
7	9740	7250	97400	105400	125600	107500
14	11490	9180	115900	18800	138900	126600
21	11320	8290	102600	101300	115600	105400
28	11180	7680	93200	87900	07900	95200

TABLE 5
RESULTS OF TOTAL ORGANIC NITROGEN OF RAW MATERIALS FOR THE PREPARATION OF BIO FERTILIZER

Days	A	B	C	D	E	F
1	960	830	16250	17540	17670	18260
7	1120	970	16590	18250	18590	18790
14	1430	1040	17240	19340	19670	19480
21	1290	890	16780	17690	18130	17590
28	1210	780	16420	16580	17250	16860

TABLE 7
RESULTS OF PHOSPHOROUS OF RAW MATERIALS FOR THE PREPARATION OF BIO FERTILIZER

Days	A	B	C	D	E	F
1	470	330	3840	5420	5670	5580
7	550	450	4130	5790	6040	5920
14	370	580	5040	6180	6590	6630
21	280	410	4640	5490	5260	5180
28	220	300	4420	5210	5110	4970

TABLE 8
RESULTS OF POTASSIUM VALUES OF RAW MATERIALS FOR THE PREPARATION OF BIO FERTILIZER

Days	A	B	C	D	E	F
1	1128.4	1241.6	1167.3	1384.2	1298.2	1301.8
7	1136.5	1252.3	1171.5	1396.3	1311.2	1315.6
14	1154.2	1247.5	1174.8	1403.2	1329.6	1364.4
21	1119.7	1234.7	1162.3	1354.6	1251.3	1364.4
28	1108.2	1225.8	1154.2	1342.5	1237.5	1263.5

TABLE 9
RESULTS OF E.COLI (MPN/G) IN RAW MATERIALS FOR THE PREPARATION OF BIO FERTILIZER

Days	A	B	C	D	E	F
1	0.00	$8.0x10^5$	$5.4x10^5$	$7.8x10^5$	$4.8x10^5$	$4.6x10^5$
7	$8.0x10^4$	$3.8x10^4$	$5.6x10^5$	$5.8x10^5$	$6.4x10^5$	$1.3x10^5$
14	$1.6x10^4$	$3.65x10^5$	$7.5x10^5$	$8.0x10^5$	$2.25x10^5$	$3.5x10^5$
21	$5.5x10^4$	$3.35x10^5$	$7.0x10^5$	$1.25x10^6$	$2.05x10^5$	$8.3x10^5$
28	$5.1x10^4$	$1.3x10^5$	$4.4x10^5$	$3.25x10^5$	$4.3x10^5$	$3.4x10^5$

TABLE 10
RESULTS OF SALMONELLA (MPN/G) IN RAW MATERIALS FOR THE PREPARATION OF BIO FERTILIZER

Days	A	B	C	D	E	F
1	0.00	$1.16x10^6$	$1.04x10^6$	$4.4x10^5$	$5.4x10^5$	$6.6x10^5$
7	$1.0x10^4$	$6.5x10^5$	$2.4x10^5$	$2.75x10^5$	$2.75x10^5$	$3.55x10^5$
14	0.00	$4.65x10^5$	$2.15x10^5$	$1.7x10^5$	$2.45x10^5$	$3.35x10^5$
21	$5.5x10^4$	$3.35x10^5$	$1.1x10^5$	$1.55x10^6$	$1.75x10^5$	$3.15x10^5$
28	$8.5x10^4$	$1.3x10^5$	$1.3x10^5$	$4.5x10^5$	$1.15x10^5$	$2.15x10^5$

B. Discussion

1. Temperature

The results of Figure 1 indicated that temperature went through only one classic phase which was mesophilic phase for all the samples. During this phase, mesophilic microoganisms in the compost tend to decompose waste at temperature values between 29.70C to 370C. As a result of biodegradation of organic compounds, temperature of sample F having the maximum temperature decreased and later increased reached 33^0C on 28 day. The results showed that mesophilic microoganisms that operate at the range of (20-40^0C) decomposed organic matter at this temperature. The Psychrophilic and Thermophilic microorganisms that operate at temperature of (0-20^0C) and (40-80^0C) are referred to as non-decomposers during the period of composting for all samples.

2. Electrical Conductivity (soluble salt) (dS/m)

The result of Figure 2 showed that sample A (rice waste) has the highest electrical conductivity at day 14 which was 41.7dS/m due to salt that has dissolved in the waste. Sample B which was the cow dung has 36 dS/m at day 7 due to digestion of grasses that has taken place in the intestine of cow. Sample C (sawdust) has the lowest electrical conductivity of 23 at day 28. If only sample A or B are to be used as organic fertilizer, this can cause phytotoxin to plants.

Therefore, from the results obtained in the Table 2 above, it can be generally concluded that soluble salt in solid wastes could be controlled, when solid wastes were mixed together which give reduction in soluble salt as shown in sample E and F respectively.

3. pH Variation During Composting

In samples, A, B, D, and E, pH values exhibited a slight declined during the first 7 days and 14 days in sample C respectively. These were later inclined in the next 14 and 21 days. The pH initially decreased due to the degradation of the organic matter leading to the production of organic and inorganic acids. Further increasing of pH was caused by (a) decomposition of organic matter containing nitrogen (organic nitrogen mineralization), leading to formation of NH3 which reacts with water and forms NH4OH that neutralized the existent acids. (b) reaction of amino acids which was released from proteins forming ammonia.

In addition, from Figure 3, the pH values of cooked rice waste was low, and reduced from 5.80 to 4.50 which made it more acidic due to fermentation, leading to retarded decomposition efficiency. Therefore, macronutrients were less available in cooked rice waste. To improve the concentration of macronutrients in composts, additional organic matters (cow dung, sawdust) were added forming sample D and F. Micronutrients were less available in compost with high pH, hence; Cu, Fe, and Zn were less available in the compost compared to macronutrients such as TON, TOC, P, K, Mg since plants need them in small quantity.

pH of compost decreased in the beginning of composting process due to acid formation and then increased again along with microbial magnification reaction, which converts organic nitrogen into ammonia. The pH of sample A, B, D, and E declined in the first week and later inclined. Sawdust was used to balance this effects as showed in sample F. Alkalinity property of sawdust in sample C increased from 7.80 to 8.90. The alkalinity property of sample F was increased when all the waste were added and this made the pH of sample F to increase from 9.40 on day 1 to 10.20 on day 14 and later decreased to 10.0 on day 28.

4. Total Organic Carbon (TOC)

From the figure 4, sawdust has high total organic carbon and has caused increase in the nutrient when it was added to both food waste and cow dung. Also, from the result of Table 4, sample E (cow dung and sawdust) has the highest nutrient compare to other samples followed by sample F, D, and C respectively. These samples had the ability to affect plant growth as both source of energy and trigger for nutrients availability through mineralization.

Total Organic Carbon of samples E, F, D and C were the main source of energy and nutrients for soil microorganisms. An increase in compost organic microorganism and total carbon, leads to biological diversity in the compost, thus increasing biological control of plant diseases and pests. Sample A and B have little total organic carbon due to absence of sawdust. Hence, absence of sawdust as bulking agent constituted for reduction in nutrient and plant growth.

Also, from day zero, total organic carbon of compost increased till day 14 having the highest nutrient and later decreased down till day 28. This showed that compost has thebest carbon on day 14.

5. Total Organic Nitrogen (TON)

However, from Figure 5, total organic nitrogen of compost increased from day zero to day 14 and decreased till day 28. Hence, 2 weeks decomposition of organic matter can be added to soil having insufficient nitrogen to increase plant growth. Also, compost has the best nitrogen when cow dung was added to sawdust as showed in sample E. Hence, to obtain bio fertilizer that can help plants with rapid growth, increasing seed, food fruit production and improving the quality of leaves and forage crops, if cow dung was mixed with sawdust as shown in sample E. In addition, sample F could also be used so as to reduce the quantity of cooked rice waste in the environment.

6. Carbon-to-Nitrogen Ratio (C/N ratio)

Low amount of C/N ratio of samples (less than 20) may leads to underutilize of nitrogen and the excess may be lost to the atmosphere as ammonia or excess nitrous oxide. From Figure 6 shown below, the C/N ratio (proteins) are lesser than 20. To improve the C/N ratio of the composts, it is necessary to mix substantial amount of sawdust or other organic substances with high carbon and low amount of cow dung.

7. Phosphorus (P)

From the result of Figure 7 of chemical analysis of compost shown below, sample A and B showed low levels of nutrients indicated low amount of phosphorus in the original materials. Sample F had highest phosphorus due to large population of microbes that supplied phosphorus into the compost. Also, sample E had higher amount of phosphorus compare with sample D. Therefore, quantity of phosphorus in cow dung was higher than the one present in rice waste.

8. Potassium (K)

From Figure 8; amount of potassium in sample B was higher than that of sample A and sample C. Also sample D had highest potassium embedded in the compost followed by sample F and E. Hence, mixture of cow dung and sawdust made concentration of potassium to reduce when compared with that of rice waste and sawdust. At day 1, quantity of potassium in compost started rising till day 14 and later decreased till day 28. This showed that day 14 compost had the best amount of potassium embedded in it. However, since concentration of mineral nutrients determines the population of microbes, hence day 14 had the largest population of microbes.

IV. Conclusion And Recommendation

A. Conclusion

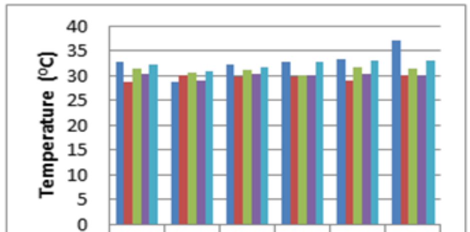
This research established the possibility of recycling waste generated from leftover of cooked rice from different eateries and household, cow dung from cattle farms, and iya timber sawdust (Daniela oliveira) from sawmills around Ladoke Akintola University of Technology (LAUTECH) environment

Ogbomoso, Oyo State. This was carried out in order to obtain bio fertilizer with a high nutritive value for plants and good amendments of soil physical, chemical, and microbiological properties.

B. Recommendation

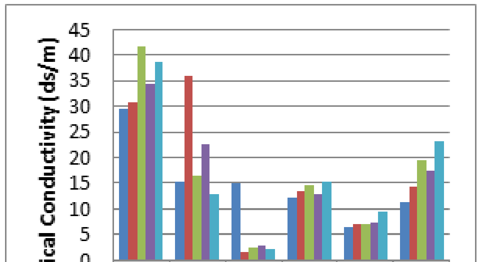
Compost can be biodegraded for 14 days to obtain optimum nutrient values before being used as bio fertilizer so that substantial mineral nutrient can be embedded within by microbes. The results of homogeneous samples A, B, and C did not produce substantial nutrient values like that of heterogeneous samples. Therefore sample A, B, and C should be mixed as ratio 1: 1: 3 so that biodegradation can be more effective for more nutrients to be generated.

Also, sample E (cow dung and sawdust) produced the best nutrient among the six samples but this can only be used to evacuate cow dung and sawdust generated as waste in the environment. To remove rice waste generated from different eateries, cow dung from cattle farm and sawdust from sawmill, sample F (rice waste, cow dung and sawdust) should be used as compost so that these nuisance can be removed.



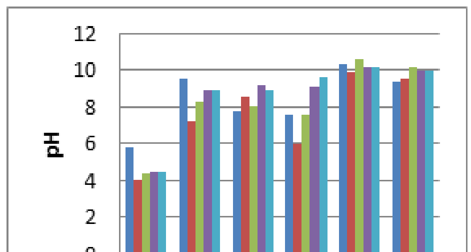
	A	B	C	D	E	F
1	32.7	28.6	32.2	32.7	33.4	37
7	28.6	30	29.7	29.9	29	30
14	31.5	30.7	31.1	30.1	31.7	31.5
21	30.4	29.1	30.4	30.2	30.4	30.2
28	32.2	31	31.8	32.7	33.1	33

Fig.1 Graph Of Temperature With Sample Batches



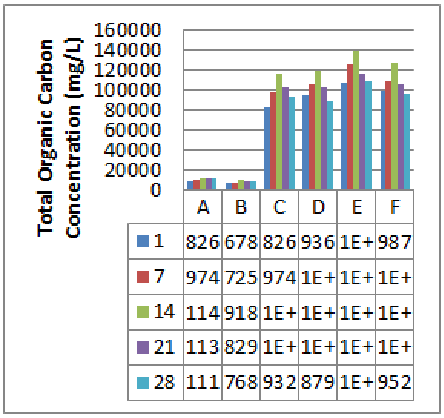
	A	B	C	D	E	F
1	29.6	15.2	15	12.3	6.5	11.2
7	30.7	36	1.6	13.5	7.2	14.4
14	41.7	16.6	2.4	14.7	7	19.7
21	34.5	22.7	2.9	12.9	7.4	17.4
28	38.8	13	2.3	15.4	9.5	23.3

Fig. 2 Graph of EC variations with sample batches



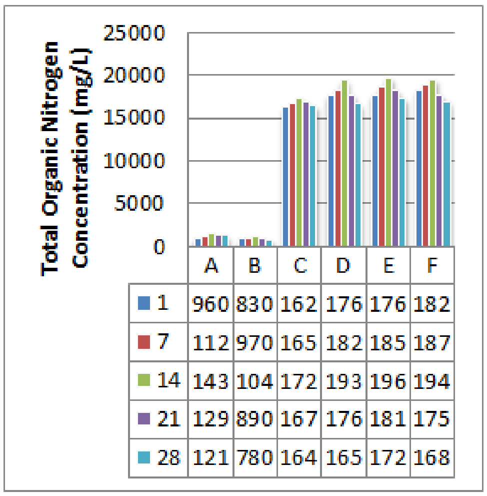
	A	B	C	D	E	F
1	5.8	9.5	7.8	7.6	10.3	9.4
7	4	7.2	8.6	6	9.9	9.5
14	4.4	8.3	8	7.6	10.6	10.2
21	4.5	8.9	9.2	9.1	10.2	10
28	4.5	8.9	8.9	9.6	10.2	10

Fig. 3 Graph of pH variations with sample batches



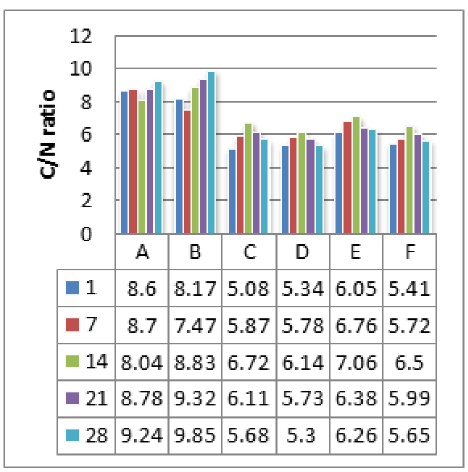
	A	B	C	D	E	F
1	826	678	826	936	1E+	987
7	974	725	974	1E+	1E+	1E+
14	114	918	1E+	1E+	1E+	1E+
21	113	829	1E+	1E+	1E+	1E+
28	111	768	932	879	1E+	952

Fig. 4 Graph Of TOC Variations With Sample Batches



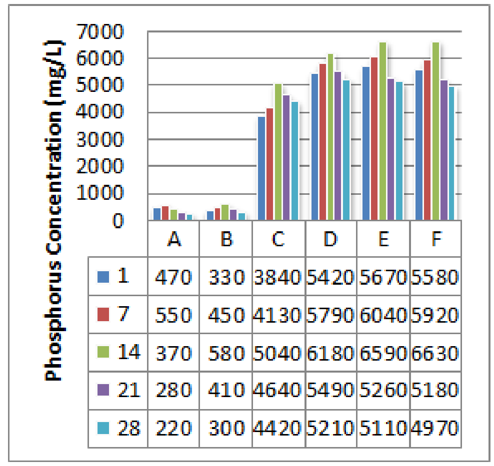
	A	B	C	D	E	F
1	960	830	162	176	176	182
7	112	970	165	182	185	187
14	143	104	172	193	196	194
21	129	890	167	176	181	175
28	121	780	164	165	172	168

Fig. 5 Graph Of Ton Variations With Sample Batches



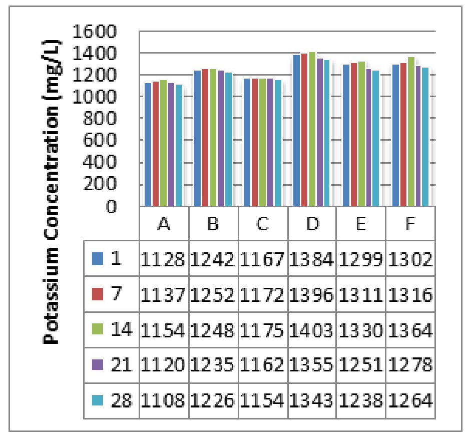
	A	B	C	D	E	F
1	8.6	8.17	5.08	5.34	6.05	5.41
7	8.7	7.47	5.87	5.78	6.76	5.72
14	8.04	8.83	6.72	6.14	7.06	6.5
21	8.78	9.32	6.11	5.73	6.38	5.99
28	9.24	9.85	5.68	5.3	6.26	5.65

Figure 6: Graph of C/N ratio with sample batches



	A	B	C	D	E	F
1	470	330	3840	5420	5670	5580
7	550	450	4130	5790	6040	5920
14	370	580	5040	6180	6590	6630
21	280	410	4640	5490	5260	5180
28	220	300	4420	5210	5110	4970

Figure 7: Graph Of Phosphorous With Sample Batches



	A	B	C	D	E	F
1	1128	1242	1167	1384	1299	1302
7	1137	1252	1172	1396	1311	1316
14	1154	1248	1175	1403	1330	1364
21	1120	1235	1162	1355	1251	1278
28	1108	1226	1154	1343	1238	1264

Figure 8: Graph Of Potassium With Sample Batches

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