Bioliquid Fertilizer Update

Tim Motis and Stacy Swartz

Figure 1. Bioliquid Fertilizer ingredient ratios (A) and the process of mixing (B). *Source:* Weslee Green (A) and Tim Motis (B)

Bioliquid fertilizer (BLF; also known as organic liquid fertilizer; Figure 1) is popular within ECHO's network and smallholder farmers around the world. ECHO West Africa introduces and instructs on how to prepare this amendment in *ECHO West Africa Note* 1 (Sié Kansié, 2017; http://edn.link/y3mrg2 (https://www.echocommunity.org/resources/57085b8e-dae3-4af7-af2f-d2c9426c1919)). This fertilizer is easier to make than other on-farm amendments such as compost and is easily adaptable. ECHO encourages using locally available manure and plant options. Recognizing a need for information on the nutrient composition of BLF, we (ECHO staff in Florida) created two formulations of BLF and sampled them over time for nutrient analysis. This article summarizes our findings, which shed light on when to apply BLF and nutrient amounts with and without manure.

Two options for generating on-farm bioliquid fertilizer

In March, 2022 we made two different batches of BLF. The first was based on the formula outlined by Sié Kansié (2017) using pigeon manure and the new growth (leaves and stems) of Mexican sunflower (*Tithonia diversifolia* (https://www.echocommunity.org/resources/4321d672-c8be-4511-b97a-fbc8646f9176)). The second, simplified formula contained tithonia and water only. Table 1 outlines formula ingredients and proportions.

Table 1. Formula ingredients used in making bioliquid fertilizers with rough guidelines refined to include more precise information in terms of weights of ingredients.

Formula	Ingredient	Rough guidelines	Measured weight
Manure-based	Pigeon manure	1/3 of volume	25.4 kg
	Plants (*Tithonia diversifolia*)	1/3 of volume	6.3 kg
	Wood ash	1 shovelful	0.8 kg
	Living soil	1 shovelful	2.7 kg
	Water	Remainder of volume	205 L
Tithonia only	Plants (*Tithonia diversifolia*)	Full container (unpacked)	0.345 kg
	Water	Remainder of volume	18 kg

* Tithonia plant material used for both formulas were primarily leaf tissue and some new shoot growth (Figure 2).

Figure 2. Tithonia plant material used in both formulations. *Source:* Quinn Beitzel

Results from nutrient analyses

Comparing nutrient content of manure and tithonia raw ingredients

Minerals analyzed, with their abbreviations, are listed in table 2. The local pigeon manure contained 4.0% total N (40 g N/kg manure), 2.7% total P (27 g P/kg manure), and 2.3% total K (23 g K/kg manure) based on dry weight. Our results are comparable to those reported by Chastain *et al.* (2001) for meat chicken manure (35.5-36 g N/kg manure, 34.5-36 g P/kg manure, and 23 g K/kg manure). Pigeon manure is nitrogen-rich and has a Carbon:Nitrogen (C:N) ratio of 8.24 on average (Villa-Serrano *et al.*, 2010). This low ratio is common among poultry manures because excrement contains both urine and solids. Cattle manure, in comparison, has a C:N ratio of about 20:1 1(Macias-Corral *et al.*, 2019).

1 A low C:N ratio is ideal when utilizing manures in thermophilic composting (composting with the aid of heat-loving bacteria) but these manures cannot be used directly on most plants because the high nitrogen content can be toxic

to plants. Poultry excrement is often captured using carbon-based litter such as sawdust or peanut shells to increase the C:N ratio. Livestock diet can impact C:N ratios of manures.

The young *Tithonia diversifolia* leaves used in both formulations contained 4.4% N, 0.7% P, and 2.5% K. Tithonia's high N content (Motis, 2017) is the primary reason for its use in making natural fertilizers such as compost and BLF. While the N and K content between the two main ingredients (pigeon manure and tithonia) are comparable, pigeon manure has greater P content. Livestock manures are common sources of P, a plant macronutrient needed for root development, photosynthesis, and cell division.

We thoroughly mixed each formula with the ingredients detailed in table 1 until uniform in appearance. The manure-based BLF was covered with a breathable cloth, allowing for aerobic decomposition. The manure-based BLF was mixed daily as outlined by Sié Kansié (2017). The tithonia-only formulation was covered with a plastic lid and was not mixed daily. Each week (including the week of initial mixing: week 0), we thoroughly mixed each formulation and obtained a sample. The tithonia-only liquid fertilizer was sampled for the first five weeks while the manure-based BLF was sampled for eleven weeks. At each sampling, a bottle of BLF was sent to a laboratory for mineral analysis.

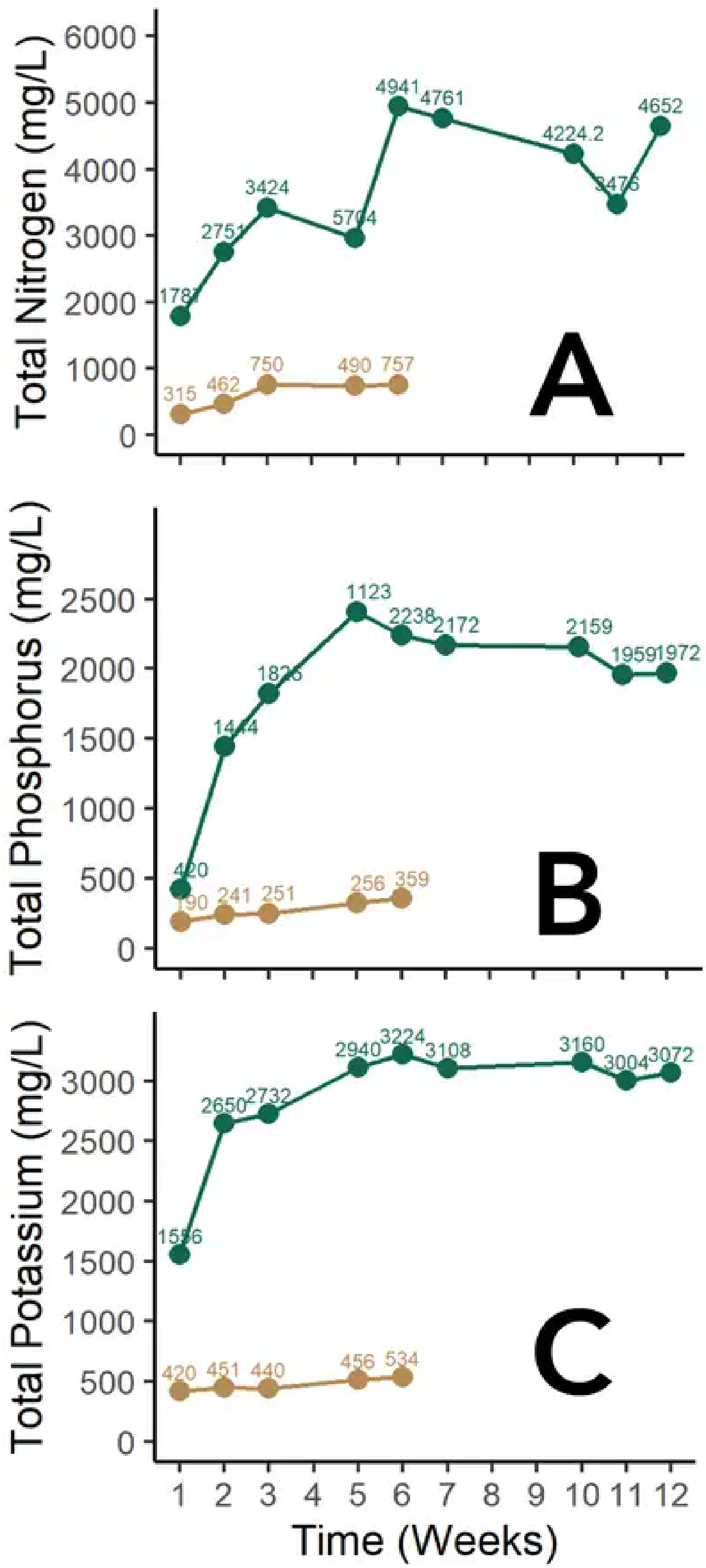
Total Nitrogen (mg/L)
6000
5000
4000
3000
2000
1000
0
1781
2751
3424
5704
4941
4761
4224.2
3476
4652
315
462
750
490
757
A
Total Phosphorus (mg/L)
2500
2000
1500
1000
500
0
420
1444
1826
1123
2238
2172
2159
1959
1972
190
241
251
256
359
B
Total Potassium (mg/L)
3000
2500
2000
1500
1000
500
0
1556
2650
2732
2940
3224
3108
3160
3004
3072
420
451
440
456
534
C
1 2 3 4 5 6 7 8 9 10 11 12
Time (Weeks)

Figure 3. Total N (A), P (B), and K (C) content of the manure-based (green) and tithonia-only (brown) BLF formulations over time.
Source: Stacy Swartz

Comparing formulations over time

Figure 3 and table 2 present macronutrient values in mg/L (the equivalent of parts per million, ppm). Nitrogen content of both mixtures increased for the first two weeks after mixing and was optimal at week three for the manure-based BLF (Figure 3A). Phosphorus content increased each week for the tithonia-only formulation but peaked for the manure-based BLF at week five (Figure 3B). Potassium content followed a similar trend as P, increasing slighting in the tithonia-only fertilizer over time and increasing rapidly in the manure-based BLF until week five (Figure 3C). Average pH for the manure-based BLF was 6.76. Micronutrient and sodium content values are detailed in table 2.

In summary, we saw that:

- Nitrogen levels peaked at two (tithonia) to three (manure-based) weeks after making the fertilizer.
- Most of the other nutrients reached their highest levels at week five.
- These trends indicate that the optimum time to apply BLF is earlier (2 to 3 weeks, depending on the formulation) for nitrogen than other nutrients. Factors such as temperature, thoroughness of mixing, and sample handling may have impacted nutrient content values over sampling weeks.

Table 2. Macronutrient, micronutrient, and sodium content of both BLF recipes over time.

		Macronutrients (mg/L)						Micronutrients (mg/L)						
Week	**Type**	**Total N**	**Total P**	**Total K**	**S**	**Ca**	**Mg**	**B**	**Zn**	**Mn**	**Fe**	**Cu**	**Al**	**Na**
0	Manure-based BLF	1787	420	1556	110	456	102	1.3	1.3	1.7	4.9	0.1	3.7	121
1	Manure-based BLF	2751	1444	2650	202	1658	281	1.8	5.4	8.4	20.1	0.8	11.3	179
2	Manure-based BLF	3424	1826	2732	234	2132	292	1.9	8.7	11.2	16.0	1.6	6.7	182
3	Manure-based BLF	5704	1123	2940	211	1329	282	2.0	4.3	6.3	17.4	0.9	9.6	190
5	Manure-based BLF	4941	2238	3224	551	5744	784	6.0	23.2	34.9	13.7	4.8	39.4	426
6	Manure-based BLF	4761	2172	3108	509	5702	774	5.8	23.6	33.3	25.0	4.9	41.4	405
9	Manure-based BLF	4224	2159	3160	522	5541	821	6.4	23.8	31.8	84.0	5.0	48.8	427
10	Manure-based BLF	3476	1959	3004	464	5080	803	5.8	23.0	27.6	76.0	4.6	43.1	404
11	Manure-based BLF	4652	1972	3072	452	5258	823	6.3	22.5	25.1	80.9	4.7	24.8	410
0	Tithonia-only	315	190	420	17	176	124	0.8	0.0	0.0	0.0	0.0	0.1	38
1	Tithonia-only	462	241	451	22	213	137	0.8	0.0	0.0	0.0	0.0	0.4	40

		Macronutrients (mg/L)						Micronutrients (mg/L)						
2	Tithonia-only	750	251	440	23	209	133	0.6	0.4	0.0	0.6	0.1	0.1	38
3	Tithonia-only	490	256	456	21	230	143	0.6	0.2	0.2	0.5	0.1	0.8	39
5	Tithonia-only	742	326	518	70	589	322	1.5	1.8	0.4	2.0	0.3	5.2	86
6	Tithonia-only	757	359	534	79	662	337	1.6	2.3	0.7	2.6	0.3	1.8	87
*Minerals analyzed were nitrogen (N), phosphorus (P), potassium (K), sulfur (S), calcium (Ca), magnesium (Mg), boron (B), zinc (Zn), manganese (Mn), iron (Fe), copper (Cu), aluminum (Al), and sodium (Na).														

Application recommendations

2A 1:15 dilution for example means that you would mix one part BLF with 14 parts water. "Part" could be any unit of measure (e.g. mL, gallon, used water bottle).

Sié Kansié (2017) recommends a dilution of 1:15 to 1:20 2applied near the base of plants 3once or twice a week. Avoid applying too strong of a solution which could be toxic to sensitive plants. To avoid salt buildup or salt-toxicity, use a hand-held TDS meter to confirm overall salt levels in the solution before application. Hoagland's solution used in hydroponic plant production is a potential benchmark to base dilutions rates on. Hoagland's solution has around 300 ppm N, so a 5000 ppm BLF formulation could be diluted 15 times to reach close to 300 ppm N. If you are using more plant material than manure, BLF N levels are unlikely to reach higher than 1000 ppm in which case a 1:3 BLF:water ratio is recommended. Even with manure included in the ingredients, nutrients in BLF are not highly concentrated, especially after dilution (e.g., a final concentration of 300 ppm N is only 0.03% N). ECHO uses BLF in combination with other nutrient sources such as compost or NPK fertilizer. Due to microbes and plant hormones that BLF contains, BLF can help plants use fertilizers more efficiently (Eudoxie and Martin, 2019).

3Liquid fertilizers are often applied to the leaves as a foliar spray. This is sometimes done with compost teas as well; however, there is a risk of contamination with human pathogens such as Escherichia coli and Salmonella. This is especially a concern with leafy greens. The risk can be reduced by applying BLF as a soil drench, and applying it well before the crop is to be harvested and consumed.

Another factor to consider when diluting is the stage of the crop. Young seedlings are more sensitive to leaf burn caused by high salts than more established plants and therefore require more dilution (to lower the amount of BLF in relation to water) early on. Plants entering reproductive stages (flowering and fruiting) require less macronutrients than they did during vegetative stages (leaves and stem growth). After flowering, you could decrease or halt application of the fertilizer entirely.

Network member Tim Tanner (founder of Kilimo Timilifu (https://kttz.co.tz/)) has also experimented with using tithonia-only fermented liquid in East Africa for the control of termites! Read more about his methods and experiences in the "Echoes from our Network" article of this issue of *EDN*.

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